Palaemonid Shrimps from the Amazon Basin, Brazil (Crustacea: Decapoda: Natantia)

BRIAN KENSLEY
and
ILSE WALKER

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ABSTRACT

Kensley, Brian, and Ilse Walker. Palaemonid Shrimps from the Amazon Basin, Brazil (Crustacea: Decapoda: Natantia). *Smithsonian Contributions to Zoology*, number 362, 28 pages, 24 figures, 3 tables, 1982.—The taxonomy of 13 species of palaemonid shrimps is dealt with, including descriptions of five new species: *Macrobrachium ferreirai*, *M. inpa*, *Pseudopalaemon chryseus*, *P. gouldingi*, and *P. nigramnis*. *Pseudopalaemon amazonensis*, previously known only from a brief summary description, is fully described and figured. A key to the five species of *Pseudopalaemon* is given. Some basic ecological and biological data of the species are included, which are related especially to the black and clear waters of the Rio Negro basin. The role of the shrimps in the submerged leaf litter habitat of the inundated forests is briefly discussed. Examination of stomach contents indicates the predatory scavenging habits of several of the shrimp species.

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Contents

Palaemonid Shrimps from the Amazon Basin, Brazil (Crustacea: Decapoda: Natantia)

Brian Kensley
and Ilse Walker

Introduction

During a study of the Rio Negro flood forest and streams by the second author, the submerged leaf litter habitat was found to be inhabited by several species of shrimps. As a preliminary to a comprehensive ecological survey, a report on the taxonomy of these shrimps was planned. During a visit to the Instituto Nacional de Pesquisas da Amazônia (INPA) laboratories at Manaus, however, the first author was asked to examine further collections made by ichthyologists Michael Goulding and Efrem Ferreira. It was decided to combine in a single report material from all three collections, and to include such biological and ecological information as was available for the black- and clear-water species.

In spite of numerous earlier reports on Amazonian shrimps (e.g., Calman, 1907; Sollaud, 1911; Gordon, 1935; Holthuis, 1951, 1952, 1966; Tiefenbacher, 1978) it is not surprising that undescribed forms should still be found, considering the area drained by the Amazon and its tributaries, and the multiplicity of microhabitats therein.

In the following systematic discussion, measurements are provided for only a few representative samples. In those samples containing several specimens the maximum and minimum sizes (lengths) are given in millimeters. For total lengths, measurements are given to the nearest millimeter. In the whole-animal figures, scales are in millimeters. As Holthuis (1951, 1952) dealt comprehensively with the American palaemonids known at that time, usually only post-1952 references are provided in the synonymies.

Holotypes and paratypes have been deposited in the invertebrate collection, Divisao de Entomologia, INPA, Manaus, Brazil, and where possible, further paratypes have been deposited in the National Museum of Natural History, Smithsonian Institution, under the catalog numbers of the United States National Museum. Specimens lacking either catalog numbers and/or collector data in the text are deposited in the invertebrate collection, INPA, Manaus, Brazil.

Abbreviations and Terms.—CL = carapace length (mm); INPA = Instituto Nacional de Pesquisas da Amazonia at Manaus, Brazil; RL = rostral length (mm); TL = total length (mm); USNM = United States National Museum collections in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; and ZSM = Zoologische Staatssammlung, Munich.

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ACKNOWLEDGMENTS.—Our thanks are extended to Michael Goulding and Efrem Ferreira, INPA, for making material available; to José Saiz of the Organization of American States, for facilitating the visit of the first author to Manaus; to Horton H. Hobbs, Jr., of the Smithsonian Institution for making specimens of *Euryrhynchus wrzesniowskii* available; and to Ludwig Tiefenbacher, ZSM, for the loan of *Euryrhynchus* material. We also thank J. Nunes Palheta and J. B. Santos da Silva, forest guides and "motoristas," for their assistance in the field, and Marilyn Schotte of the Department of Invertebrate Zoology, Smithsonian Institution, who assisted with the figures and stomach content dissections. We are grateful to Horton H. Hobbs, Jr., Fenner A. Chace, Jr., and Charles W. Hart, Jr., for reading the manuscript, and for their many useful comments and criticisms.

Genus *Euryrhynchus* Miers, 1877

Euryrhynchus amazoniensis Tiefenbacher

FIGURES 1, 2

Euryrhynchus amazoniensis Tiefenbacher, 1978:183, fig. 2a–b.
Euryrhynchus burchelli.—Holthuis, 1966:6.—Irmler, 1975:391 [in part].

TYPE-LOCALITY.—Amazônia, Brazil.

MATERIAL EXAMINED.—*Paratypes:* ZSM A332-5, Igapó Curitiau, Rio Negro, 6 Feb 1962, 2♂, 1♀, 6 juveniles; ZSM A416, Igarapé Incarnada, Rio Negro near Manaus, 24 Sept 1962, 2♂, 1♀, 16 juveniles; ZSM, Poco II Maues, 26 Jan 1941, 16 juveniles.

Other Material: INPA, Rio Negro, Anavilhanas Arquipélago, 26 Feb–6 Mar 1976, 7♂: CL 6.8–7.5, TL 17.8–19.0, 2 ovigerous ♀: CL 5.2–5.6, TL 14.7–15.2. INPA, Tarumazinho, 18 Sept 1980, 20 juveniles. Rio Tefé, 11 Mar 1980, 3♂, 1 juvenile. Rio Negro, Urubaxi, 3 Feb 1980, coll. M.G., 1♂, 3 juveniles. INPA, Reserva Egler, 6 Feb 1976, 4♂, 4 juveniles.

COLOR NOTES.—Animal in life overall dark blue-green to naked eye. Under low-power microscope, blue chromatophores distinguishable. Few chromatophores on mediodorsal margin of antennular peduncle. Pereopod 2 faintly blue, but lacking discreet chromatophores. Walking legs and pleopods unpigmented. Rostrum with triangular patch of pigment, flanked by two inverted triangles on anterior carapace. Latter with large scattered chromatophores, posterior margin with continuous band of pigment. Abdominal segments and pleura with large scattered chromatophores; anterodorsal margins of abdominal segments each with continuous band of pigment. Telson with marginal and middorsal pigment band. Uropodal rami with scattered chromatophores.

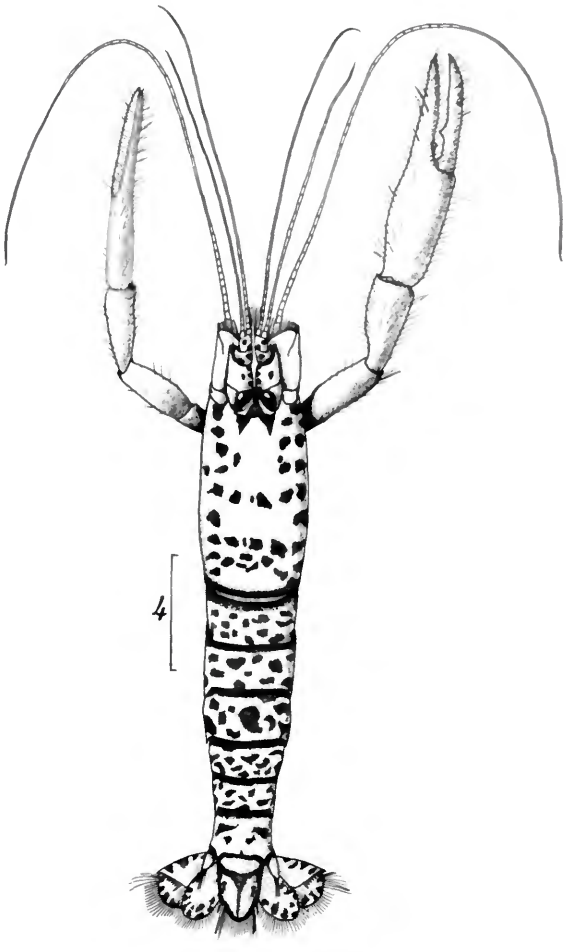


FIGURE 1.—*Euryrhynchus amazoniensis*, dorsal view.

Newly-emerged eggs and ovaries, pale green; maturing eggs becoming orange brown.

REMARKS.—Although Tiefenbacher (1978) rec-

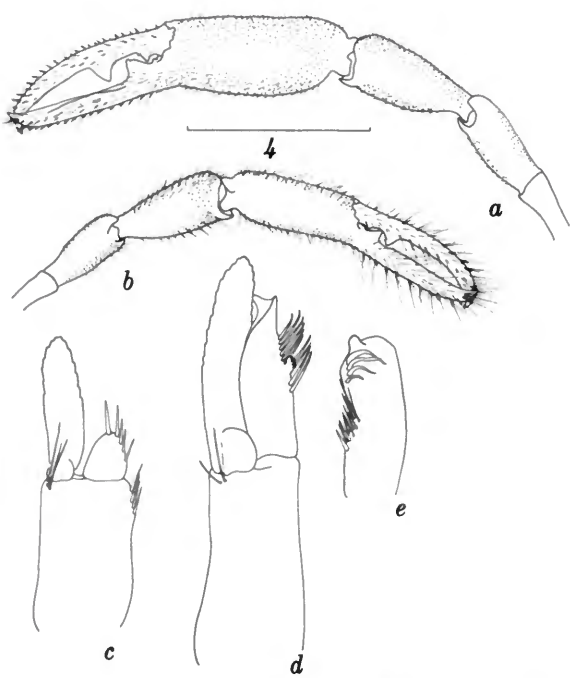


FIGURE 2.—*Euryrhynchus amazoniensis: a,* pereopod 2, large chela; *b,* pereopod 2, small chela; *c,* ♂, pleopod 1; *d,* ♂, pleopod 2; *e,* ♂, apex of endopod of pleopod 2 enlarged.

ords *E. burchelli* and *E. amazoniensis* as co-occurring especially around Manaus, the present collection contains only the latter species. Tiefenbacher separates these species by the presence (in *E. burchelli*) or absence (in *E. amazoniensis*) of spines at the distal ends of the carpus and merus of pereopod 2. He further suggests a fairly close relationship between *E. amazoniensis* and *E. wrzesniowskii* based on external morphology and supported by the recent geological and hydrological history of the river basins of the area.

Examination of pleopod 2 of mature males of all three species suggests a closer relationship between *E. wrzesniowskii* and *E. burchelli* (Figure 3). Both species possess an elongate pleopod 2 endopod, with a double row of spines distal to the reduced appendix interna. *Euryrhynchus amazoniensis* differs markedly from this pattern, having the endopod shorter than the exopod, with a single row of spines starting proximal to the appendix interna, the apex of the endopod hollowed, with a flattened lobe-like structure, and a group of four strong curved spines anterodistally. Fenner A. Chace, Jr. (pers. comm.) has expressed the tentative opinion that in *Euryrhynchus* the true endopod of pleopod 2 in the male has been lost, and replaced by the appendix masculina.

In 26 ovigerous females examined, the brood size varied from 8 to 22 eggs (mean = 13).

PREVIOUS RECORDS.—Rio Negro, Rio Solimoes, Rio Purus, Rio Amazonas, and Rio Tapajos, Brazil (Tiefenbacher, 1978).

Euryrhynchus wrzesniowskii Miers

FIGURE 3*c, d*

Euryrhynchus wrzesniowskii.—Holthuis, 1951:5, pl. 1; pl. 2: figs. a–f; 1959:100, fig. 14.—Tiefenbacher, 1978:183.

TYPE-LOCALITY.—Cayenne, French Guiana.

MATERIAL EXAMINED.—USNM 92520, Suriname, 1♂: Cl 4.6, TL 11.8; 1 ovigerous ♀: CL 4.2, TL 12.1 (12 eggs in brood pouch). USNM 76604, Manicole Swamp, upper Cuyuni River, Guyana, 1♂, 1♀. USNM 173103, forest pond above Lago Jacaré, Rio Trombetas Biological Reserve, Para State, Brazil, 5 Feb 1979, coll. R.I. Crombie, 2♂: CL 3.9, TL 10.4; 6♀.

REMARKS.—The material from Rio Trombetas, Brazil, is the first to be recorded outside of the three Guianas. The Rio Trombetas, a tributary of the Amazon, arises in the highlands of Guiana and Suriname and empties into the Amazon less than 100 miles from Santarem, the type locality of Calman's *Euryrhynchus burchelli.*

PREVIOUS RECORDS.—Guyana, Suriname, and French Guiana (Holthuis, 1951).

Genus *Macrobrachium* Bate, 1868

Macrobrachium amazonicum (Heller)

FIGURE 4

Macrobrachium amazonicum.—Holthuis, 1952:18, pl. 2: figs. a–h; 1959:85, fig. 10; 1966:2.—Coêlho, 1963:76.—Favaretto et al., 1976: 449, fig. 1.—Hanson and Goodwin, 1977:203.

TYPE-LOCALITY.—Amazon River.

MATERIAL EXAMINED.—Anavilhanas Arquipélago, 28 Feb–6 Mar 1976, 2 juveniles. Parana

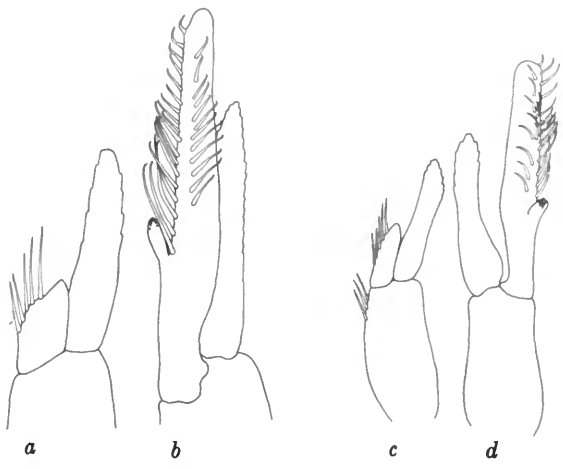


FIGURE 3.—*Eurytrhynchus burchelli: a*, ♂, pleopod 1; *b*, ♂ pleopod 2; *Eurytrhynchus wrzeniowskii: c*, ♂, pleopod 1; *d*, ♂, pleopod 2.

