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A NEW SPECIES AND TWO NEW SUBSPECIES OF SHRIMP OF THE GENUS *PENAEUS* FROM THE WESTERN ATLANTIC

By Isabel Pérez Farfante[1]

Bureau of Commercial Fisheries Ichthyological Laboratory, Washington, D. C.

Many aspects of the biology of various species of *Penaeus* from Atlantic America, particularly of the three most common in North America, have been and continue to be the object of much research. Thus far, however, the information gleaned has little bearing on systematics, and only meager information has been accumulated in this field since Burkenroad (1934, 1939), published his major contributions to the systematics of the genus. He advanced considerably our understanding of the group, but the lack of adequate material prevented him from carrying his work to completion and often from reaching definite conclusions.

I have been able to assemble extensive collections from much of the range of the genus in the western Atlantic, and to carry out biometric studies. Such studies of large series of specimens have revealed several recognizable geographic taxa among the widely ranging species of *Penaeus*. Among them are the species and two subspecies described below. A monograph of the western Atlantic species, subspecies, and subpopulations, including full descriptions and figures, as well as an evaluation of the significant information on the biology of each, is near completion.

The present paper has been made possible through the cooperation of many institutions and individuals. I am particularly indebted to Fenner A. Chace and Horton H. Hobbs for many suggestions, to Daniel M. Cohen for continuous encouragement, and to Harvey R. Bullis for

[1] Isabel C. Canet.

critical material from usually inaccessible localities. Also hearty thanks are due to María Manuela Diéguez de Farfante for preparing the drawings included here. The work was done with the support of the Radcliffe Institute for Independent Study, the Bureau of Commercial Fisheries, and the National Science Foundation (Grant No. GB-3907). The various institutions that made material available are cited by abbreviations before each lot to indicate where it is deposited: American Museum of Natural History (AMNH); Centro de Investigaciones Pesqueras, Cuba (CIP); Muséum National d'Histoire Naturelle, Paris (MNHNP); Museum of Comparative Zoölogy, Harvard University (MCZ); University of Miami Marine Laboratory (UMML); United States National Museum (USNM); and Peabody Museum of Natural History, Yale University (YPM).

Particularly useful information pertinent to the species and subspecies described below can be found in the following works: Boschi (1963), Burkenroad (1934, 1939), Davant (1963), Eldred and Hutton (1960), Holthuis (1959), Ives (1891), Lindner (1957), Magalhães (1944), Mistakidis (1965), Ortmann (1891), Pérez Farfante (1953, 1954), Pérez Farfante, Acosta, and Alemany (1961), da Silva (1965), Tremel and Mistakidis (1965).

Penaeus paulensis new species

Fig. 1 a–d

Camarão rosa, ("pink shrimp"); langostino

Penaeus brasiliensis: Ortmann, in part, 1891. Zool. Jahr. Abt. Syst. Geogr. Biol. 5(3): 445–449, table 36, Figs. 1 a–c; not *P. brasiliensis* Latreille 1817.

Penaeus aztecus: Burkenroad, in part ("Form C"), 1939. Bull. Bingham Oceanogr. Coll. *6*, art. 6: 34–45, figs. 32, 33; not *P. aztecus* Ives 1891.

Holotype: 1 ♂, USNM 119128, Santos, São Paulo, Brazil, April 1964, M. Vannucci.

Paratypes: BRAZIL: Rio de Janeiro: 1 ♂, 1 ♀, MNHNP–USNM, off mouth Guanabara Bay, 34–65 fms, 2 December 1961, *Calypso* Sta. 105. 1 ♂, 1 ♀, YPM, Rio de Janeiro. 2 ♂, 2 ♀, USNM, Santana Island, 16 fms, SUDEPE. 1 ♀, USNM, off Rio de Janeiro, 23 August 1925, S. M. Waelsof. São Paulo: 3 ♂, 1 ♀, USNM, off São Sebastião, 20–35 fms, 10 December 1961, *Calypso* Sta. 129. 2 ♂, 2 ♀, MNHNP–USNM, off São Sebastião, 25–30 fms, 10 December 1961, *Calypso* Sta. 130. 3 ♂,

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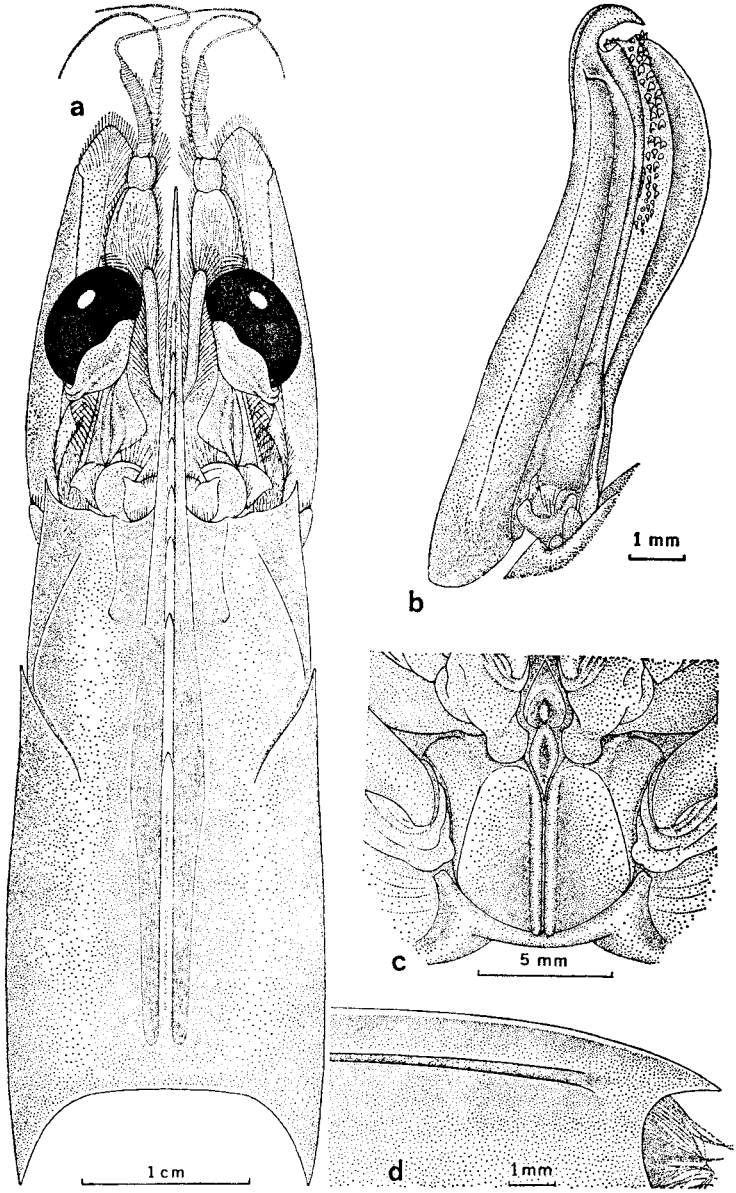
Fig. 1. *Penaeus paulensis* n. sp. *a*, Carapace, holotype ♂ 35 mm c.l., Santos, São Paulo, Brazil. *b*, Petasma, ♂ 39 mm c.l., S Point do Boi, São Paulo, Brazil. *c*, Thelycum, ♀ 49.5 mm c.l., Santos, São Paulo, Brazil. *d*, Sixth abdominal somite (posterodorsal portion), holotype.


