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ON SPINY LOBSTERS OF THE GENERA *PALINURELLUS*, *LINUPARUS* AND
PUERULUS (CRUSTACEA DECAPODA, PALINURIDAE)

L. B. HOLTHUIS

Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands

ABSTRACT

The two known species of *Palinurellus* are discussed and new locality records provided; the question of the presence or absence of pleopods on the first abdominal somite in the two sexes is considered but no satisfactory solution reached. The only known living species of *Linuparus*, *L. trigonus* (Von Siebold) is now reported for the first time from the Philippines. A lectotype is selected. The genus *Puerulus* is revised, and a key to the three species provided. *Puerulus angulatus* (Bate), the type of the genus is extensively described and its synonymy is discussed. The two other species, *P. sewelli* Ramadan and *P. velutinus* Holthuis are described and compared with *P. angulatus*. Of all the genera and species treated a complete synonymy is provided.

DURING a year's stay in Washington, D.C. (1959-60) the Decapoda Macrura Reptantia of the U.S. National Museum were studied by me and some interesting finds were made in the rich and well-kept collections. In the present paper part of the examined material is dealt with, while also specimens from other institutions are taken into account.

I wish to express here my sincere gratitude to Dr. Fenner A. Chace, Jr., at that time Curator of the Division of Marine Invertebrates of the U.S. National Museum, who made the arrangements enabling me to pay this visit to the United States, and who has continuously given me all the help that I needed to carry out my work. I am also very grateful to the other members of the staff of the division for their kindness and help. Furthermore I should like to express my indebtedness to Dr. Isabella Gordon of the British Museum (Nat. Hist.), London, Dr. Gilbert L. Voss and Dr. Frederick M. Bayer of the Institute of Marine Science, Miami, and Dr. J. H. Stock of the Zoological Museum, Amsterdam, for allowing me to study material of the collections of their institutions and for valuable help and advice.

Part of the material studied has been published upon elsewhere (cf. Holthuis, 1960, 1961; Holthuis and Villalobos, 1962; Holthuis, 1963, 1964), and part will be included in future publications. The present paper deals with three of the genera of Palinuridae, of which all the known species are listed here.

Palinurellus Von Martens, 1878

Palinurellus Von Martens, 1878, *S.B. Ges. naturf. Freunde Berlin*, 1878, p. 131. Type species, by monotypy: *Palinurellus gundlachi* Von Martens, 1878, *S.B. Ges. naturf. Freunde Berlin*, 1878, p. 131. Gender: masculine.

Synaxes Bate, March 1881, *Ann. Mag. nat. Hist.*, ser. 5, 7: 220. Type species, by monotypy: *Synaxes hybridica* Bate, 1881, *Ann. Mag. nat. Hist.*, ser. 5, 7: 220 (a junior subjective synonym of *Palinurellus gundlachi* Von Martens, 1878). Gender: feminine.

Araeosternus De Man, July 1881, *Notes Leyden Mus.*, 3: 131. Type species, by monotypy: *Araeosternus wieneckii* De Man, 1881, *Notes Leyden Mus.*, 3: 131. Gender: masculine.

- Araeosternus* Bouvier, 1910, *Bull. Mus. Hist. nat. Paris*, **16**: 377. Erroneous spelling of *Araeosternus* De Man, 1881.
- Palidurellus* Torralbas, 1917, *Anal. Acad. Ci. med. fis. nat. Habana*, **53**: fig. 46. Erroneous spelling of *Palinurellus* Von Martens, 1878.
- Palinurella* F. G. W. Smith, 1948, *Fish. Ser. Caribb. Comm.*, No. 3, p. 12. Erroneous spelling of *Palinurellus* Von Martens, 1878.

The genus contains two species, one Atlantic, the other Indo-West Pacific.

***Palinurellus wieneckii* (De Man, 1881)**

- Araeosternus wieneckii* De Man, 1881, p. 131.
- Araeosternus wieneckei* Winkler, 1881, p. 105, pl. 1, fig. 3; Winkler, 1882, p. 146.
- Araeosternus wieneckei* De Man, 1882, p. 1, pls. 1, 2.
- Palinurellus wienecki* De Man, 1882 a, p. 162.
- Palinurellus Wieneckii* Pfeffer, 1883, p. 103; Bouvier, 1915, p. 186, pl. 7, fig. 2; De Man, 1916, p. 34.
- Palinurellus wieneckii* Ortmann, 1891, p. 16.
- Palinurellus Wienecki* Bouvier, 1910, p. 376; Gruvel, 1911, p. 1350; Bouvier, 1914, p. 701; Belloc, 1959, p. 9.
- Palinurellus Gunlachi Wieneckii* Gruvel, 1911 a, p. 9, pl. 1, figs. 1, 2.
- Palinurellus gurdachi wieneckei* Holthuis, 1946, p. 114, pl. 11, fig. 9; Chace and Dumont, 1949, p. 11.

Material Examined

U.S. National Museum, Washington

Danawan Island near Darvel Bay, N. E. Borneo; in stomach of *Epinephelus fuscoguttatus* (Forskål); 27 September 1909; "Albatross" Philippine Expedition 1907-1909.—1 ♂, cl. 65 mm.

Lagoon reef at southern end of Falarik Island, opposite the Fannap (= men's house), Rauau village, Ifaluk Atoll, Caroline Islands; 14 September 1953; F. M. Bayer no. 334.—dry fragments, cl. 44 mm.