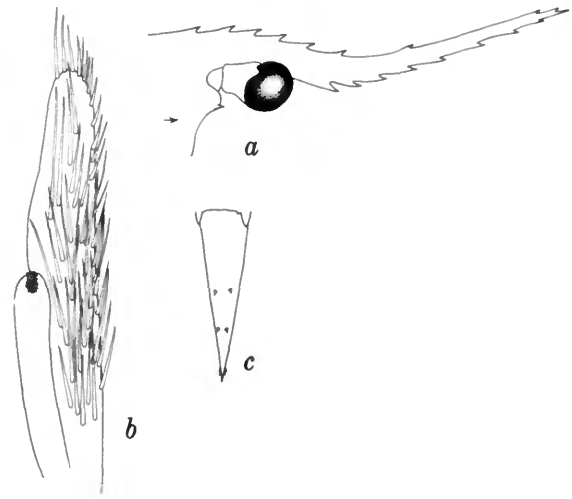


FIGURE 4.—*Macrobrachium amazonicum: a*, lateral view of anterior part of carapace; *b*, appendix masculina and appendix interna; *c*, telson.

do Araria, 4 Jan 1978, 1♀, 7 juveniles. Parana do Jacaré, 31 Mar 1978, 16 ovigerous ♀: CL 12.9–19.4, RL 16.2–23.4, TL 66–94; 15♂: CL 15.0–16.5, RL 22.0–22.3, TL 81–98. Rio Madeira, Ilha do Focaré, 18 Aug 1976, 2♂, 3♀. Rio Madeira, Lago do Caraparú, Calama, 11 Dec 1980, 1♂, 3♀, 1 ovigerous ♀, 74 immature specimens. Rio Toca Tana, 12 Nov 1980, 2 immature specimens.

REMARKS.—Brood size ranges from 917 to 1277 eggs per ovigerous female, with egg size 0.5 × 0.7 mm.

PREVIOUS RECORDS.—Venezuela, Guyana, Suriname, French Guiana, Brazil, Peru, Ecuador, Bolivia, and Paraguay (Holthuis, 1952).

Macrobrachium ferreirai, new species

FIGURES 5, 6, 12*b*

MATERIAL EXAMINED.—*Holotype:* INPA, Igarapé near Castanhal, Aripuaná, 22 Aug 1976, coll. E.F., 1: CL 15.8, RL 9.1, TL 54, length of pereopod 2, 74, 65.

Paratypes: USNM 184883, Igarapé near Costanhal, Aripuaná, 22 Aug 1976, coll. E. F., 1♂: 14.8, RL 9.0, TL 53. INPA, Igarapé ?, 18 Mar 1980, coll. E.F., 1 ovigerous ♀: CL 13.1, RL 7.5, TL 47; 1♀: CL 13.1, RL 8.0, TL 47. INPA, Tarumazinho, 25 Sept 1979, coll. I.W., 1♂: CL 14.7, RL 9.0, TL 52; 3 juveniles. USNM 184884, Iguapi da Aeronautica, Tefé, 21 Mar 1973, 1♂: CL 12.4, RL 7.9, TL 44; 4 juveniles.

DESCRIPTION.—*Male:* Rostrum almost three-quarters carapace length, with strong lateral keel, formula: 9/1; 3–4 postorbital spines (3 in holotype). Carapace smooth, except for very small scattered spinules or setae on branchiostegite; strong antennal and slightly smaller hepatic spine present. Posteroventral angle of pleuron 5 almost rectangular, not spinose. Posteroventral corner of abdominal segment 6 spinose, flared laterally. Telson shorter than uropodal rami, with 2 pairs of dorsolateral spines, at midlength and three-quarters length from base; posterior margin broadly triangular, with prominent median spine, short outer and longer inner spine, about 18 plumose and several simple setae.

Antenna 1, fused part of longer ventral flagellum one-quarter length of free part; longer ventral branch about twice the length of shorter branch; basal peduncular segment with strong narrow proximal spine on outer margin; outer distal angle strongly spinose, with straight setose margin between spine and second peduncular segment; small ventrally directed spine at midlength of medioventral margin. Antenna 2, sca-

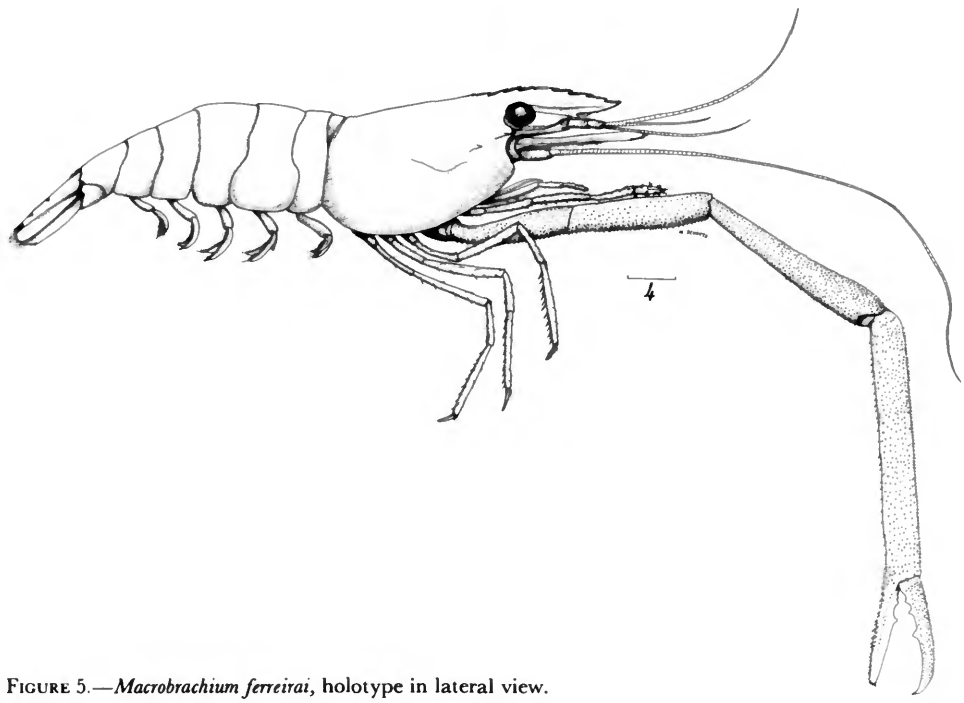


FIGURE 5.—*Macrobrachium ferreirai*, holotype in lateral view.

phocerite with outer distal spine almost reaching end of blade; basal segment with strong ventral spine; flagellum longer than entire body length. Mouthparts as shown in Figure 6. Maxilliped 3, two distal segments together subequal in length to antepenultimate segment of endopod. Pereopod 1 chela with fingers subequal in length to palm. Pereopod 2 considerably longer than entire body; both legs very similar, left or right only slightly shorter; fingers of chela somewhat less than half length of palm; dactylus with numerous fine setules running almost to tip; cutting edge with triangular tubercle at about midlength, 2 smaller proximal tubercles; unarmed between corneous tip and distalmost tubercle; fixed finger of propodus with triangular tubercle in proximal half, with 2 smaller tubercles near articulation; single row of spinules on outer surface slightly longer than those on dactylus; palm slender, parallel-sided, set with numerous spinules, those on outer-upper surfaces slightly smaller than those on inner-lower surfaces; carpus proximally narrow, widening distally, about two-thirds length of propodal palm, closely set with spinules; merus and ischium together about one-fourth longer than carpus, set with numerous spinules. Pereopods 3–5 similar, dactylus one-third length of propodus; latter armed with 10–13 spines on posterior surface of pereopod 3, spines decreasing in number on pereopods 4 and 5. Pleopod 1, endopod slightly more than half length of exopod, narrow, flexed at midlength. Pleopod 2, appendix masculina of endopod about 4 times longer than wide, with outer and anterior margin bearing numerous spines. Uropodal inner ramus slightly shorter and narrower than outer.

REMARKS.—Using Holthuis's key to the American species of *Macrobrachium* (1952:12), one progresses through the following characters with the present species: carpus male pereopod 2 as long or longer than merus; telson with distinct posterior margin; male pereopods 2 subequal in shape; no tubercles on cutting edges of chelae; male pereopod 2 with 1 or 2 large proximal teeth on cutting edges of chelae, but without pubescence; rostrum shorter than scaphocerite; male carpus

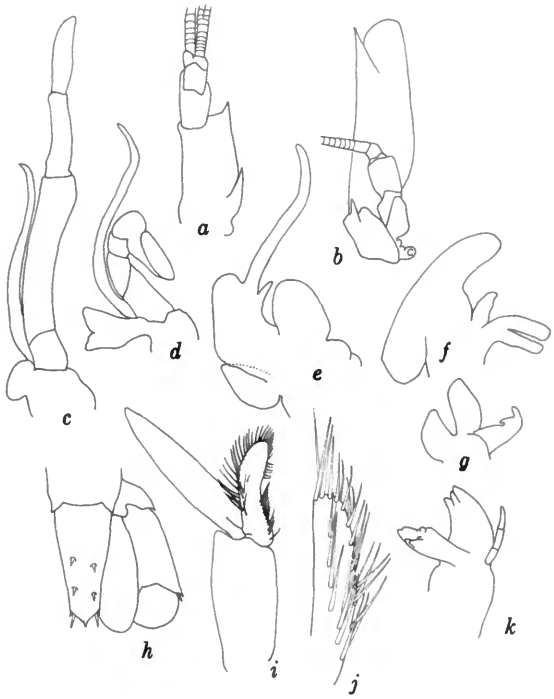


FIGURE 6.—*Macrobrachium ferreirai: a,* antenna 1; *b,* antenna 2; *c,* maxilliped 3; *d,* maxilliped 2; *e,* maxilliped 1; *f,* maxilla 2; *g,* maxilla 1; *h,* telson and right uropod; *i,* ♂, pleopod 1; *j,* appendix masculina; *k,* mandible.

pereopod 2 elongate; not longer than palm. This last character leads to *M. borelli* (males have relatively longer fingers of pereopod 2 chelae) or *M. quelchii* (which possess relatively more robust chelae with characteristic distal widening of the carpus).

Superficially, *M. ferreirai* resembles *M. brasiliensis* from the Guianas, Brazil, and Ecuador, especially in the slender male pereopod 2, with fingers less than half the palm length. However, the carapace of *M. brasiliensis* is more scabrous anterolaterally, while the fingers have a row of tubercles on the cutting edges of the chelae. Further, comparison of material from Ecuador (det. F.A. Chace, Jr.) shows fewer and longer spinules on the male pereopod 2 (see Figure 12*a*).

Macrobrachium nattereri differs from *M. ferreirai* in having longer medial spines on the palm and carpus of pereopod 2 in the male, while the fingers are always more than half the palm length.

For the above reasons, *M. ferreirai* is described as a new species, though this action is taken with some trepidation. It would seem that in the area of the Rio Negro basin under consideration, a group of similar and perhaps closely-related species are slowly gaining distinctiveness, which can be detected in mature males, but which in the juveniles and females is indeed subtle. This group includes *M. ferreirai*, *M. nattereri*, and *M. inpa.*

ETYMOLOGY.—The species is named for Efrem J. Gondim Ferreira of INPA, in thanks for material he made available.

Macrobrachium inpa, new species

FIGURES 7–9, 12*c*

MATERIAL EXAMINED.—*Holotype.* INPA, Igarapé da Cachoeira, 17 June 1979, coll. I.W., ♂: CL 11.9, RL 6.2, TL 41.

Paratypes: USNM 186885, da Igarapé Cachoeira, 21 June 1978, 1♂: CL 10.6, RL 6.2, TL 38; 2 immature ♂. INPA, Campina, Km 60, 1♂: CL 10.2, RL 5.4, TL 35. INPA, Amazônia, Olo, Km 21, 2 km from Estade Piscicultura, 30 Oct 1978, 1♂: CL 12.3, RL 7.2, TL 43. USNM 184886, Beija Flor, 19 Mar 1981, coll. B.K., 1♂: CL 11.6, RL 6.5, TL 43; 3 ovigerous ♂: CL 7.2–8.1, RL 3.8–4.7, TL 25–29. INPA, 1♂: CL 11.0, RL 6.1, TL 40; 4 ovigerous ♀: CL 6.9–7.5, RL 3.9–4.1, TL 26–27; 40 immature specimens.

DESCRIPTION.—*Male:* Rostrum shorter than carapace, almost reaching end of scaphocerite, with strong lateral ridge; rostral formula: 9–10/1–3; 3–4 postorbital spines. Carapace smooth apart from scattered setules; with a strong antennal and a smaller hepatic spine. Posteroventral corner of pleuron 5 rectangular; posteroventral corner of abdominal segment 6 spinose. Telson shorter than uropodal rami, with 2 pairs of dorsal spines at about one-third and two-thirds of the length from base; posterior margin broadly triangular, with short outer and longer inner spine, and 10–12 elongate plumose setae and several simple setae.