a
1 cm
b
1 mm
c
5 mm
d
1mm

MNHNP–USNM, São Sebastião, 11 fms, 11 December 1961, *Calypso* Sta. 135. 2♂, 1♀, MNHNP–USNM, off Point do Boi, 26–40 fms, 11 December 1961, *Calypso* Sta. 136. 12♂, 3♀, MNHNP–USNM, off Point do Boi, 36–30 fms, 11 December 1961, *Calypso* Sta. 137. 2♂, 3♀, USNM, Santos, 8 May 1964, M. Vannucci. 1♂, USNM, Santos, June 1913, H. Leuderwaldt. 1♂, USNM, Santos, 24 October 1949, Carvalho. 11♂, 11♀, USNM, Cananéia, September 1965, V. Sadowski. 4♂, 1♀, MNHNP–USNM, Laje dos Santos Island, 24–75 fms, 14 December 1961, *Calypso* Sta. 143. SANTA CATARINA: 4♂, 5♀, USNM, Lake da Conceição, Santa Catarina Island, 19 November 1965, E. Tremel. 3♂, 3♀, MNHNP–USNM, Zimbros Bay, 16 December 1961, *Calypso* Sta. 148. RIO GRANDE DO SUL: 1♀, MNHNP, off Mostardas, 17 December 1961, *Calypso* Sta. 151. 1♀, MNHNP, off Mostardas, 36–30 fms, 17 December 1961, *Calypso* Sta. 152. 9♂, 13♀, MCZ, Rio Grande, 7 June 1865?, G. Harrington. 3♂, 3♀, MNHNP–USNM, off southernmost end Rio Grande do Sul, 20 December 1961, *Calypso* Sta. 155. URUGUAY: 2♂, 3♀, USNM, Arroyo Balizas, Castillos Lake, 19 April 1961, H. Ferrando. 3♂, 1♀, USNM, Lake de Rocha, 18 April 1961, H. Ferrando. 2♂, 1♀, USNM, Lake de Rocha, 18 April 1961, H. Ferrando.

Description: Rostrum short, reaching at least distal half of second antennular segment but not beyond distal end of third, slender and straight in apical portion. Adrostral sulcus (Fig. 1a) broad along entire length, width 1 to 2 times postrostral carina width, long, ending 1/12 to 1/20 carapace length from posterior margin of carapace. Median sulcus short, ending well anterior to posterior end of adrostral sulcus; shallow, continuous or interrupted, often limited to anterior fossette.

Dorsolateral sulcus (Fig. 1 d) very narrow, relation between keel height and sulcus width (measured at distance about 1/8 somite length from posterior margin) 3 to 15, modally 6. K/S (keel/sulcus) relation showing modal value of 6 for all size classes of both sexes.

Third pereopod short, reaching at least distal third of second but not beyond distal end of third antennular segment, shorter in larger individuals.

Petasma (Fig. 1 b): Ventral costa broad and blunt at distal end, extending proximally in extremely slight curve or almost straight line, with free distal border even or with faintly undulating flange; group of medium sized, irregularly set teeth close to apex. Membranous portion of ventrolateral lobule with band of spines, very narrow distally, moderately wide proximally. Distal fold of lateral lobe armed with prominent spinules.

Thelycum (Fig. 1 c): Apical process typically very narrow, bordered by nearly triangular or highly arched ridge, with knob often at center of slightly concave ventral surface. Posterior protuberance with median carina bifurcated anteriorly, forming two ridges converging at apical process, resulting in narrow, diamondshaped structure. Lateral plates

with anteromedian angles divergent, leaving posterior protuberance exposed.

Color: Usually pinkish, thus the name camarão rosa ("pink shrimp") is applied to it in different localities within its range.

Size: The largest female examined was 54 mm c.l., 215 mm t.l., and the largest male, 40 mm c.l., 171 mm t.l.

Distribution: *P. paulensis* ranges from south of Cape Frio along the coast of Brazil to Lake de Rocha and, according to Burkenroad (1939), as far south as Montevideo, Uruguay. The specimen mentioned by Boschi (1963) in the Museo Bernardino Rivadavia, in Buenos Aires, labeled "North Patagonia," may possibly be a straggler from waters farther north.

Name: I have named this species for São Paulo State, Brazil, where it is fished commercially in large quantities offshore as well as in the estuarine waters along the coast.