Antenna 1 with fused part of shortest flagellum about one-fifth the length of free part; longer of 2 ventral flagellar branches about twice the

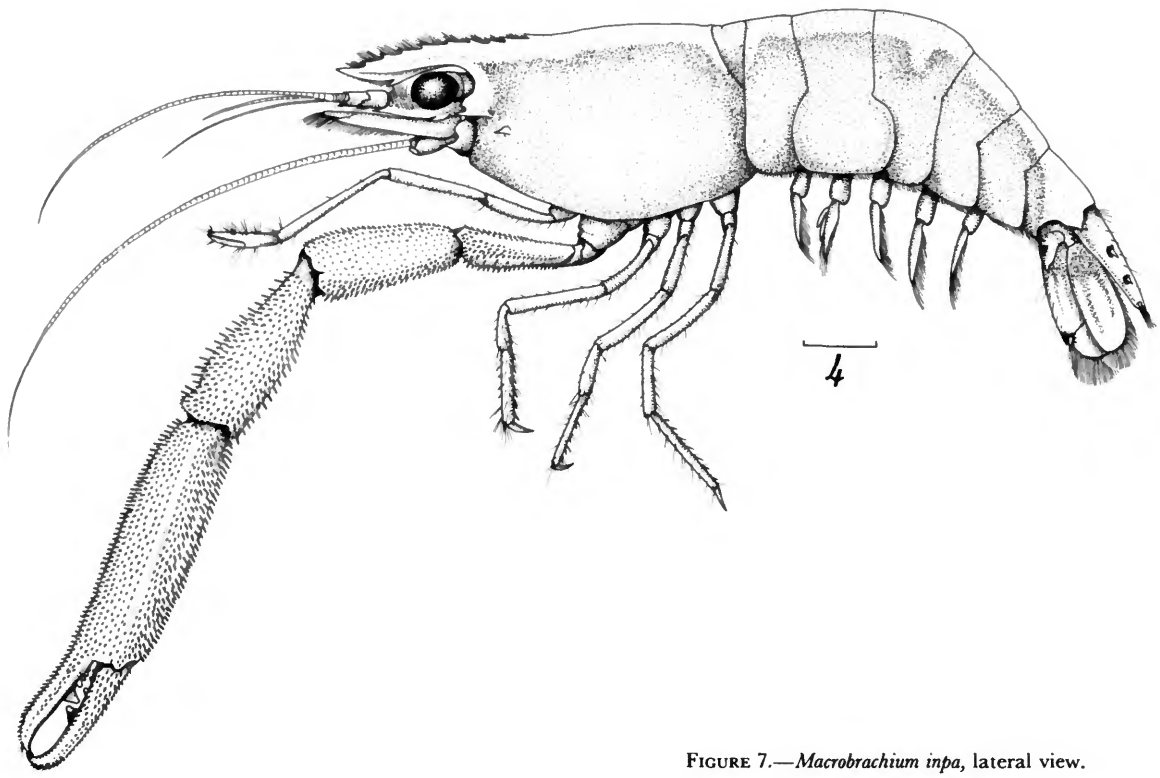


FIGURE 7.—*Macrobrachium inpa,* lateral view.

length of dorsal flagellum; basal peduncular segment with strong narrow lateral spine on outer margin, small spine at about midpoint of medioventral margin; outer margin ending in strong spine, distal margin between spine and second peduncular segment straight. Antenna 2, scaphocerite with spine on outer margin almost reaching end of blade, distal margin of blade obliquely truncate; basal segment with strong distolateral spine. Mouthparts as in Figure 9.

Pereopod 1 slender, fingers of chela subequal in length to palm; chela slightly more than half length of carpus; latter distinctly longer than merus. Pereopod 2, larger cheliped, fingers of chela about half length of palm; dactylus with distal half of cutting edge unarmed, with strong tubercle at midlength and 3 smaller tubercles proximally; fixed finger with distal half of cutting edge entire, large tubercle at about midlength, and 4 small proximal tubercles; both fingers bearing irregular rows of small spines, those on ventral surface of fixed finger longest; palm somewhat inflated, never parallel-sided, outer and ventral surfaces with fairly dense scattered short spines, upper and mesial surfaces with spines 3–4 times longer than spines on outer surface; carpus three-fourths length of palm, proximally narrow, distally widened, with short spines on outer and ventral surfaces, longer spines on upper and mesial surfaces; merus three-fourths length of carpus, spination as in carpus; ischium about three-fourths length of merus, with similar spination. Smaller cheliped similar to larger, but shorter and less robust, with similar spination and armature. Pereopods 3–5 similar; pereopod 3 reaching slightly beyond apex of scaphocerite; dactylus one-third to one-fourth length of propodus; latter with ventral row of spines and scattered setae. Pleopod 1, endopod elongate-narrow, two-thirds length of exopod, flexed at midlength. Pleopod 2, appendix interna two-thirds length of appendix masculina; latter elongate-oval, with numerous spines on mesial margin. Uropodal basis with strong distolateral spine; rami subequal

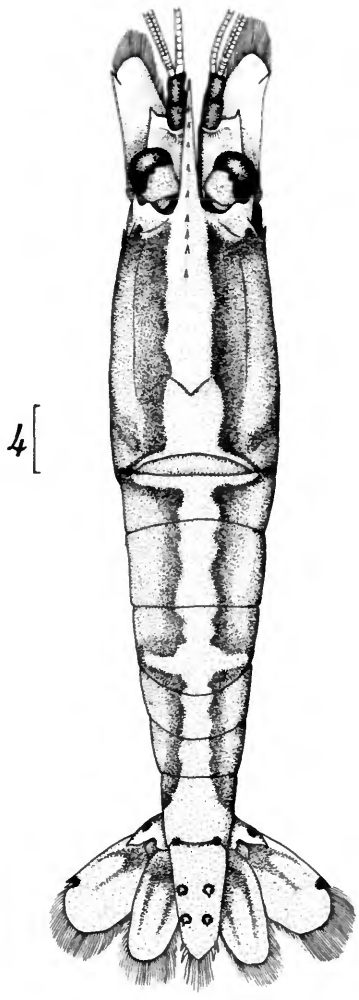


FIGURE 8.—*Macrobrachium inpa*, dorsal view.

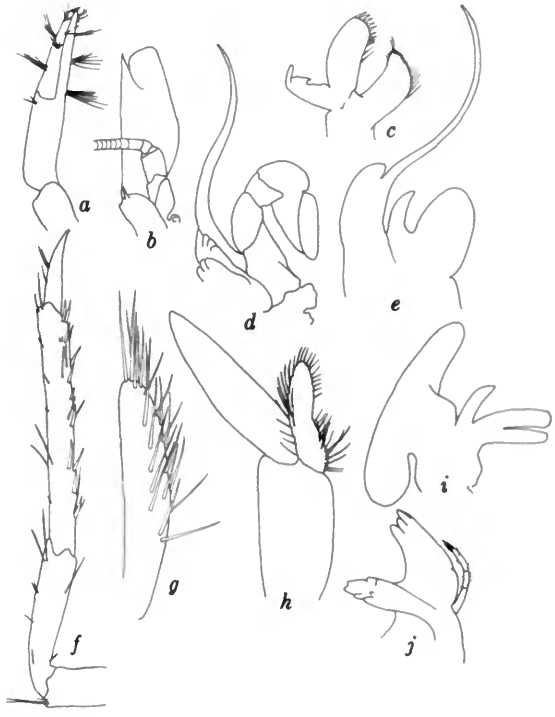


FIGURE 9.—*Macrobrachium inpa: a*, pereopod 1 chela; *b*, antenna 2; *c*, maxilla 1; *d*, maxilliped 2; *e*, maxilliped 1; *f*, distal podomeres of pereopod 3; *g*, appendix masculina; *h*, ♂, pleopod 1; *i*, maxilla 2; *j*, mandible.

in length, outer ramus with fixed spine and slightly longer articulated spine at base of distal third.

Female. Brood size 10–14 eggs per ovigerous female; eggs 2.2 × 1.5 mm, dark red.

COLOR NOTES.—Animal in life overall chestnut brown to dark purple brown, with broad salmon-pink middorsal band on rostrum, carapace, and abdomen intersected on anterior carapace margin, carapace-abdomen articulation, and abdominal segment 3 by narrow transverse pink stripe. Inner edge of proximal segment and 2 distal segments of antenna 1 with dark pigmentation, flagella dark-banded at each articulation. Eyestalks mottled. Pereopod 2 with pale fingertips, darker bands across bases of fingers, proximal part of palm, distal and proximal parts of carpus and merus. Six narrow darker bands on posterior 3 pereopods. Dorsal telsonic spines encircled by dark chromatophores. Uropodal rami with irregular Y-shaped dark mottling.

REMARKS.—The immature and juvenile forms of *M. inpa* are difficult to separate from those of *M. nattereri* with which they occur. Mature males and females, however, can be easily separated from the congener by several features. In life, the color pattern of *M. inpa*, with the striking pale middorsal stripe is most distinctive. *Macrobrachium inpa* (ovigerous females, CL 6.9–8.1 mm; largest male, CL 12.3 mm) matures at a smaller size than *M. nattereri* (ovigerous females, CL 11.5–12.1 mm,

largest male, CL 19.4 mm), while the second pereopods in both the male and female are relatively more robust and spinose in the former species. The palm of pereopod 2 in *M. nattereri* is parallel sided, while in *M. inpa* the palm is more inflated, with markedly longer spines on the mesial surface of the propodus and carpus. The dactylus of pereopod 2 in *M. nattereri* usually has a strong tooth in the distal half of the cutting edge, while the same tooth is more proximally placed in *M. inpa.* The carpus of pereopod 2 is also more inflated than in *M. nattereri.*

ETYMOLOGY.—The specific name is the acronym for Instituto Nacional de Pesquisas da Amazonia in Manaus, Brazil.

Macrobrachium jelskii (Miers)

FIGURE 10

Macrobrachium jelskii.—Holthius, 1952:26, pl. 4: figs. a–d; 1959:88, fig. 11; 1966:3.—Bastos and Paiva, 1959:413.—Chace and Hobbs, 1969:109, fig. 25f.

TYPE-LOCALITY.—Saint-Georges, French Guiana.

MATERIAL EXAMINED.—INPA, Parana do Jacaré, 31 Mar 1978, 7 ovigerous ♀: CL 11.1–11.9, RL 12.5–14.8, TL 54–78; 2♂. INPA, Lago Amaña, 19 Mar 1979, 2♀. Rio Cuieiras, 23 Feb 1973, 4 ovigerous ♀, 4♀. INPA, Rio Negro, mouth of the Rio Urubaxi, 6 Feb 1980, coll. M.G., 120 immature specimens.

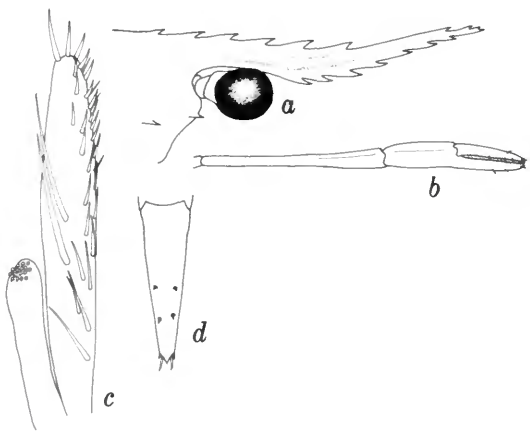


FIGURE 10.—*Macrobrachium jelskii: a,* lateral view of anterior part of carapace; *b,* pereopod 2; *c,* appendix interna and appendix masculina; *d,* telson.

REMARKS.—The appendix masculina figured for a male of CL 8.8 mm, collected in Suriname by Chace and Hobbs (1969), is considerably more setose than in the present material, perhaps reflecting population differences.

The brood size ranges from 46 to 76 eggs per ovigerous female, an egg being 1.3 × 2.0 mm.

PREVIOUS RECORDS.—Venezuela, Trinidad, Costa Rica, Bolivia, Guyana, Suriname, French Guiana, and Brazil, including Rio Preto da Eva and Lago Redondo (Holthuis, 1966).

Macrobrachium nattereri (Heller)

FIGURES 11, 12*d*

Macrobrachium nattereri.—Holthuis, 1952:83, pl. 20: figs. a–d; 1966:3.

TYPE-LOCALITY.—Rio Negro, Brazil.

MATERIAL EXAMINED.—INPA, Rio Negro, Anavilhanas Arquipélgao, Igapó, June 1980, coll. M.G., 1♀: CL 15.6, RL 8.5, TL 55. INPA, Anavilhanas Arquipélago, 27 Jan 1980, 1♂: CL 18.1, RL 10.6, TL 63. INPA, Rio Negro, Igarapé Gadi Pequeno, 4 Feb 1977, 1♀: CL 16.2, RL 9.2, TL 58; 11 juveniles. INPA, Rio Negro, Urubaxi, 3 Feb 1980, 4 juveniles. INPA, Rio Cuieiras, Praia Putode, 23 Feb 1979, coll. E.F., 4♂: CL 15.2–19.4, RL 9.0–11.1, TL 48–63. INPA, Rio Cuieiras, Igapó, 17 Oct 1979, 2♂: CL 12.5–15.8, RL 8.3–9.2, TL 47–58; 4 juveniles. INPA, Igarapé do Guaraná, 14 Dec 1977, 1♀: CL 13.8, RL 8.8, TL 51. INPA, Igarapé Sobrado, 19 Jan 1970, 1 juvenile. INPA, Igarapé do Veado, Manaus, Boa Vista, Km 106, 6 Nov 1978, 1♂: CL 19.2, RL 11.0, TL 67; 1 juvenile. INPA, Tarumá, 27 Apr 1979, 1 ovigerous ♀: CL 12.1, RL 8.6, TL 47; 3♀: CL 14.3–16.1, RL 8.4–11.0, TL 53–62; 1 juvenile. INPA, Transamazonian Highway, Km 3353, 18 June 1977, 1♂: CL 16.0, RL 9.5, TL 59; 1 juvenile. INPA, Amazônia, Olo, Km 21, 30 Oct 1978, 1♂: CL 19.0, RL 12.3, TL 68; 1♀: CL 16.8, RL 9.4, TL 58; 3 juveniles. INPA, Tucurí, Feb 1981, 1♂:

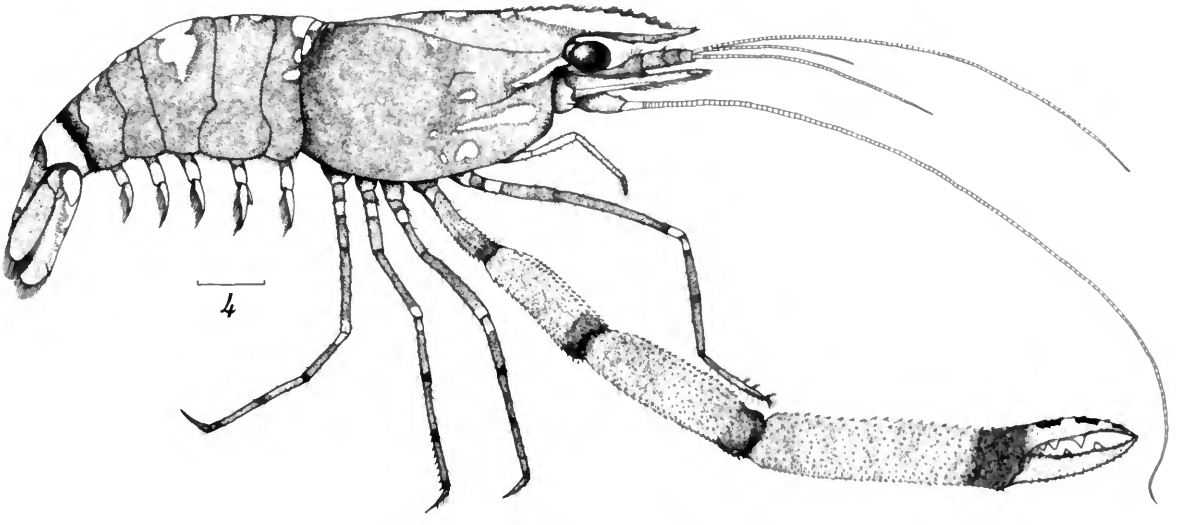


FIGURE 11.—*Macrobrachium nattereri*, lateral view.

CL 16.1, RL 9.0, TL 56; 1 ovigerous ♀: CL 11.5, RL 6.9, TL 41; 1 juvenile

COLOR NOTES.—Body in life overall dark blue, with speckling of red chromatophores; somewhat darker blue on fingers, base of chela, and propodus-carpus articulation of pereopod 2, and on abdominal segment 6 at base of telson and uropods. Unconnected, irregular white (or pale pink, from scattered red chromatophores) patches down middorsal line on rostrum, carapace, and abdomen, largest patch on abdominal segment 3. Small white patches on branchiostegite, outer part of scaphocerite blade, carpus-merus and merus-ischium articulations of pereopods 3–5, and on outer uropodal ramus. Setae on scaphocerite and uropodal rami light brown.

REMARKS.—The problems involved in identifying this species are discussed under "Remarks" in *Macrobrachium ferreirai* and *M. inpa* (p. 6).

PREVIOUS RECORDS.—Rio Negro, Brazil and St. Laurent, French Guiana (Holthuis, 1952).

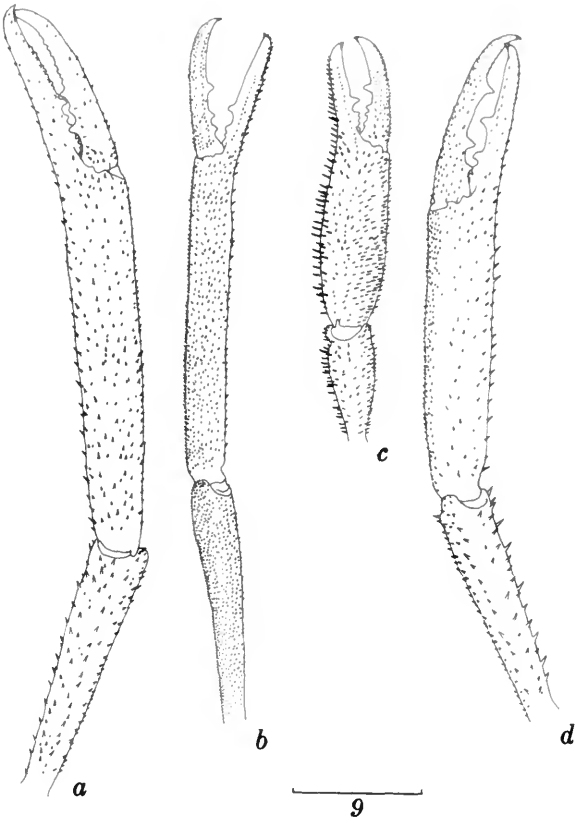


FIGURE 12.—*Macrobrachium* species, ♂, pereopod 2 larger chela: *a*, *M. brasiliensis*, CL 20.2 mm, Ecuador; *b*, *M. ferreirai*, CL 15.5 mm; *c*, *M. inpa*, CL 55.8 mm; *d*, *M. nattereri*, CL 18.8 mm.

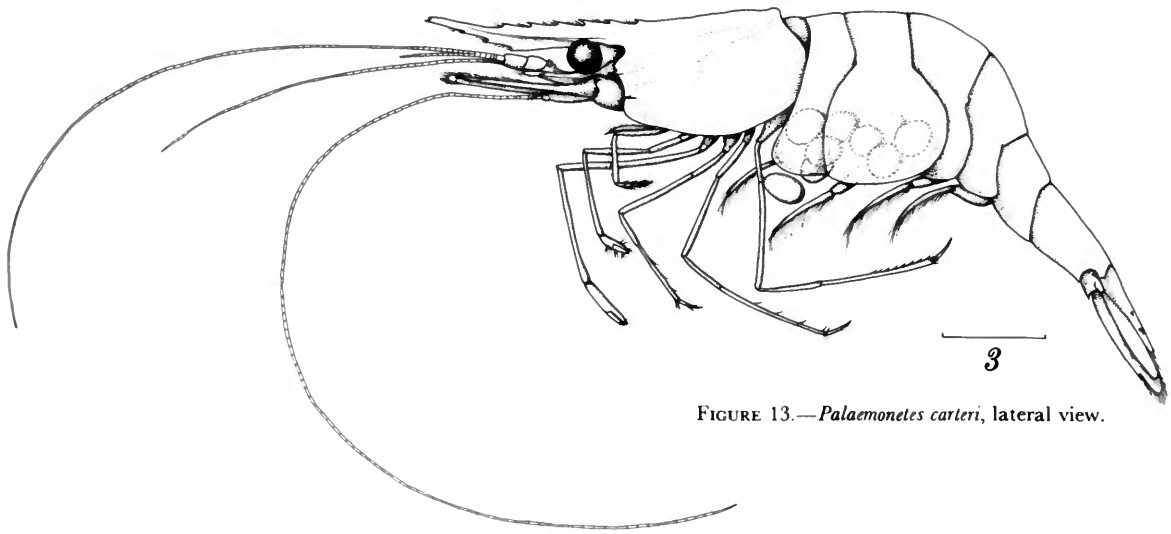
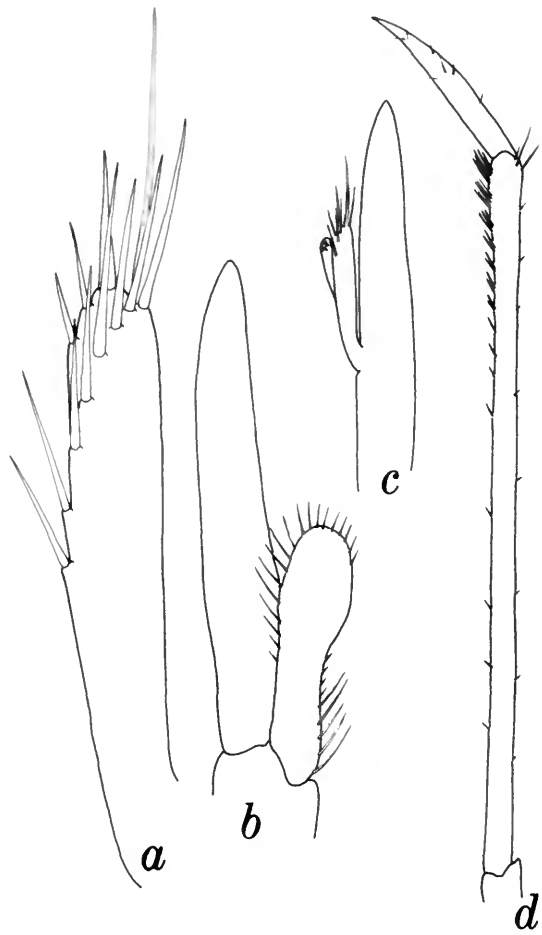


FIGURE 13.—*Palaemonetes carteri*, lateral view.



Genus *Palaemonetes* Heller, 1869

Palaemonetes (*Palaemonetes*) *carteri* Gordon

FIGURES 13, 14

Palaemonetes (*Palaemontes*) *carteri*.—Holthuis, 1952:218, pls. 52, 53; 1959:81, fig. 9; 1966:6.

MATERIAL EXAMINED.—INPA, Anavilhanas Arquipélago, 28 Feb–6 Mar 1976, 2♂. INPA, Anavilhanas Arquipélago, Lago Samauma, 8 Apr 1978, 1♂. INPA, Rio Cuieiras, 23 Nov 1979, 1 ovigerous ♀. Rio Curua Una, Para, Km 15, 14 Feb 1977, 3♀. INPA, Igarapé do Aeronautica, Tefé, 21 Mar 1973, 7♂, 9 ovigerous ♀, 4♀. INPA, Rio Madeira, Igarapé Ananaquara, 26 Aug 1976, 3♂, 5♀. INPA, Rio Negro, Urubaxi, 3 Feb 1980, coll. M.G., 4 ovigerous ♀: CL 5.8–6.2, RL 7.0–8.1, TL 32–36; 11♂: CL 4.5–4.8, RL6.1–6.8, TL 28–30; 5♀, 2 juveniles. INPA, Rio Negro, mouth of the Rio Urubaxi, 6 Feb 1980, coll. M.G., 6♂, 11♀. INPA, Rio Negro, near mouth of Rio Urubaxi, 11 Feb 1980, coll. M.G., 1 juvenile. INPA, Rio Negro, Ilha da Cumuru, near Rio Ariravá, Lago da Ilha, 1 Feb 1980, coll. M.G., 4♂, 3♀. Rio Negro, Abaixo do Daraà, 17 Feb 1980, coll. M.G.,

FIGURE 14.—*Palaemonetes carteri*: *a*, appendix masculina; *b*, ♂, pleopod 1; *c*, ♂, pleopod 2 endopod; *d*, distal podomeres of pereopod 5.

500+ immature specimens. INPA, Parana do Jacaré, 31 Mar 1978, 3♂, 8 ovigerous ♀: CL 6.0–6.8, RL 5.8–6.5, TL 29–32.

REMARKS.—Brood size in ovigerous females ranges from 21 to 37 eggs in 12 specimens, with an average of 27 eggs per female. The eggs measure 1.0 × 1.5 mm.

PREVIOUS RECORDS.—Venezuela, Suriname, French Guiana, and Brazil, including Igarapé Mapiri south of Santarém, Igarapé do Tento, and Lago Redondo (Holthuis, 1966).

Genus *Pseudopalaemon* Sollaud, 1911

DIAGNOSIS (adapted from Holthuis, 1952).—Rostrum well developed, compressed, with dorsal and ventral teeth. Carapace with antennal and hepatic spines. Telson with 2 pairs dorsal and 2 pairs posterior spines. Eyes pigmented, with well developed corneas. Mandible lacking palp. Exopods present on all maxillipeds. Pleurobranchs at bases of maxilliped 3 and all pereopods. Dactyli of pereopods 3–5 simple. Propodus of pereopod 5 with ventrodistal rows of setae (except in *P. nigramnis*). Endopod of male pleopod 1 lacking appendix interna.

TYPE-SPECIES.—*Pseudopalaemon bouvieri* Sollaud, 1911. The type-species and the four Amazonian species show several morphological differences, which are summarized in the following key and in Table 1.

Key to the Species of the Genus *Pseudopalaemon*

1. Rostrum at least 1½ times longer than carapace; pleuron 5 acute-spinose ..... ***P. amazonensis***
   Rostrum shorter than, subequal to, or only slightly longer than carapace; pleuron 5 rounded or rectangular 2
2. Pleuron 5 fairly broadly rounded; no postorbital rostral spines ..... ***P. bouvieri***
   Pleuron 5 rectangular or narrowly rounded; at least 1 postocular rostral spine 3
3. One postocular spine; cornea of eye markedly flattened ... ***P. nigramnis***
   At least 2 postocular spines; cornea of eye nearly spherical 4
4. Rostrum distinctly crested over eye; dorsal telsonic spines situated in posterior half ..... ***P. gouldingi***
   Rostrum not crested over eye; first pair dorsal telsonic at midlength ..... ***P. chryseus***

Pseudopalaemon amazonensis Ramos-Porto

FIGURES 15, 16

Pseudopalaemon amazonensis Ramos-Porto, 1979:693.

TYPE-LOCALITY.—Lago dos Sapos, 70–80 km above the mouth of the Rio Janaperi, in the environs of Manaus.

MATERIAL EXAMINED.—INPA, Beija Flor, 19 Mar 1981, coll. B.K., 2♂: RL 6.8–7.9, CL 4.7–5.1, TL 26–32; 3 ovigerous ♀: RL 8.0, CL 5.1–5.9, TL 30–33; 7 juveniles. INPA, Igarapé Bacia, 11 Feb 1980, coll. I.W., 1 ovigerous ♀: RL 9.0, CL 5.9, TL 35. INPA, Barro Branco, Reserva Ducke, 14 Mar 1981, coll. I.W. and B.K., 1♂, 1♀, 2 juveniles. INPA, Reserva Egler, 6 Feb 1976, coll. E.F., 1♂. INPA, Igarapé Gadi Pequeno, Rio Negro, 14 Feb 1977, 4♂, 7♀. INPA, Rio Negro, Urubaxi, 3 Feb 1980, coll. M.G., 1♂, 4♀, 1 juvenile. INPA, Rio Preto da Eva, 10 Nov 1978, 2♂, 2♀, 4 juveniles.

Materials also recorded, though not examined, from Anavilhanas, Campina (Res. Km. 60), São Gabriel da Cachoeir (upper Rio Negro), and Tarumazinho.