Remarks: *P. paulensis* is closely allied to *P. aztecus aztecus* from northern waters and *Penaeus aztecus subtilis* (see below) from the Caribbean Sea and the Atlantic off northern–eastern South America. It differs from both by the narrower dorsolateral sulcus in which both lips are sharp and by the external genitalia. Females have the apical process and the posterior protuberance of the thelycum much narrower than in *P. a. aztecus* and *P. a. subtilis*, and in the males the ventral costa of the petasma is almost straight or only slightly curved rather than markedly convex distally; and also is armed close to the apex with a group of teeth of moderate size and irregularly set, instead of a compact, elongated patch of small teeth on the attached edge of the ventral costa as is typical of the two subspecies of *P. aztecus*. It also differs from *P. a. aztecus* by the shorter, shallower, and often interrupted median sulcus, and shorter third pereopod; and from *P. aztecus subtilis* by the broader adrostral sulci.

Burkenroad (1939) referred to this shrimp as *Penaeus aztecus* Ives "Form C," which he distinguished from the typical *P. aztecus* by characters other than the external genitalia; however, both the thelycum and particularly the petasma are characteristic. Consequently, I consider this southern *Penaeus* a distinct species. The female *P. aztecus* "Form C" recorded by Burkenroad from Pernambuco is most likely a specimen of *P. a. subtilis* in which the adrostral sulcus is narrow, the width at the lowest limit of its range of variation.

Penaeus aztecus subtilis new subspecies

(Fig. 2 a–b; Fig. 3 a–c)

Langostino amarillo, ("yellow shrimp"); camarón marrón ("brown shrimp"); short feelered prawn; sara-sara; camarão lixo, ("dark shrimp"); camarão branco ("white shrimp").

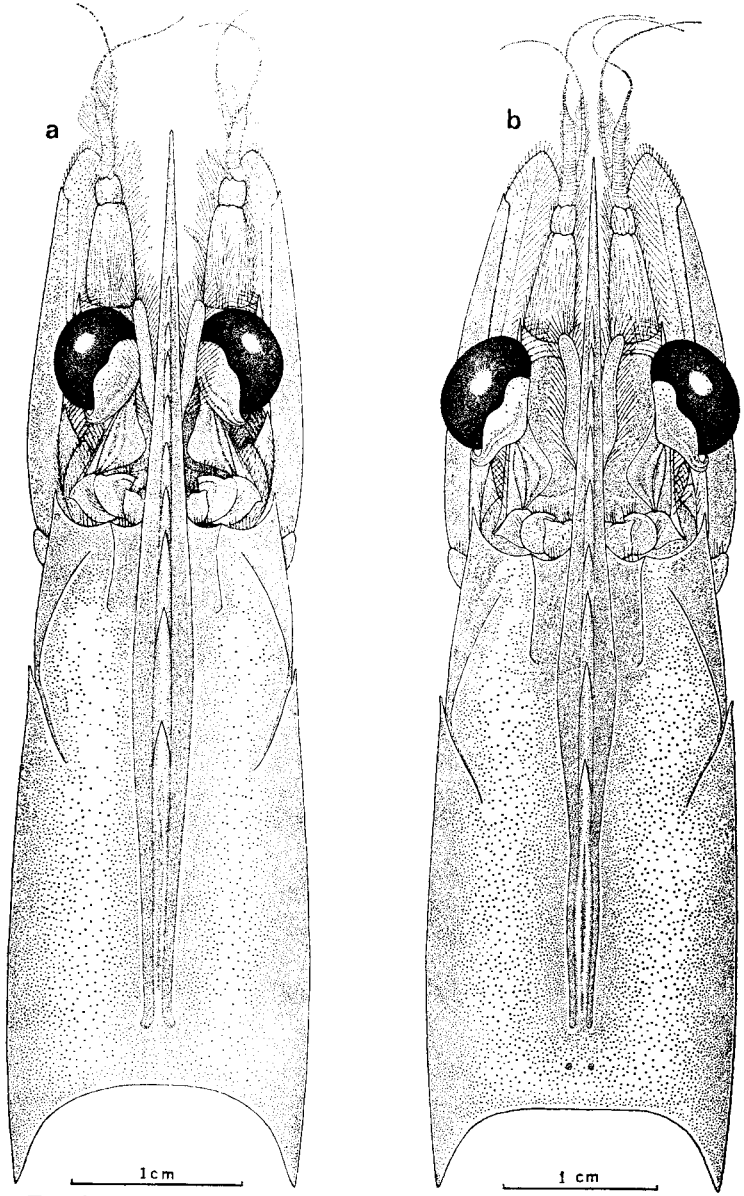
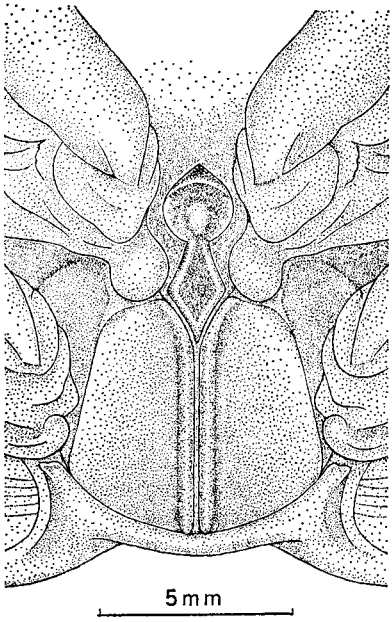


FIG. 2. *Penaeus aztecus subtilis* n. subsp. *a*, Carapace, ♀ 36 mm c.l., Gulf of Venezuela. *b*, Carapace, ♀ 35 mm c.l., off mouth Surinam River, Surinam.

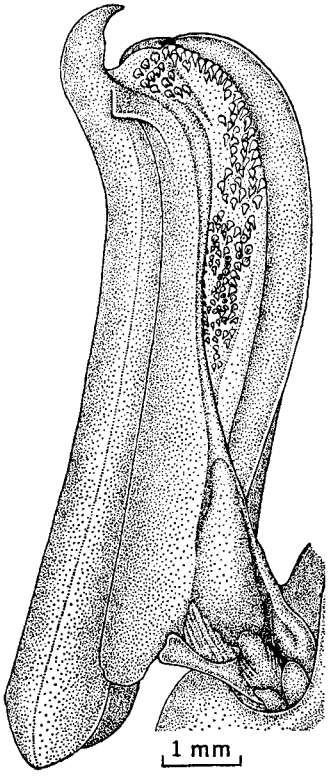
Penaeus aztecus Ives, Burkenroad in part ("Form B"), 1939. Bull. Bingham Oceanogr. Coll. 6: 34–52 Figs. 28, 29.