DESCRIPTION.—*Male:* Rostrum 1.75 times as long as carapace, with distal half curving dorsally, with one postorbital spine, one spine above orbit,

TABLE 1.—Major differences among the five species of *Pseudopalaemon*

Character	*P. bouvieri*	*P. amazonensis*	*P. chryseus*	*P. gouldingi*	*P. nigramnis*
Rostrum	equal to, or slightly longer than carapace	about 1.75 times longer than carapace	slightly longer than carapace	shorter than carapace	slightly longer than carapace
Formula	4–8/2–4	5–7/5–7	8–9/3–5	8–13/1–3	7–10/2–3
No. of postorbitals	0	1	2	2 or 3	1
Shape	straight	distally upturned	straight	crested	distally slightly upturned
Eye					
Cornea	spherical	spherical	spherical	slightly flattened	flattened
Ocellus	present	present	present	absent	inconspicuous
Antenna 1, shorter dorsal flagellum, free/fused ratio*	2.5/1	3–3.5/1	5/1	2.5–3/1	5/1
Pereopod 2, chela	fingers longer than palm carpus longer than merus	fingers longer than palm carpus longer than merus	fingers shorter than palm carpus longer than merus	fingers equal to palm carpus shorter than merus	fingers shorter than palm carpus equal to merus
Pereopods 3–5, propodus/dactylus ratio	3/1	3–4/1	2.5/1	3/1	2/1
Pleura 5	rounded	acute, spinose	almost rectangular	rectangular	almost rectangular

* There is a possibility that the free/fused ratio is an expression of the degree of maturity.

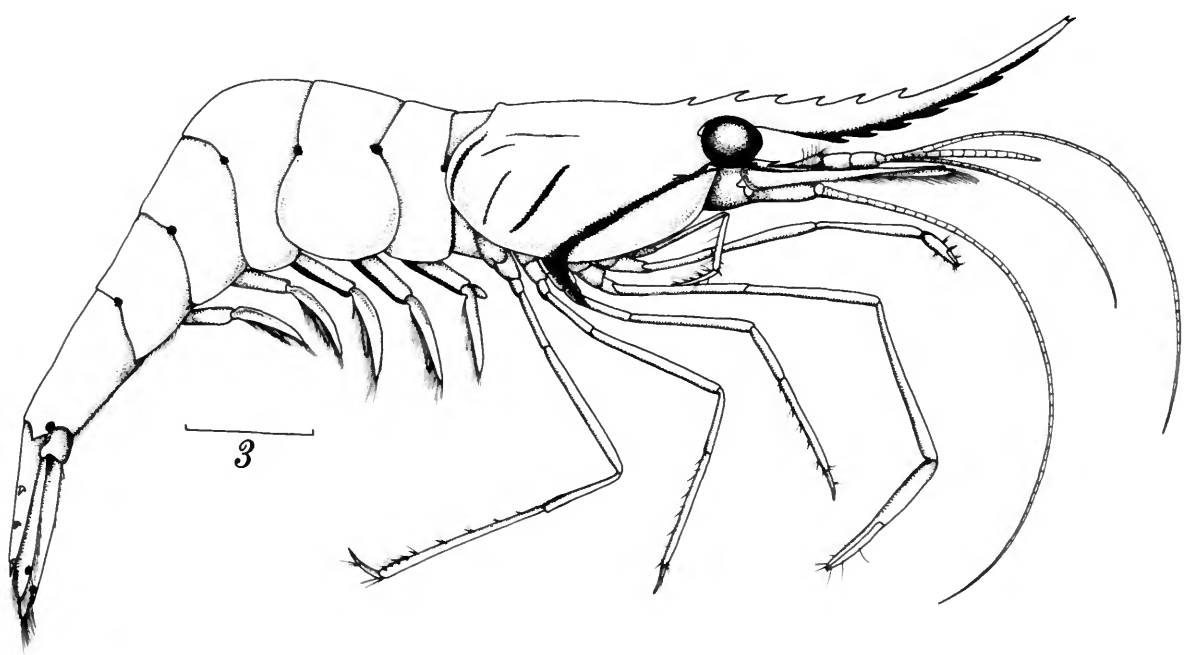


FIGURE 15.—*Pseudopalaemon amazonensis*, lateral view.

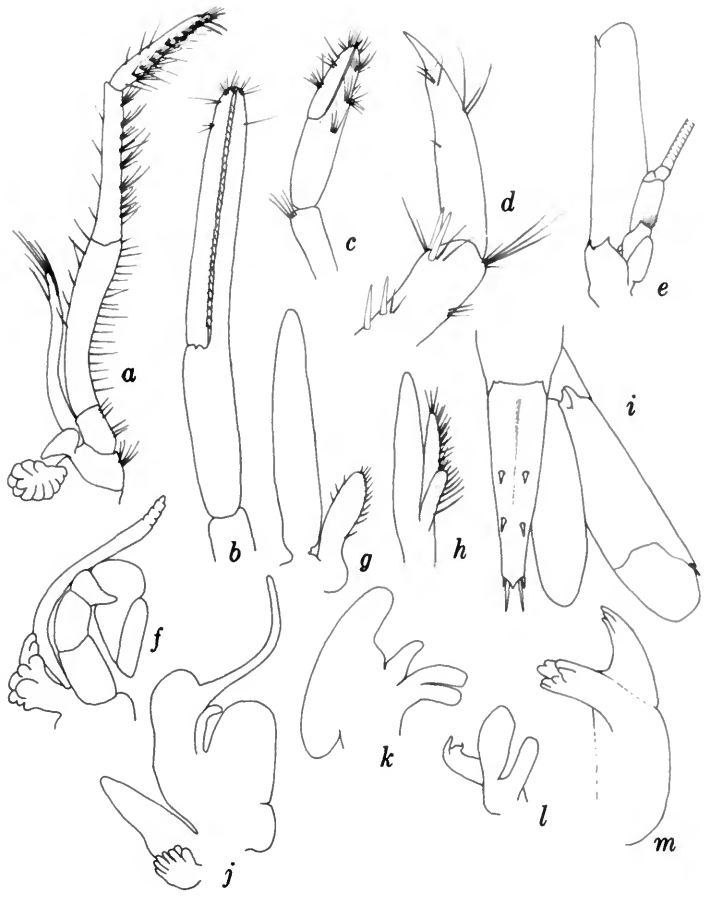


FIGURE 16.—*Pseudopalaemon amazonensis*: *a*, maxilliped 3; *b*, pereopod 2 chela; *c*, pereopod 1 chela; *d*, pereopod 3 dactylus; *e*, antenna 2; *f*, maxilliped 2; *g*, ♂, pleopod 1; *h*, ♂, pleopod 2; *i*, telson and right uropod; *j*, maxilliped 1; *k*, maxilla 2; *l*, maxilla 1; *m*, mandible.

followed by 4 or 5 more or less evenly spaced spines, dorsodistal half of rostrum unarmed, apex bifid, 6 ventral spines extending anteriorly beyond dorsal spines; rostral formula range: 5–7/5–7. Carapace with strong antennal and hepatic spines. Abdominal segments dorsally rounded; pleura of segments 1–3 ventrally rounded, pleuron 4 with posteroventral angle narrowly rounded, 5 and 6 produced into acute spine; segment 6 almost twice length of 5, subequal in length to telson. Latter with 2 pairs of dorsal spines, first pair just proximal to midlength, second pair at about base of posterior fourth; apex acutely triangular, with 2 pairs of posterior spines, inner pair 3 times longer than outer.

Eyestalk longer than well-pigmented cornea, with dorsal ocellus. Antenna 1, basal segment dorsally hollowed; mesial margin straight, with small spine ventrally at midpoint; outer margin gently convex, ending in distolateral spine, with strong spine at distal end of proximal third; 2 distal peduncular segments subequal in length, second segment with convex setose outer margin; dorsal flagella fused for distance of about one-

third length of free part, latter of 18 articles, extending beyond rostral apex; ventral flagellum considerably shorter than longer of 2 dorsal flagella. Antenna 2, scaphocerite reaching anterior third of rostrum, outer margin straight, blade distally convex, extending beyond lateral spine, inner setose margin straight for distal two-thirds, basal segment with small ventrolateral spine on distal margin; flagellum longer than longest flagellum of first antenna. Mandible lacking palp; incisor lobe of three narrowly rounded cusps; molar cylindrical, armed distally with about seven rounded processes. Maxilla 1, epipod with outer digitiform and inner curled acute processes. Maxilliped 1 with broad triangular epipod and gill; maxilliped 3 not quite reaching distal margin of basal peduncular segment of antenna 1; two distal segments of endopod bearing clumps of setae or spines, 2 stronger spines on terminal segment near apex. Pereopod 1 extending just beyond scaphocerite, setose fingers of chela slightly shorter than palm; carpus about twice length of chela, subequal to merus. Pereopod 2 extending beyond rostral apex by length of fingers; latter narrow, with straight cutting edges, longer than palm; carpus slightly longer than chela; merus three-quarters length of carpus. Pereopods 3–5 similar, becoming longer posteriorly, propodi armed with 3–5 widely spaced ventral spines, plus two ventrodistal spines; pereopod 5 with 4 short rows of setae ventrodistally. Pleopod 1, endopod elongate-oval, less than half length of exopod. Pleopod 2 with appendix interna half the length of strong setose appendix masculina. Outer uropodal ramus extending well beyond inner ramus and telsonic apex, outer margin straight, with short fixed spine and longer mobile spine at about base of distal fifth; outer (ventral) margin of basis terminating in triangular spine.

Female: Brood pouch formed by pleura and pleopods containing 7–9 large eggs (maximum diameter 2.4 mm).

Color Notes.—Animal in life almost completely transparent, except for pigment stripes and very faint scattered tiny red chromatophores. Purple-black stripe running almost from rostral apex, along ventral edge of rostrum, along underside of basal peduncular segments of antenna 1 and inner scaphocerite margins. Lateral stripe from antennal spine, in gently curved line across carapace onto base of third pereopod. Anterior stripe dividing posteriorly over upper lip, and running across base of maxilla 2 and maxillipeds 1–3, and onto anteroventral margin of carapace. Anterior margin of eyestalk with dark band. Branchiostegite with 3 more or less vertical lines, narrower than antennal stripe; faint line on carapace above branchial region; articulations of abdominal segments marked laterally by circular spots; abdomen with narrow midventral line of pigment ending on segment 5; anterior margin of pleuron 1, and posterior margins of bases of pleopods 1–3 with dark line; dark spots at base of uropods and on outer distal margin of both uropodal rami.

Remarks.—See "Discussion," p. 21.

Previous Records.—Rio Janaperi, near Manaus, Brazil (Ramos-Porto, 1979).

Pseudopalaemon bouvieri Sollaud

Figure 17

Pseudopalaemon bouvieri.—Holthuis, 1952:133, pl. 32.

Type-Locality.—Montevideo, Uruguay.

Material Examined.—USNM 84862, Concor-

Figure 17.—*Pseudopalaemon bouvieri*: *a*, anterior carapace; *b*, antennular peduncle and scaphocerite; *c*, pleurae 4 and 5.

dia, Argentina; USNM 155587, Laguna la Totora, Corrientes, Argentina.

PREVIOUS RECORDS.—Uruguay, Argentina, and Arroyo del Bellaco, Brazil (Holthuis, 1952).

Pseudopalaemon chryseus, new species

FIGURES 18, 19

MATERIAL EXAMINED.—*Holotype:* INPA, Rio Tarumazinho, 29 Aug 1980, coll. I.W., ♂: CL 4.5, RL 4.5, TL 23.

Paratypes: USNM 189044, Rio Taromazinho, 29 Aug 1980, coll. I.W., 2♂: CL 4.1, RL 4.3–4.4, TL 20–22; 4♀ CL 5.2–6.8, RL 4.9–5.0, TL 25–28; 6 juveniles: CL < 4.0. USNM 184887, Rio Negro, Anavilhanas Arquipélago, 28 Feb 1976, 2 ovigerous ♀: CL 7.0, RL 6.5–6.9, TL 31–32. INPA, Rio Negro, Anavilhanas Arquipélago, Lago Samauma, 8 Apr 1978, ♀: CL 7.9, RL 7.0, TL 35. USNM 184888, Rio Negro, Anavilhanas Arquipélago, 26 Aug 1979, ovigerous ♀: CL 8.0, RL 6.9, TL 34; ovigerous ♀: CL 6.9, RL 6.9, TL 31; ♀: CL 4.1, RL 5.0, TL 21. USNM 184889, Rio Tefé, 11 Mar 1980, ♂: CL 5.1, RL 5.0, TL 24; 3♀: CL 6.0–8.1, RL 5.6–6.8, TL 28–32.

Other Material: INPA, Rio Negro, near Rio Branco, 1♂. INPA, Rio Negro, Urubaxi, 3 Feb 1980, coll. M.G., 4♀, 6♂. INPA, Rio Preto da Eva, 10 Nov 1978, 3♀. INPA, Rio Tarumá, 12 Sept 1977, 1♀. INPA, Rio Negro near mouth of Rio Urubaxi, 6 Feb 1980, 4♂, 18♀, 6 juveniles.