Holotype: ♂, USNM 119130, off Gallinas Point, Departamento de la Guajira, Colombia, 95 fms, 9 October 1965, *Oregon* Sta. 5685, 12°29′ NL, 71°54′WL.

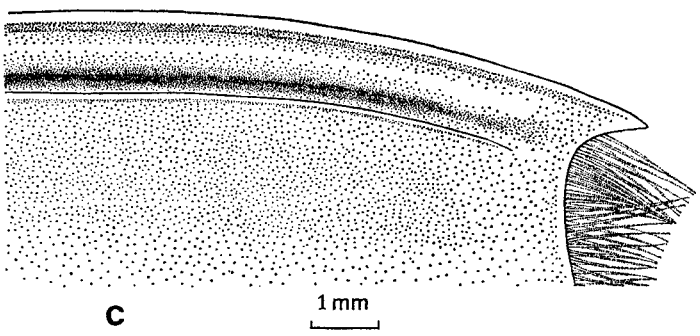
Paratypes: CUBA: 1♀, USNM, Doctor Lagoon, Baracoa Beach, Havana, 1958, G. Mayor. 1♂, 2♀, USNM, Canímar River, Matanzas, 1954, C. Sánchez. 1♂, USNM, Key Francés, Caibarién, 300 fms [?], M. S. Roig. JAMAICA: 3♂, 1♀, YPM, western end Kingston Harbor, 4 feet, 1 February 1934. 5♂, 4♀, YPM, Kingston Market, 1 February 1934. 16 ♂, 11♀, USNM, 1–11 March 1884, *Albatross*. 1♂, 1♀, USNM, Montego River (1 mile from sea), 11 July 1916, C. B. Wilson. HAITI: 1♂, USNM, Port au Prince, 8 November 1965, A. Curtis. SANTO DOMINGO: 1♀, USNM, Puerto Plata, Ch. H. Fraser. PUERTO RICO: 3♂, 1♀, USNM, Mayagüez Harbor, 75–76 fms, 19–20 January 1899, *Fish Hawk*. 1♂, 4♀, USNM, Puerto Real, 26 January 1899, *Fish Hawk*. 1♂, 4♀, USNM, Hucares, 13–14 February 1899, *Fish Hawk*. VIRGIN ISLANDS: ST. CROIX: 12♂, 11♀, USNM, 27 January 1937, H. A. Beatty. 5♂, 3♀, USNM, Envy Bay, January 1938, H. A. Beatty. ST. JOHNS: 5♂, 2♀, AMNH, *Antares* Expedition, W. Beebe. LESSER ANTILLES: ANTIGUA: 1♂, USNM, English Harbor, 4–9 April 1956, Smithsonian Bredin Expedition, Sta. 83–56, F. A. Chace and D. V. Nicholson. 1♀, USNM, Tank Bay, English Harbor, 3 April 1956, Smithsonian Bredin Expedition, Schmitt, Chace, Nicholson and Jackson. ST. LUCIA: 3♂, 7♀, USNM, Port Castries, 2 December 1887. ARUBA–CURAÇAO: 1♂, USNM, off Aruba, 40 fms, 3 October 1965, *Oregon* Sta. 5656. Curaçao: 1♂, 2♀, USNM, 10–18 February 1884, *Albatross*. NICARAGUA: 1♂, USNM, Bluefields, 1965, A. Flores. PANAMA: 5♂, 6♀, USNM, Fox Bay, Colón, 3 January 1911, S. E. Meek and S. F. Hildebrand. COLOMBIA: OLD PROVIDENCE ISLAND: 1♂, USNM, 4–9 April 1884, *Albatross* Sta. 2149–2150. 31♂, 23♀, YPM, Sabanilla, 16–22 March 1884, *Albatross*. 3♂, 7♀, USNM, off Puerto Colombia, 8–9 fms, 3 May 1964, *Oregon* Sta. 4867. 1♂, USNM, off Barranquilla, 75 fms, 17 May 1964, *Oregon* Sta. 4845. 2♂, 2♀, USNM, off Barranquilla, 40 fms, 18 May 1964, *Oregon* Sta. 4851. 1♀, USNM, off Faro Point, 13–14 fms, 18 May 1964, *Oregon* Sta. 4849. 7♂, 3♀, USNM, off Faro Point, 60–65 fms, 18 May 1964, *Oregon* Sta. 4852. 1♂, 7♀, USNM, off Ciénaga, 50 fms, 17 May 1964, *Oregon* Sta. 4846. 1♀, USNM, off Cape la Vela, 100 fms, 1 June 1964, *Oregon* Sta. 4913. 2♂, 1♀, USNM, off Departamento de la Guajira, 105 fms, 8 October 1965, *Oregon* Sta. 5684. 1♂, 5♀, USNM, off Gallinas Point, Departamento de la Guajira, 95 fms, 9 October 1965, *Oregon* Sta. 5685. VENEZUELA: 27♂, 28♀, USNM, Barranquita, Lake of Maracaibo, 23 April 1964, J. J. Ewald. 8♀, USNM, Gulf of Venezuela, 12 June 1964, *Fioveca*, J. J. Ewald. 3♂, 6♀, USNM, off Las Piedras, Gulf of Venezuela, 26 fms, 5 October 1965,