DESCRIPTION.—*Male:* Rostrum equal to, or slightly longer than carapace, dorsally straight or very slightly upturned distally; ventrally gently convex; with faint rounded lateral ridge; 2 postorbital teeth; rostral formula: 8–9/3–5. Abdominal segments dorsally rounded; pleura 1–4 ventrally rounded, 5 posteroventrally bluntly acute, abdominal segment 6 about three-fourths as long as telson, with acute spine posteroven-

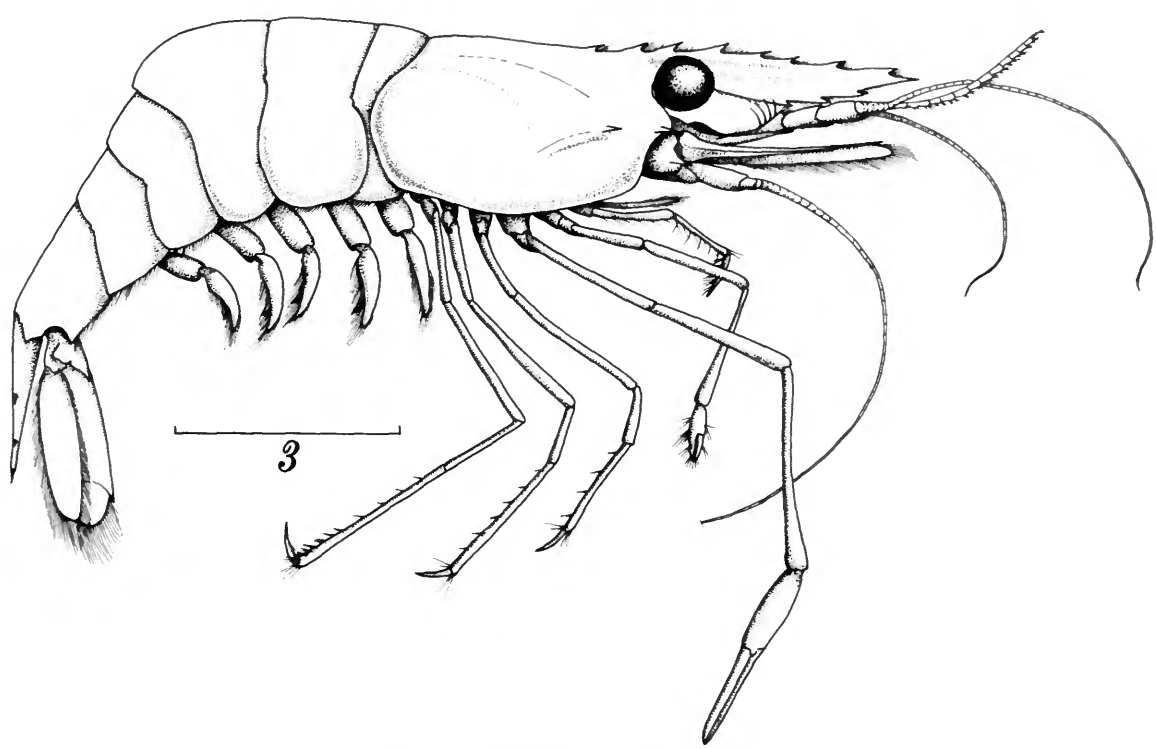


FIGURE 18.—*Pseudopalaemon chryseus*, lateral view.

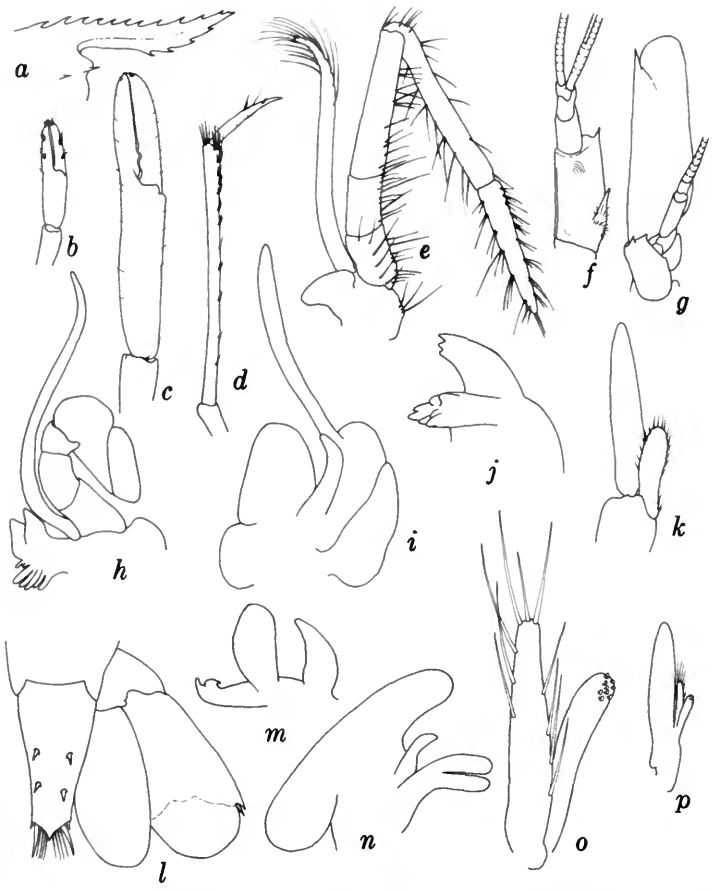


FIGURE 19.—*Pseudopalaemon chryseus*: *a*, lateral view of anterior part of carapace; *b*, pereopod 1 chela; *c*, pereopod 2 chela; *d*, pereopod 3 dactylus and propodus; *e*, maxilliped 3; *f*, antenna 1; *g*, antenna 2; *h*, maxilliped 2; *i*, maxilliped 1; *j*, mandible; *k*, ♂, pleopod 1; *l*, telson and right uropod; *m*, maxilla 1; *n*, maxilla 2; *o*, appendix masculina and appendix interna; *p*, ♂, pleopod 2 endopod.

trally. Telson with 2 pairs dorsal spines, first pair at midlength, second pair at base of posterior fourth; posterior margin triangular, with short outer and longer inner spine, 4 plumose setae on each side between inner spine and acute triangular apex.

Antenna 1, peduncle almost reaching end of scaphocerite; mesial margin of basal segment straight, lower mesial margin with small spine at midpoint; outer margin with slender acute spine proximally, acute spine at outer distal angle; second peduncular segment longer than distal segment, produced ventrodistally; dorsal flagellum fused for distance about one-fifth as long as free part, latter of 12–14 articles; ventral flagellum shorter than longer of 2 dorsal flagella. Antenna 2, scaphocerite reaching almost to rostral apex, outer margin straight, ending in acute spine not quite reaching apex of blade; basal segment with small ventrodistal spine; flagellum longer than longest antennular flagellum. Mandible lacking palp; incisor lobe with 3 cusps, molar

cylindrical, with 7 distal cusps. Maxilla 1, lower endite distally tapered, upper endite distally broad. Maxilliped 1 with broad epipod. Maxilliped 2, antepenultimate segment with mesiodistal fingerlike process. Maxilliped 3, terminal segment three-fourths as long as penultimate segment, bearing clumps of setae. Pereopod 1 reaching slightly beyond scaphocerite; chela less than half length of carpus, fingers subequal to palm in length. Pereopod 2, chela equal in length to carpus, fingers subequal to palm, each with 2 low proximal tubercles on cutting edge; merus two-thirds length of carpus. Pereopods 3–5 increasing in length posteriorly, pereopods 3 and 4 with 6–8 short spines on ventral margin of carpus; pereopod 5 with clumps of setae/spines distally on ventral margin, increasing in length distally. Pleopod 1, endopod elongate-oval, fringed with setae, about half length of exopod. Pleopod 2, endopod with distally tapering appendix masculina longer than appendix interna, bearing about 10 marginal spines. Uropodal basis with strong spine on outer margin; outer ramus only slightly longer than inner, with fixed and articulated spine on outer margin.

Female: Rostrum generally anterodorsally more curved than in male. Egg clutch size, 19–34; eggs, 1.5 × 2.0 mm.

Color Notes.—Animal in life semi-transparent, with overall pale golden color, and fine stippling of tiny red chromatophores. Gastric mass with patch of dark chromatophores visible in dorsal and lateral view. Midventral nerve cord with thin scattered line of chromatophores.

Remarks.—See "Discussion," p. 21.

Etymology.—The specific name, derived from the Greek word for golden, refers to the overall color of the living animal.

Pseudopalaemon gouldingi, new species

Figures 20, 21

Material Examined.—*Holotype:* INPA, Rio Negro, Ilha de Cumuru, Lago da Ilha, 1 Feb 1980, coll. M.G., ♂:CL 5.1, RL 4.0, TL 24.

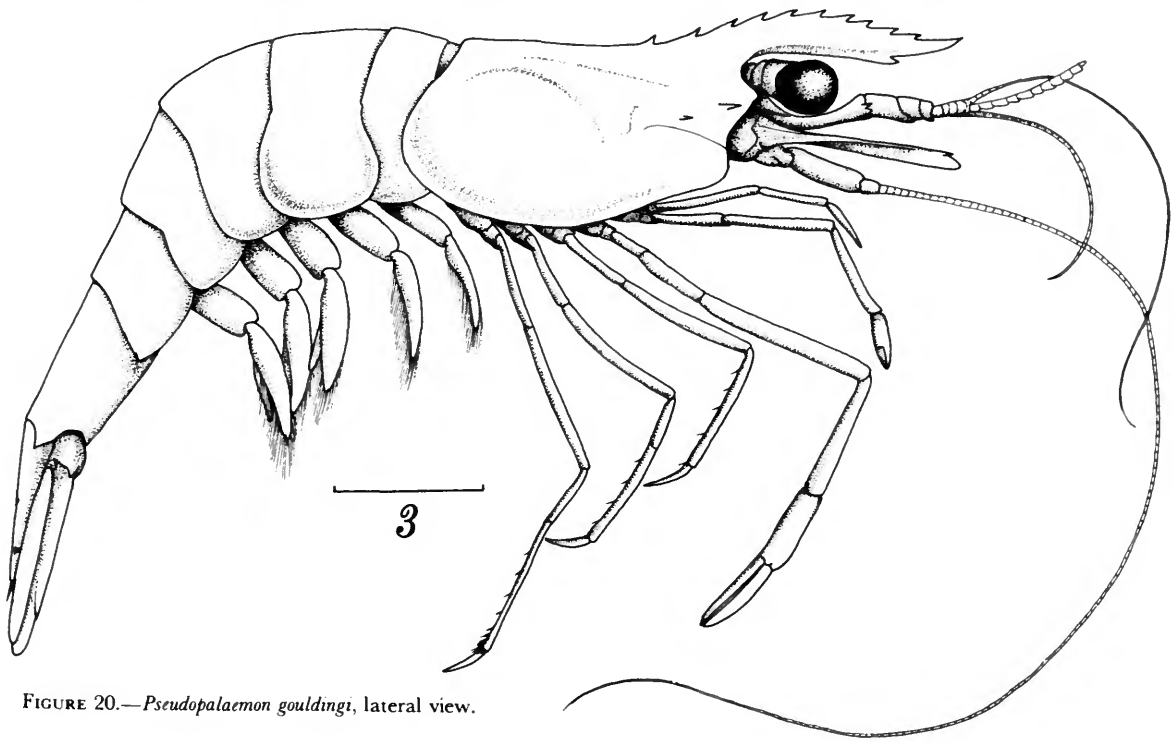


Figure 20.—*Pseudopalaemon gouldingi*, lateral view.

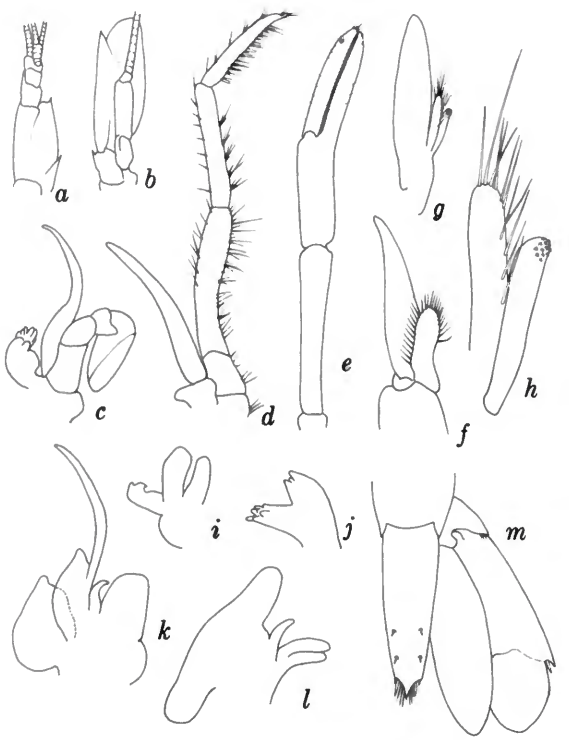


FIGURE 21.—*Pseudopalaemon gouldingi: a*, antenna 1; *b*, antenna 2; *c*, maxilliped 2; *d*, maxilliped 3; *e*, pereopod 2, chela and propodus; *f*, ♂ pleopod 1; *g*, ♂, pleopod 2 endopod; *h*, appendix masculina and appendix interna; *i*, maxilla 1; *j*, mandible; *k*, maxilliped 1; *l*, maxilla 2; *m*, telson and right uropod.

Paratypes: INPA, Rio Negro, Ilha de Cumuru, Lago da Ilha, 1 Feb 1980, coll. M.G., ♂: CL 5.4, RL 3.8, TL 25; ♀: CL 6.9, RL 4.8, TL 29; 508 juveniles, TL 17–20. INPA, Rio Cuieiras, 23 Nov 1979, ♂: TL 20. INPA, ovigerous ♀: CL 6.5, RL 4.5, TL 30. USNM 184890, ovigerous ♀: CL 7.0, RL 4.9, TL 30. INPA, Rio Negro, Paraná do Jacaré, 7 Oct 1979, coll. M.G., ♂: CL 5.2, RL 4.0, TL 24. USNM 184891, ♂: CL 4.9, RL 3.5, TL 23. USNM 184891, ♀: CL 7.9, RL 5.0, TL 34; 120 juveniles. INPA, Rio Negro, Urubaxi mouth, 6 Feb 1980, coll. M.G., ♂: CL 5.2, RL 3.8, TL 24; 3♀: CL 4.2–4.6, RL 3.4–3.6, TL 21–22; 120 juveniles. Rio Urubaxi, close to river mouth, 11 Feb 1980, coll. M.G., 118 juveniles.

DESCRIPTION.—*Male:* Rostrum shorter than carapace, markedly convex over orbit, with two or three postorbital spines, rostral formula: 8–13/1–3. Carapace with strong postmarginal antennal spine, smaller hepatic spine. Abdominal segments dorsally rounded; pleuron of abdominal segment 4 posteroventrally rounded, 5 rectangular, abdominal segment 5 half length of 6, latter subequal to telson in length. Telson with two pairs of dorsal spines in posterior half; posterior margin acutely triangular, with shorter outer and longer inner spines and several plumose setae.