a



b



c

Oregon Sta. 5664. 1♀, USNM, off Mariusa Island, 13–15 fms, 26 August 1958, *Oregon* Sta. 2211. 5♀, USNM, off Boca Araguao, 9–10 fms, 27 August 1958, *Oregon* Sta. 2215. TRINIDAD: 1♀, USNM, off Casa Cruz, 20–22 fms, 26 August 1958, *Oregon* Sta. 2207. 1♂, 1♀, UMML, Icacos Point, March 1951, *Antilles.* 1♂, 1♀, UMML, Icacos Point, 19 January 1953, *Antilles.* 5♀, USNM, Gulf of Paria, February–October 1944, Anglo-American Caribbean Comm., R. T. Whiteleather and H. H. Brown. 2♀, USNM, Maturin Bar, off Point Barrial, Gulf of Paria, 26 April 1944, Anglo-American Caribbean Comm., R. T. Whiteleather and H. H. Brown. GUYANA: 1♂, USNM, off Marlborough, 20–25 fms, 30 August 1958, *Oregon* Sta. 2215. 3♂, 6♀, USNM, off Demerara Beacon, 11–22 July 1944, R. T. Whiteleather and H. H. Brown. SURINAM: 4♂, 7♀, USNM, off mouth Surinam River, 15 fms, 11 May 1957, *Coquette* Sta. 2. 1♂, 1♀, USNM, NE of mouth Surinam River, 30 fms, 30 May 1957, *Coquette* Sta. 36. 4♂, 1♀, USNM, NE of mouth Surinam River, 14 fms, 30 May 1957, *Coquette* Sta. 144. 1♂, USNM, between mouths of Coppename and Surinam Rivers, 15 fms, 6 June 1957, *Coquette* Sta. 172. 7♂, 13♀, USNM, off Surinam, 50 fms, 2 November 1957, *Oregon* Sta. 2016. FRENCH GUIANA: 2♂, 11♀, USNM, off Isère Point, 34 fms, 14 September 1958, *Oregon* Sta. 2322. BRAZIL: AMAPÁ: 4♀, USNM, Cape do Norte, 30 fms, J. F. Filho. PARÁ: 1♀, USNM, 100 miles off Cape Magari, 4 July 1965, J. F. Filho. 3♂, 25♀, USNM, off Salinopolis, 12 fms, 8 March 1963, *Oregon* Sta. 4215. PARÁ-MARANHÃO: 1♂, 1♀, USNM, June–July 1965, J. F. Filho. MARANHÃO: 2♂, 2♀, USNM, 27 June 1965, J. F. Filho. 1♀, USNM, off Paulino Neves, 20 fms, 11 March 1963, *Oregon* Sta. 4236. 12♂, 20♀, USNM, F. E. Sawyer. CEARÁ: 1♀, USNM, off Melancia, 20 fms, 16 March 1963, *Oregon* Sta. 4171. 1♂, 1♀, USNM, off Camocim, 15 fms, 12 March 1963, *Oregon* Sta. 4247. 1♂, USNM, off Camocim, 18 fms, 12 March 1963, *Oregon* Sta. 4250. 1♂, 1♀, USNM, Fortaleza, J. F. Filho. RIO GRANDE DO NORTE: 2♀, USNM, 1 February 1965, C. C. Neto. PERNAMBUCO: 10♂, 8♀, USNM, Public Market, San José, Recife, 10 August 1964, Ex. P. Alves Coêlho. ALAGOAS: 2♂, 2♀, MNHNP, Maceió, 2⅛–3¼ fms, 22 November 1961, *Calypso* Sta. 35. SERGIPE: 2♂, 6♀, MNHNP–USNM, off *Aracajú*, 26⅝–31⅛ fms, 23 November 1961, *Calypso* Sta. 42. 6♂, 14♀, USNM, mouth Agua Azeda River, Nossa Senhora do Socorro, 9 March 1966. BAHIA: 22♂, 18♀, USNM, Itaparica, 11 March 1966, A. Barreto. 6♂, MNHNP–

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FIG. 3. *Penaeus aztecus subtilis* n. subsp. *a*, Thelycum, ♀ 45.5 mm c.l., off Isère Point, French Guiana. *b*, Petasma, ♂ 34 mm c.l., off Gallinas Point, Departamento de la Guajira, Colombia. *c*, Sixth abdominal somite (posterodorsal portion), ♀ 36 mm c.l., Gulf of Venezuela.

USNM, off Bahia, 27–28 fms 24 November 1961, *Calypso* Sta. 35. ESPIRITO SANTO: 6♂, 10♀, MNHNP–USNM, Anchieta, 30 November 1961, *Calypso* Sta. 92. UNITED STATES: FLORIDA: 1♂, YPM, Key Largo, 19 March 1934, M. B. Bishop, *Atlantis* [?].

Description: Rostrum long, reaching at least to distal end on antennular peduncle and at most to distal third of thickened portion of antennular flagellum, sinuous in shape, with apical portion markedly upturned. Adrostral sulcus (Figs. 2 a–b) narrow, width 1/5–3/4 postrostral carina width, either tapering to a point posteriorly or turning laterally and broadening slightly at end, and usually short, ending 1/6–1/15 of carapace length from posterior margin of carapace. Median sulcus shallow, often interrupted, ending well anterior to posterior end of adrostral sulcus.

Dorsolateral sulcus (Fig. 3 c) variable in width, usually narrow; relation between keel height and sulcus width 2 to 8, modally 3.5.

Third pereopod relatively short, reaching only distal half of second antennular segment, at most exceeding peduncle by entire dactyl length.

Petasma (Fig. 3 b): Ventral costa curving proximally in gentle arc with distal portion unarmed along free border, two to three series of small teeth arranged in compact patch on attached border. Membranous portion of ventrolateral lobule extensively covered with spines. Distal fold of free margin of lateral lobe small, plain or armed with numerous spinules.

Thelycum (Fig. 3 a): Apical process projecting ventrally in sharp, broad, low-arched ridge which surrounds moderately concave surface with small knob usually present at center; posterior protuberance wide, with anteriorly bifurcate median carina, resulting ribs turning medially and converging at apical process, giving rise to diamondlike structure; surface enclosed by this structure plain or bearing median rib anteriorly, posteriorly or along entire length. Lateral plates with anteromedian angles divergent, leaving posterior protuberance exposed.

Color: *P. aztecus subtilis*, although of variable color, is most often brown, thus the name camarón marrón ("brown shrimp") in Venezuela, and camarão lixo ("dark shrimp") in Brazil. Yellowish specimens are rather common, and in some localities individuals are translucent pale yellow and are called camarão branco ("white shrimp") in Brazil.

Size: The largest female examined was 55 mm c.l., 205 mm t.l., and the largest male 36 mm c.l., 152 mm t.l. Holthius (1959) reported a larger male, 187 mm t.l.

Distribution: This subspecies ranges from Cuba along the arc of the Antilles, and from south of Cape Catoche throughout the Caribbean coast of Central and South America, and along the northern and eastern coast of South America, to at least Cape Frio, Brazil. Burkenroad (1939) identified and illustrated some specimens from "Rio de Janeiro."

Name: The name *subtilis* was suggested by the narrow and shallow adrostral sulci and the delicate, often indistinct and interrupted median sulcus.

Remarks: This subspecies differs rather strikingly from typical *P. aztecus*, the brown shrimp from the western Atlantic and the Gulf of Mexico. *P. a. subtilis* has a shallow, often interrupted and short median sulcus, instead of a deep, continuous, and long one as in *P. a. aztecus*; the adrostral sulci are very narrow and are either tapering or turned laterally posteriorly, rather than deep, long, broad, and of rather uniform width as they are on *P. a. aztecus*. The dorsolateral sulcus, although of variable width, is usually narrow, with a modal relation K/S of 3.5, whereas in *P. a. aztecus* it is wide, K/S modal 1.25. Finally, the third pereopod of *P. a. subtilis* is much shorter than that of *P. a. aztecus*.

P. a. subtilis may be separated from its close relative *P. paulensis* by the longer, sinuous rostrum and by the narrow adrostral sulcus. In males of *P. a. subtilis* the distal portion of the ventral costa of the petasma is strongly convex and armed with an elongated patch of closely set small teeth, very different from the almost straight costa provided with irregularly set, moderately strong apical teeth of *P. paulensis*. In females of *P. a. subtilis* the apical process and diamond-like structure on the posterior protuberance are much wider.

Burkenroad (1939) referred to this subspecies as *P. aztecus* "Form B." The study of extensive collections from throughout its range has indicated that it differs from *P. aztecus* from northern waters by constant characteristics; consequently I consider each population a geographical subspecies. Burkenroad, in the same publication, recorded one specimen of *P. aztecus* "Form B" from the Atlantic of "North America" and another (at Yale Peabody Museum of Natural History) from Key Largo, Florida. I have examined the latter, and it undoubtedly belongs to the southern subspecies; however, the accompanying label reads "*Atlantis*, March 19, 1934," and William C. Schroeder, from the Woods Hole Oceanographic Institute, has kindly informed me that the *Atlantis* was at Woods Hole on that date. It seems most unlikely that the error can ever be rectified. I strongly doubt that either of the North American specimens has been labeled correctly, because in the enormous collections from the northwestern Atlantic examined, I have not found the southern subspecies nor is there any reference in the literature other than Burkenroad's to its presence in northern waters.

The population of *P. a. subtilis* extending from the Gulf of Paria approximately to off Camocim, Brazil, shows some characteristics by which it can usually be distinguished from the population of this subspecies from the Caribbean region and that from northern South America and eastern Brazil. The former has the adrostral sulcus shorter (ending $\frac{1}{5}$ to $\frac{1}{11}$ of the carapace length from the posterior margin of the carapace), much shallower, and more tapering posteriorly; also the

rostrum is longer and more distinctly sinuous. Many individuals, however, have a faint linear indication of the posterior portion of a longer adrostral sulcus. In addition, at both ends of the range of this population (in the Gulf of Paria and off Camocim), specimens showing the above characters are intermingled with specimens that have a longer and wider adrostral sulcus and a slightly shorter and less sinuous rostrum. Furthermore, in Colombia and Venezuela, the ranges of variation of the length and width of the adrostral sulcus and the length of the rostrum intergrade with those characters in specimens from the Gulf of Paria to northeastern Brazil. Too, the relation K/S ranges to a higher value in the latter population (2–8) than in the former (2–5); K/S modal value is almost the same, however, in both: 3 and 3.5, respectively. It thus seems that these are different populations of *P. a. subtilis* and that environmental conditions might be acting to produce the characters observed.

Penaeus duorarum notialis new subspecies

Fig. 4 a–d

Camarón acaramelado ("candied shrimp"); langostino amarillo ("yellow shrimp"); camarón rosado sin mancha ("pink spotless shrimp") camarón cocinero ("cook shrimp"); camarón carbonero, ("coal carrying shrimp"); langostino or camarón rosado ("pink shrimp").

Penaeus brasiliensis: auct. in part; not *Penaeus brasiliensis* Latreille, 1817.

Penaeus duorarum Burkenroad in part ("Form B"), 1939. Bull. Bingham Oceanogr. Coll. *6*, art. 6: 31–52, Figs. 18, 19, 26, 27.

Holotype: 1♂, USNM 119132, off Las Piedras, Gulf of Venezuela, 26 fms, 5 October 1965, *Oregon* Sta. 5664, 11°44′NL, 70°22′WL.

Paratypes: CUBA: 2♂, 3♀, CIP, Mariel, 17 November 1953, I. Pérez Farfante. 1♂, USNM, Cape San Antonio–Cape Cajón, 2–12 fms, 24 May 1914, *Thomas Barrera*. 3♂, 3♀, USNM, Doctor Lagoon, Baracoa Beach, 1952, J. Mayor. 1♂, YPM, Siguanea Bay, Island of Pines, 6 April 1925, *Pawnee*. 1♂, 1♀, USNM, Siguanea Bay, Island of Pines, 1954, G. Canet and I. Pérez Farfante. 23♂, 28♀, CIP, Gulf of Batabanó, 2–6 fms, December 1954, *Aida*, G. Canet and I. Pérez Farfante. 5♂, 7♀, CIP, Mouth Yumurí River, Matanzas Bay, 1954, C. Sánchez. 10♂,