Antenna 1, basal peduncular segment with strong proximal spine, smaller distolateral spine, margin between distolateral spine and base of second segment short, slightly convex; tiny spine at midlength of medioventral margin; shorter dorsal flagellum fused for distance about one-third as long as free part; ventral flagellum shorter than dorsal flagellum. Antenna 2, scaphocerite blade reaching beyond spine on straight outer margin; inner margin convex. Mandible with three-cusped incisor; molar with 7 cusps. Maxilliped 3 with two distal segments of endopod subequal in length, reaching midlength of carpus of pereopod 1. Pereopod 1, fingers of chela slightly shorter than palm; carpus shorter than merus. Pereopod 2 relatively robust compared to other legs; fingers of chela subequal in length to palm, cutting edges entire, each bearing row of short oblique setae; carpus about one-third shorter than merus. Pereopods 3–5 becoming more slender and elongate posteriorly; propodus with 5 or 6 small slender equally spaced spines on ventral margin. Pereopod 5, propodus with few rows of setae distally. Pleopod 1, endopod slightly less than half length of exopod; elongate-oval, with short marginal setae. Pleopod 2, endopod bearing appendix interna somewhat shorter than setose appendix masculina. Both uropodal rami extending well beyond telsonic apex; inner ramus elongate-lanceolate, apically rounded; outer ramus slightly longer and broader than inner, with a fixed and an articulated spine at base of distal third of outer margin.

Female: 22 eggs in brood pouch; eggs, 1.5 × 1.0 mm.

REMARKS.—See "Discussion," p. 21.

ETYMOLOGY.—The species is named for M. Goulding of INPA, Manaus, who collected both this and several other shrimp species.

Pseudopalaemon nigramnis, new species

FIGURES 22, 23

MATERIAL EXAMINED.—*Holotype:* Rio Marania, Rio Negro basin, 13 Oct 1979, coll. M.G., immature specimen: CL 3.8, RL 4.0, TL 20.

Paratypes:—INPA 10 immature specimens: CL 3.0–3.5, RL 4.0–4.5, TL 18–20. USNM 184892, 10 immature specimens: CL 3.0–3.4, RL 3.9–4.1, TL 17–19; 296 immature specimens.

DESCRIPTION.—*Immature specimen:* Rostrum longer than carapace, slightly crested over eye, one postorbital spine, rostral formula: 7–10/2–3, anterior third to quarter unarmed, spike-like, slightly upturned, faint rounded lateral ridge present. Carapace with strong antennal and hepatic spine. Abdominal segments dorsally rounded. Pleuron of abdominal segment 4 ventrodistally rounded, 5 almost rectangular; segment 5 half length of 6; telson subequal in length to abdominal segment 6, with 2 pairs of dorsal spines in posterior half; posterior margin acutely triangular, with slightly concave margins.

Cornea somewhat flattened, wider than eyestalk, ocellus small, inconspicuous. Antenna 1 with small spine at midlength of mesioventral margin of basal segment; margin between distolateral spine and second peduncular segment faintly sinuous; inner ventral flagellum reaching rostral apex, fused part about one-fifth as long as free part; dorsal flagellum subequal in length to inner dorsal flagellum. Antenna 2, scaphocerite blade extending well beyond distal spine on outer margin. Mandible with 3-cusped incisor, cylindrical molar with 6 or 7 terminal cusps. Maxilliped 3 not quite reaching midlength of carpus of pereopod 1, penultimate segment slightly longer than terminal segment. Pereopod 1, fingers of chela subequal in length to palm; carpus and

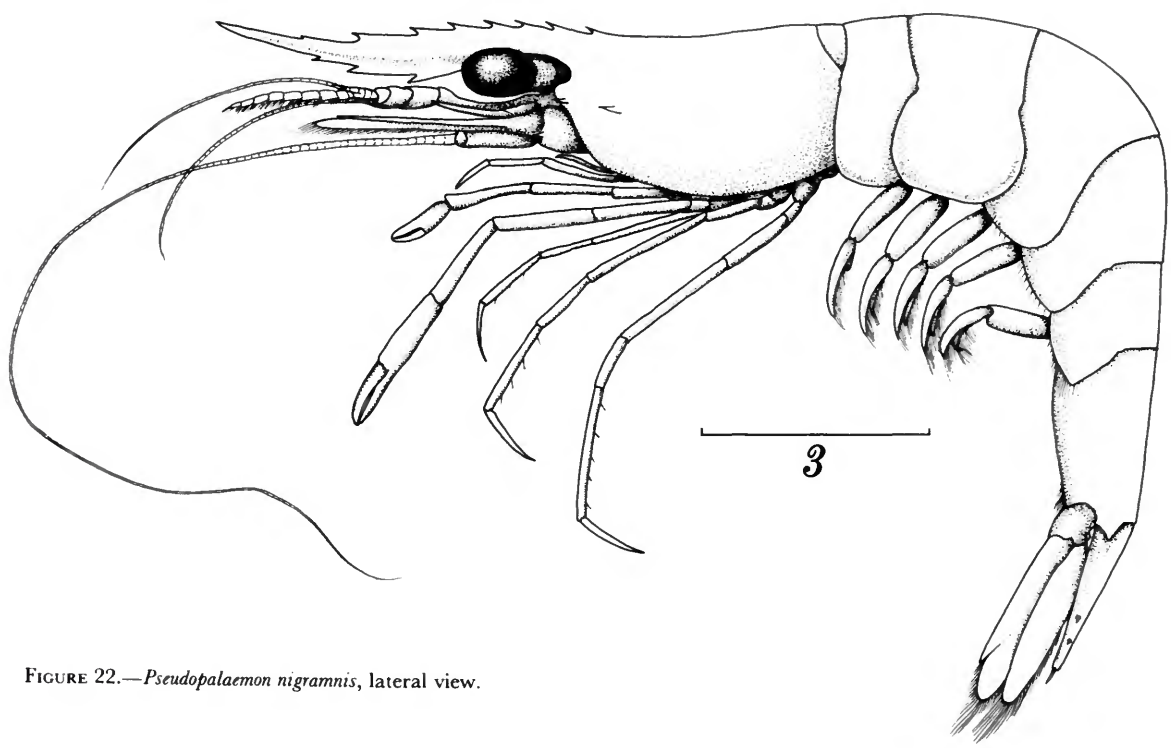


FIGURE 22.—*Pseudopalaemon nigramnis*, lateral view.

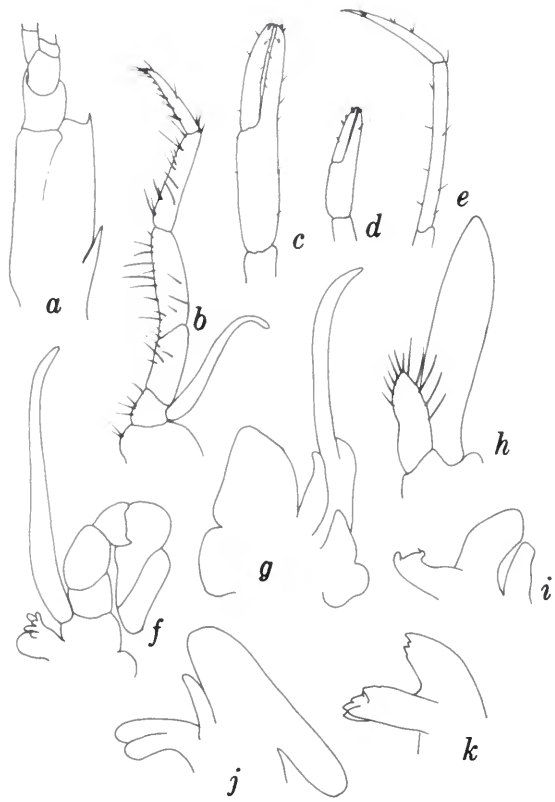


FIGURE 23.—*Pseudopalaemon nigramnis*: *a*, antenna 1; *b*, maxilliped 3; *c*, pereopod 2 chela; *d*, pereopod 1 chela; *e*, pereopod 3 dactylus and propodus; *f*, maxilliped 2; *g*, maxilliped 1; *h*, ♂, pleopod 1; *i*, maxilla 1; *j*, maxilla 2; *k*, mandible.

merus subequal in length. Pereopod 2 relatively robust; carpus and merus subequal in length; fingers of chela with cutting edges entire, slightly shorter than palm, reaching beyond scaphocerite. Pereopods 3–5 with dactyli at least half length of propodi, becoming more elongate posteriorly. Pereopod 5 with few small spines on posterior margin of propodus, but lacking distal rows of setae. Pleopod 1, endopod lanceolate, margins with widely spaced plumose setae. Uropodal rami subequal in length, extending well beyond telsonic apex; fixed spine on outer margin of outer ramus at base of distal third of length.

REMARKS.—See the following "Discussion."

ETYMOLOGY.—The specific name is derived from the Latin *niger* (black) plus *amnis* (river), and refers to the Rio Negro.

DISCUSSION.—Apart from the type-species, *Pseudopalaemon bouvieri* Sollaud, only *P. amazonensis* has been described in this genus. The description of the latter species appeared in summary form in the proceedings of the Annual Meeting of the Sociedade Brasileira para o Progresso de Ciência for 1979 (Ramos-Porto, 1979:693). Although the report is very brief and no figures are provided, the author does list the major differences between it and *P. bouvieri*. This species is fully described above, along with three new species. Considerable hesitation was felt in describing *P. nigramnis*, for although the sample consists of about 300 specimens from a single locality, no adults were caught. Nevertheless, these specimens differ sufficiently from immature specimens of the other four species to be distinguished with some ease. Unfortunately, we have seen live material only of *P. amazonensis* and *P. chryseus*; the three remaining species were collected by M. Goulding incidental to fish-collecting.

Ecological Notes

Some background information on the Amazonian river basin is necessary before the ecology and biology of the shrimp can be discussed. The rivers involved in this paper include the Amazon (called the Solimões above Manaus) and the Rio Negro, with their tributaries (see Sioli, 1950).

Water level fluctuates in these rivers with annual periodicity over an average of about 9–10 m (range 7–13 m). From December/January to May/June the water rises; this is the period of "enchente." From August to November, the water level falls—the period of "vazante." During the enchente enormous expanses of forest are inundated, and, depending on their altitude, remain so for weeks or even months. The Amazon carries so-called "white water," which, due to suspended sediment, is the color of light milk-coffee. Its pH is close to neutral, and it is fairly rich in dissolved nutrients (conductivity ~70μ Siemens). Lakes and inundated forests (and de-

forested areas) fed by these waters abound with macrophytes and algae, and support the famous "floating meadows." Areas inundated by white water are termed "várzea." In contrast, the waters of the Rio Negro and the majority of its tributaries are lower in mineral content than rain water (conductivity 14–20μ Siemens), and carry almost no sediments. Streams draining sandy forest soils rich in organic matter (Campinas and Campinaranas) contain dissolved humic and fulvic acids, and their waters appear light brown and transparent in transmitted light, but black in incident light falling on deep layers (Leenheer, 1980). Streams originating in heavy clay-rich latosols are completely clear and colorless. The Rio Negro and most of its tributaries carry a mixture of clear and black water. Both are distinctly acid (pH 3.8–5.8). These waters are devoid of macrophytes, and algal density is very low. The inundated forest of the Rio Negro basin is termed "igapó;" regions that are never inundated are referred to as "terra firme." The food chains in these nutrient-poor black and clear waters, with their negligible primary production, start with decomposition of organic material that falls into the water from the surrounding forest, mostly leaf litter and dead wood. Decomposition in this acid milieu is accomplished predominantly by fungi, which constitute the main source of protein in the food chains of this ecosystem.

The periods of vazante and enchente in the lowlands, together with the intensity of precipitation and drainage of the terra firme, determine the pattern and intensity of water currents as well as the distribution pattern (i.e., accumulation, elimination, desiccation, and inundation) of water plants and organic materials. According to these fluctuations, which are strictly periodic in the lowlands and more erratic toward the terra firme, the aquatic faunas colonize and abandon areas, dispersing and retreating with the advancing and receding waters.

Biological Notes on Black- and Clear-Water Shrimp Species

HABITAT.—Six of the species listed in this paper were collected repeatedly over a period of four years in the course of a general research program on the invertebrate fauna in black- and clear-water streams in the region of Manaus (see Figure 24; Walker, 1978). We are thus able to furnish some ecological and biological data along with their taxonomy. The study concentrated largely on the animal communities in submerged leaf litter, from which the bulk of the biomass of these river-systems seems to originate. The following six species were collected in this habitat: *Euryrhynchus amazoniensis*, *Macrobrachium inpa*, *M. nattereri*, *Palaemonetes carteri*, *Pseudopalaemon amazonensis*, and *P. chryseus*. These species can be assigned to 2 ecological groups: 1) *E. amazoniensis*, *M. nattereri*, and *M. inpa*, the three species that live and forage inside accumulations of litter and are never observed outside this cover; 2) *P. amazonensis*, *P. chryseus*, and *P. carteri*, species that take refuge inside the litter accumulations when disturbed, perhaps regularly spend some time in their hiding places, but can also be observed in open water on the sandy bottoms of streams or above the litter layer. If bait is left in a stream, *Macrobrachium* species emerge for the instant necessary to grasp and drag it under cover, while *Pseudopalaemon* species tackle it in the open water. In its natural habitat, *Euryrhynchus* never stirred on presentation of any bait (see Table 2). Observations of all but *P. carteri* in the laboratory suggest that these decapods are rather sedentary in behavior, having habitual hideouts in aquaria. An individual *Euryrhynchus*, for example, was invariably found under the same leaf over a period of many weeks. In the natural habitat they would have to move about according to currents and water level fluctuations, yet this does not exclude the possibility that they live in defined places as long as circumstances permit.