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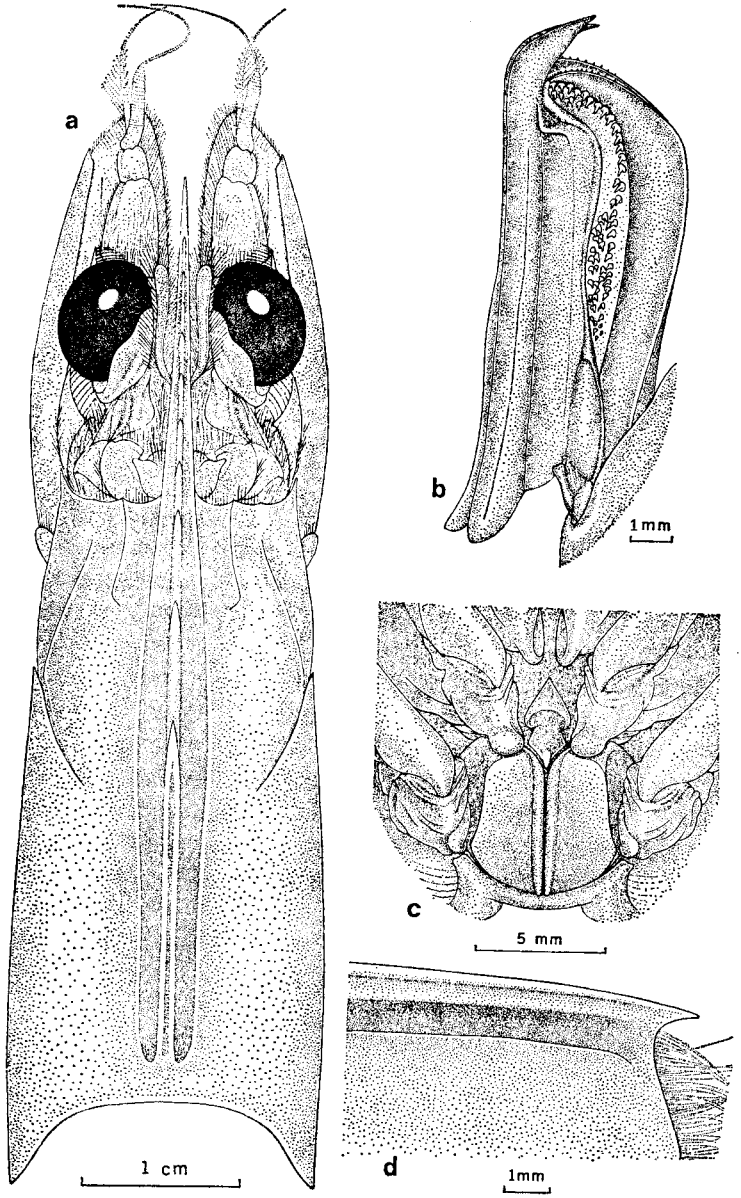
FIG. 4. *Penaeus duorarum notialis* n. subsp. *a*, Carapace, holotype ♂ 41.5 mm c.l., off Las Piedras, Gulf of Venezuela. *b*, Petasma, ♂ 34 mm c.l., off Las Piedras, Gulf of Venezuela. *c*, Thelycum, ♀ 38 mm c.l., off Las Piedras, Gulf of Venezuela. *d*, Sixth abdominal somite (posterodorsal portion), ♀ 42 mm c.l., off Great Pedro Bluff, Jamaica.


a
1 cm
b
1mm
c
5 mm
d
1mm

38♀, CIP, Tunas de Zaza, 17 June 1954, *Camarón* II, G. Canet and T. Sánchez. 3♂, 2♀, USNM, Cienfuegos Bay, 1954, G. Canet and I. Pérez Farfante. 1♂, 4♀, CIP, Nuevitas, 1954, J. Suárez Caabro. 6♂, 22♀, CIP, Sevilla Keys, August 1955, *Camarón* II, G. Canet and I. Pérez Farfante. 1♂, YPM, Guantánamo Bay, 22 April 1933, *Atlantis*. JAMAICA: 21♂, 31♀, USNM, 1–11 March 1884, *Albatross*. 1♂, YPM, 1–11 March 1884, *Albatross*. 1♂, 6♀, YPM, Kingston Market, 1 February 1934. 4♂, YPM, Kingston, 26 February 1937, I. H. Olsen. 9♂, 5♀, USNM, 22 fms, 15 May 1962, *Oregon* Sta. 3545. 8♂, 5♀, USNM, off Great Pedro Bluff, 11–12 fms, 18 May 1965, *Oregon* Sta. 5395. 141♂, 71♀, USNM, off Great Pedro Bluff, 12–13 fms, 18 May 1965, *Oregon* Sta. 5396. HAITI: 12♂, 6♀, AMNH, Bizeton, 1 March 1927, W. Beebe. 1♂, 1♀, AMNH, Port au Prince, 1927, W. Beebe. PUERTO RICO: 2♀, USNM, off San Juan, 40 fms, 29 September 1959, *Oregon* Sta. 2625. 1♀, USNM, Mayagüez Bay, winter 1965, *Carite*, P. W. Glynn. VIRGIN ISLANDS: TÓRTOLA: 1♂, 3♀, USNM, 27 fms, 27 September 1959, *Oregon* Sta. 2612. ST. CROIX: 2♂, 4♀, USNM, Kranse lagoon, H. A. Beatty. ST. JOHNS: 1♂, 1♀, AMNH, 1932, *Antares* Expedition, W. Beebe. ARUBA-CURAÇAO: 4♂, 2♀, USNM, 1937, P. W. Hummelinck. HONDURAS: 22♂, 20♀, USNM, off Ceiba, May 1966, R. Flores. 2♂, 1♀, YPM, Turneffe Cay, Gulf of Honduras, 21 April 1925, *Pawnee II*. 9♂, 12♀, USNM, Caratasca, May 1966, R. Flores. NICARAGUA: 2♀, USNM, Bluefields, 1965, A. Flores. PANAMA: 3♂, 3♀, USNM, Bocas del Toro, 15 fms, 28 April 1963, *Pelican* Sta. 800. 1♀, USNM, Fox Bay, Colón, 31 March 1911, S. E. Meek and S. F. Hildebrand. 3♂, 2♀, USNM, Fox Bay, Colón, 22 January 1912, S. E. Meek and S. F. Hildebrand. 6♂, 12♀, USNM, Fox Bay, Colón, 22 March 1912. 9♂, 1♀, YPM, Sweetwater River, Limón Bay, Canal Zone, 12 February 1934. COLOMBIA: 14♂, 23♀, USNM, Gulf of Urabá, 34 fms, 17 October 1965, *Oregon* Sta. 5728. 6♂, 6♀, USNM, off Cape Tiburón, Gulf of Darién, 43 fms, 18 October 1965, *Oregon* Sta. 5731. 6♂, 13♀, USNM, Gulf of Morrosquillo, 23 fms, 25 May 1964, *Oregon* Sta. 4886. 1♀, YPM, Sabanilla, 16–22 March 1884, *Albatross*. 10♂, 6♀, USNM, off Barranquilla, 40–50 fms, 19 May 1964, *Oregon* Sta. 4857. 1♂, 2♀, USNM, off Ciénaga, 50 fms, 17 May 1964, *Oregon* Sta. 4846. 1♀, USNM, off Departamento de la Guajira, 40 fms, 25 September 1963, *Oregon* Sta. 4395. VENEZUELA: 9♂, 10♀, USNM, off Las Piedras, Gulf of Venezuela, 26 fms, 5 October 1965, *Oregon* Sta. 5684. 10♂, 2♀, USNM, Gulf of Venezuela, 12 June 1964, *Fioveca*, J. J. Ewald. 1♀, UMML, off Boca Tuy, 1962, Tovar. 1♀, USNM, off Araguapiche Point, 2–22 fms, 26 August 1958, *Oregon* Sta. 2207. GUYANA: 1♀, USNM, off Demerara, 11–22 July 1944, Anglo-American Caribbean Comm., R. J. Whiteleather and H. H. Brown. SURINAM: 1♂, USNM, off westernmost end Surinam, 21 fms, 19 February 1963, *Oregon* Sta. 4169. 1♀, USNM, NE mouth Surinam River, 23 fms, 12 May 1957, *Coquette* Sta. 27. BRAZIL: MARANHÃO: 1♀, USNM, F. E. Sawyer.

Description: Rostrum relatively short, reaching at least distal third of second and at most distal end of third antennular segment, high and straight apically. Adrostral sulcus (Fig. 4 a) broad, ⅘ to 1½ postrostral carina width, wider at level of epigastric spine, width either uniform or slightly narrowing at posterior end, and long, ending 1/14 to 1/20 carapace length from posterior margin of carapace. Median sulcus deep along entire length, and long, ending immediately anterior to posterior end of adrostral sulcus.

Dorsolateral sulcus (Fig. 4 d) broad, relation between keel height and sulcus width ranging from 0.25 to 3, modally 1.75.

Third pereopod relatively long, exceeding antennular peduncle by half length of dactyl to ⅛ length of carpus.

Petasma (Fig. 4 b): Ventral costa broadening and turning proximally abruptly, distal portion armed with minute spines along free border and compact group of large teeth on attached border. Membranous portion of ventrolateral lobule with narrow band of spines, consisting of single series distally and three or four rows abreast proximally. Distal fold of free margin of lateral lobe small, either unarmed or with few marginal spinules.

Thelycum (Fig. 4 c): Apical process bordered by strongly convex, sharp ridge, surrounding rather strongly concave ventral surface. Posterior protuberance bearing single, prominent median carina, extending anteriorly toward apical process. Lateral plates with anteromedian corners slightly divergent, leaving median carina exposed.

Color: Although variable in color, *P. d. notialis* is most frequently light brown, thus the name langostino amarillo in Venezuela, and camarón acaramelado ("candied shrimp") in Cuba. In certain areas it is pink and is known as camarón rosado ("pink shrimp") and in others it is very dark brown and is called camarón carbonero ("coal carrying shrimp"), or camarón cocinero ("cook shrimp").

In the West Indies this subspecies, like the typical *P. duorarum* from northern waters, usually has a dark, reddish brown spot on each side at the juncture of the third and fourth abdominal somites. In northern South America, however, *P. d. notialis* consistently seems to lack these lateral spots.

Size: The largest female examined was 48 mm c.l., 192 mm t.l., and the largest male 41 mm c.l., 175 mm t.l.

Distribution: *P. d. notialis* ranges from Cuba throughout the Greater Antilles to the Virgin Islands, and from Belize, British Honduras, along the Caribbean coast of Central and South America, and the Atlantic coast of northern South America to São Luís, Brazil. It seems to be absent from northeastern Brazil, because it has not been reported nor have I found it in the series examined from Parnaiba to Bahia. *P. d. notialis* appears again in Ilheus and extends south to Cape Frio. There thus seem to be two discrete populations of "candied shrimp," one in

the Caribbean Sea and Atlantic coast of northern South America, and another along the coast of eastern Brazil, from Ilheus to Cape Frio.

This subspecies is very abundant in some areas in the Caribbean region, apparently is extremely scarce along the Guianas and northern Brazil, but becomes abundant again in the southernmost portion of its range.

Name: The name is from the Latin *notialis*, meaning *southern*, and refers to its distribution in relation to typical *P. duorarum*.

Remarks: The dorsolateral sulcus of *P. d. notialis* is wider than that of *P. d. duorarum* from the northwestern Atlantic and the Gulf of Mexico. Burkenroad (1939) pointed out this difference between the two stocks and called the latter "Form A" and the former "Form B." The biometric studies I made have indicated a highly significant statistical difference in the relation between the height of the keel and the width of the adrostral sulcus: in *P. d. notialis* K/S ranges from 0.25 to 3, modally 1.75, in *P. d. duorarum* K/S ranges from 2.5 to 15, modally 4.5. In addition, overlapping is very limited; in only a few specimens of *P. d. notialis* from south Cuba does K/S reach 3, and in all the rest of the numerous specimens examined by me, including those from north Cuba, K/S is less than 2.5 *P. duorarum* from the Caribbean region and northern and middle portions of South America is distinct from *P. duorarum* from northern waters. It should be emphasized that the two stocks, each with a long pelagic larval phase, do not seem to mix across the Gulf Stream.

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