FEEDING.—In all six species, the contents of full stomachs have been analyzed for a number of individuals (Table 3). (The stomach contents of some of the species collected by Michael Goulding, not represented in the black-water leaf litter habitat, were examined. These were from long-preserved material, and only brief descriptions of food-remains are given in these cases.)

It would seem that stomachs are filled to ca-

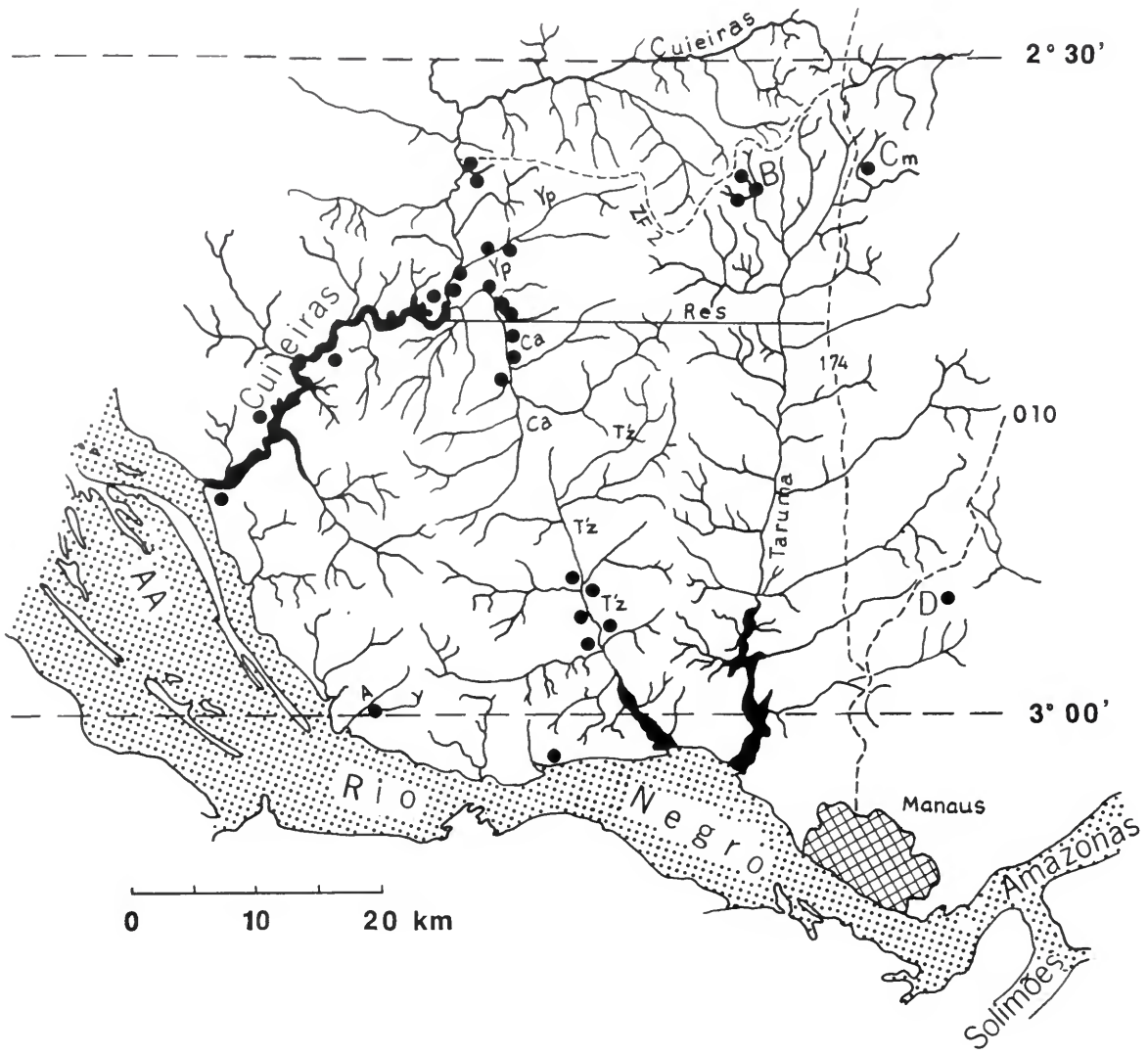


FIGURE 24.—The basin of the Cuieiras, Tarumã, and Tarumazinho (T'z) rivers, with collection sites, adapted from Projeto RADAMBRASIL, 1:250,000. (Black circles = collection sites; A = Igarapé [small stream] Arara; AA = eastern end of the Anavilhanas Arquipélago [extending for 80 km upstream]; B = experimental hydrographic basin in the INPA Forest Reserve, Km 60, with the two igarapés Beija Flor and Bacia, Road Br 174; Ca = Igarapé da Cachoeira; Cm = Forest Reserve Campina, with the Igarapé da Campina; D = Forest Reserve Ducke, Road 010 to Itacoatiara, with the Igarapé Barro Branco; Res = southern boundary of the Forest Reserve Km 60; T'z = Rio Tarumazinho (or Tarumã-Mirim); Yp = Igarapé Ypiranga [local name, Igarapé Ambrosio on RADAM map]; ZF 2 = local road and boundary of the Forest Reserve km 60. Only sites B, Cm, and D are not contiguous with the igapó [inundated forest]. The customary name of the Reserve in INPA is "Reserva Km 60;" however, according to the new enumeration, the forest reserve is at km 45, highway Br 174.

TABLE 2.—Acceptance (+) and rejection (−) of bait by five black- and clear-water shrimp species

Bait	*Eurythynchus amazoniensis*	*Macrobrachium nattereri*	*Macrobrachium inpa*	*Pseudopalaemon chryseus*	*Pseudopalaemon amazonensis*
Natural habitat					
Bread	−	−	−		−
Cheese	−	+	+		+
Meat	−	+			+
Laboratory					
Pupunia[1]	−	+	+		+
Beef liver	−	+	−	+	+
Commercial fish meat		−			
Freshly killed insects (ants, beetles, roaches)	−		−		
Live insects (ants, beetles, roaches)	−		−		
Termites, live on surface			+		
Insect larvae					
Chironomids, live	+		+		
Mosquitoes, live	+		+		
Small fish, dead[2] (Siluriformes, Pimelodidae, *Hypopygus* sp., Cichlids in decomposition)		+			

[1] Fruit of local palm tree.

[2] Healthy fish are never attacked by shrimp.

pacity, then time is allowed for digestion to run its course, as no more than 10–25% of animals have a full proventriculus in any collection and the contents appear to be in a fairly homogeneous state within any single stomach. All six species prey predominantly on arthropods, especially aquatic insect larvae. The frequency of stomachs containing fungi, plant material, and sponges is considerable, but in terms of volume these resources appear to be of secondary importance. Prey is frequently swallowed whole, then ground up within the proventriculus. At least in the *Macrobrachium* species, sand seems to be taken up, perhaps to assist in trituration. It was ascertained in the laboratory that *Eurythynchus amazoniensis* and *Macrobrachium inpa* catch their prey live; both were observed catching and ingesting live chironomid and mosquito larvae. Prey organisms found whole in stomachs include Cladocera, Ostracoda, oligochaetes (?Lumbriculidae), chironomid larvae (up to 9 entire chironomid larvae were found in a single stomach of *M. nattereri*), Plecoptera and Ephemeroptera (identified from mandibles), a trichopteran pupa, and hydrophiliid beetle, a small dipteran, nematodes, a microhymenopteran, and hydrachnid, oribatid, and parasitic mites.

The variety of material found in the stomachs of the shrimp species is presented in Table 3; particulars of distribution and behavior for each shrimp species are given in the following section.

Biological Notes on Individual Species

Eurythynchus amazoniensis: This species is typical of shallow igapó waters, and was never collected in streams remote from the inundated forest. It colonizes small streams contiguous with the igapó, and retreats into these refuges when the forest becomes dry during the vazante. Ovigerous females were found only during the period of rising water. The species is restricted to the habitat of submerged leaf litter, and individuals may

TABLE 3.—Frequency of shrimp (n = 25) found containing various materials in stomachs (blank = no data)

Stomach contents	*Eurythynchus amazoniensis*	*Macrobrachium nattereri* juvs	*Macrobrachium nattereri*, adults	*Macrobrachium inpa*	*Pseudopalaemon chryseus*	*Pseudopalaemon amazonensis*	*Palaemonetes carteri*
Sand	3	7		11	4	1	
Fungi (spores, hyphae)	13	12		15	11	13	8
Algae							
Unspecified		2	1		3	2	
Diatomaceae	1			1	5	1	7
Desmidiaceae (*Micrasterias*)	1	1			6	3	
Plant tissue							
Unspecified	12	6	4	4	3	4	3
Fruits, seeds, flowers			1	1	3		
Bryophyta			1	1			
Thecamoebae	3	2		1	3	1	
Spongia	10	11	4	3	9	8	6
Nematoda	1			1		1	
Rotifera	2	1				4	1
Annelida							
Naididae	7	7		14	8	11	4
Other (?Lumbriculidae)		1		1		1	
Tardigrada	1	2			2	2	
Crustacea							
Cladocera	4	4		2	1	4	2
Ostracoda						1	
Copepoda	2					4	
Decapoda			1	6		3	
Arachnida							
Unspecified		1				2	
Acari (Oribatidae, parasites)	5	2	1	1	4	9	
Hydracarina		1			1	2	
Insecta							
Odonata (larvae)		2	2	3			
Trichoptera (larvae)	1	1		2	2		
Ephemeroptera (larvae)	2	3		2	3	6	
Plecoptera (larvae)		4		7	2	9	
Chironomid (larvae)	3	7	7	9	4	12	
Diptera (pupae, adults)	2		1	2			
Trichoptera (pupae)	1			1			
Hymenoptera (ants)			10				
Hymenoptera (others)						2	
Termites			2				
Coleoptera (adults)	4	7	1	13	10	6	2
Unspecified arthropod material	16	21		11	15	10	7
Invertebrate eggs	1		1	1	3	1	
Vertebrates							
Fish		1	1				
Lizard or frog embryo		1					

be found together with those of any other of the six species in the same place, or indeed, in the same litter sample of about 100 grams dry-weight.

Macrobrachium amazonicum: Of 10 specimens examined for stomach contents, all contained plant remains, including algal filaments; seven had setae (either oligochaete or larval insect); seven had arthropod (mainly larval insect) remains; five had diatoms; five had fine sediment grains; one had a single fish scale; one had two different dipteran larvae.

Macrobrachium inpa: This species has the same habitat and distribution as the juveniles of *M. nattereri*; in fact, the juveniles of the two species are sometimes difficult to distinguish. The adults of *M. inpa* remain in submerged leaf litter, and in the laboratory were not seen to leave this even at night. In the region of the igapó, ovigerous females were found only during rising water, but in the small streams of the terra firme, ovigerous females appear sporadically the year round. *Macrobrachium inpa* is less of a scavenger than *M. nattereri*, and has been observed to feed on the young stages of shrimp. The prey species could not be ascertained, but it is probable that it was either its own young or that of its congener.

Macrobrachium jelskii: Of 10 specimens examined for stomach contents, all contained setae (either oligochaete or larval insect); eight had arthropod remains (mainly larval insect), three individuals contained a single ostracode each; diatoms were present in five, algal remains in four. Fine sediment grains were found in seven specimens.

Macrobrachium nattereri: The juveniles live in submerged leaf litter, and, according to laboratory observations, do not leave this cover even at night. The adults, however, hide in hollows of dead wood in rivers, streams, and in the igapó during the day, emerging at night. They were collected at night in large numbers on the sandy bottom of the Rio Tarumã and Rio Cuieiras, by Efrem Ferreira. Within the dead submerged branches, they are often densely packed in with siluroid fish *Trachycoristes trachycoristes* (Auchenipteridae). Besides being a voracious predator, *M. nattereri* is also a scavenger. The species extends from the igapó to the remote sources of small streams of the terra firme of either black or clear water. In the igapó, this species occurs with the other five leaf litter dwellers, but is found less frequently than *Euryrhynchus amazoniensis*.

Palaemonetes carteri: In the leaf litter areas sampled, this was the least common shrimp species. It is rare in the Tarumazinho, but locally abundant in the Rio Cuieiras basin, where it was found together with *Pseudopalaemon chryseus*. In the clear water of the Rio Urubaxi, the species is abundant, and is also recorded here from white water of the Rio Madeira. As it was only recognized as a separate species during analysis of preserved material, nothing can be said about its behavior. The species did not appear in samples from the small terra firme streams remote from the igapó.

Examination of the stomach contents of 10 adults revealed algal filaments in five, arthropod remains in one, and oligochaete remains in one.

Pseudopalaemon amazonensis: This is essentially an open water species, and can easily be observed in shallow running water on sandy bottoms. It takes refuge in leaf litter when inactive or when disturbed, but only in the vicinity of running water. Its distribution extends from the igapó up into the smallest streams of the terra firme. Ovigerous females appear during rising water in the igapó, and sporadically the year round in small terra firme streams. The spectrum of its diet is most similar to that of *P. chryseus* and is characterized by a predeliction for rotifers, microcrustacea, and acari. The animals accept bait readily in their natural habitat.

Pseudopalaemon chryseus: This species is found in the shallow igapó (but less frequently than *Euryrhynchus*), in litter beds in the meanders of rivers, and in small streams contiguous with the igapó. It was never found in the small streams of the terra firme remote from the igapó. In the laboratory it spends most of the time hidden in the litter, but occasionally forages in the open water above the leaves during the day. The observation that in the laboratory it feeds more on

algae and less on debris of higher plants than do *M. inpa*, *M. nattereri*, or *E. amazoniensis*, suggests that this behavior also holds in the natural habitat.

Pseudopalaemon gouldingi: This is a clear-water species, and is locally abundant in the Rio Urubaxi. Of the 10 specimens examined for stomach contents, diatoms were present in five, eight had arthropod remains (mainly larval insects), and one had unidentifiable plant remains.

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