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Pulu Tikus (= Rat Island) near Benkulen, S. W. Coast of Sumatra; 1865; G. F. Wienecke; holotype.—1 ♂, cl. 80 mm. (reg. no. Crust. D. 965).

British Museum (Nat. Hist.), London

Mauritius.—1 specimen, cl. 72 mm. (dry).

The fragments from Ifaluk Atoll, which were described by the collector as "parts of a bright red, fuzzy lobster", were found in a coral head of the lagoon reef. They consist of the entire carapace to which the sternum is still attached, while it also carries the entire left antennal peduncle and the two basal segments of the right. Of all the other cephalic and thoracic appendages only one of the large first legs is present. The abdominal skeleton is fairly complete: it lacks all but the first pair of pleopods and one of the uropods. The Borneo specimen is 137 mm. long and in rather good

shape. Both specimens agree well with De Man's (1881, 1882) descriptions and figures, only in both the rostrum is longer, reaching distinctly beyond the anterolateral angles of the carapace and almost attaining the middle of the second segment of the antennal peduncle. It is triangular and pointed, the lateral margin showing several small teeth, the proximal of which is the largest. In the shape of the rostrum the present specimens show a great resemblance to that figured by Bouvier (1915). A re-examination of De Man's type specimen, which is preserved in the Leiden Museum, showed the distal margin of the rostrum to be somewhat irregular so that it is quite well possible that its shape is abnormal, *e.g.*, through breaking and subsequent regeneration of the tip.

In the Ifaluk specimen the first pereopod is somewhat more slender than that of the type, but this is evidently due to the fact that the specimen is much smaller; in the Bornean specimen the first pereopods are as robust as in De Man's type.

The first abdominal somite of the Bornean male shows no sign of pleopods, and in this respect it is similar to the type, also a male. In the Ifaluk specimen, however, the first abdominal somite bears a pair of pleopods, each of which consists of two segments. Unfortunately, the specimen is too fragmentary to allow the determination of its sex. It would not be surprising, however, if it were a female. The question of the presence or absence of the first pleopods in specimens of this genus is quite interesting. Boas (1885, p. 183), who examined the type of *Palinurellus gundlachi* Von Martens, which is a female, remarked that the species has a pair of pleopods on the first abdominal somite; these pleopods consisting of a single branch. Such pleopods are figured also by Bate (1881, pl. 14, fig. 2) for the type of his *Synaxes hybridica* (= *Palinurellus gundlachi*), which likewise is a female. Bouvier (1915, p. 10) stated that Boas (1880) and Calman (1909) "ont justement observé que les *Palinurellus*, à l'encontre des autres Palinuridés, présentent encore des fausses pattes sur le premier segment abdominal". This statement seems to indicate that these first pleopods also are present in Bouvier's male specimen. However, this same specimen has been figured by Gruvel (1911 *a*, pl. 1, figs. 1, 2) and Gruvel's fig. 2, showing the ventral view of the animal, makes it clear that these pleopods actually are missing, at least at the time that the photograph was taken. In six males and four females of *Palinurellus gundlachi*, which I could examine, I found that in the males the first pleopods are invariably absent, while they are present in the females. There is thus a strong indication that the presence of first pleopods in females of this genus and their absence in males is a constant character. However, Calman (1909, p. 443) in a footnote emphatically stated: "I find that they [*i.e.*, the pleopods of the first abdominal somite] are also present in a male specimen belonging to this genus [= *Palinurellus*] in the British Museum collection". This specimen, the above-mentioned male from Mauritius, is still present in the British Museum. Dr. Isabella Gordon was so kind to examine this dry specimen again and remarked (in litt., 2 October 1964): "I can verify Calman's statement, for the genital ♂ openings are distinct on coxae p5 and there are indeed two small lash-like pleopods on the first abdominal sternum" . . . "I can see no trace of ♀ genital openings on coxae 3." The specimen might be abnormal, but as Dr. Gordon stated there are no clear indications for that. The problem of the presence or absence of the pleopods of the first abdominal somite therefore still remains unsolved.

The colour of the present species is not known. Dr. F. M. Bayer, when collecting the Ifaluk specimen noted it to be bright red, a colour still shown by the preserved animal. As at the time of collecting the lobster was already dead and broken up, it is not certain that this is the true colour in life.

Distribution.—So far, *Palinurellus wieneckii* was only known from Port Louis, Mauritius (Bouvier, 1910; Gruvel, 1911, 1911 *a*; Bouvier, 1914, 1915) and Pulu Tikus near Benkulen, Sumatra (De Man, 1881; Winkler, 1881, 1882; De Man, 1882, 1882 *a*; Pfeffer, 1883; Ortmann, 1891; Holthuis, 1946), so that the present records of the species from Bornco and the Caroline Islands greatly extend our knowledge of its range.

Type locality.—Pulu Tikus near Benkulen, Sumatra, Indonesia.

Palinurellus gundlachi Von Martens, 1878

Palinurellus Gundlachi Von Martens, 1878, p. 131; Pfeffer, 1881, p. 23; Boas, 1882, p. 112; Gruvel, 1911, p. 1350; Belloc, 1959, pp. 8, 9.

Palinurellus Boas, 1880, p. 92, figs. 2, 3.

Synaxes hybridica Bate, 1881, p. 220, pl. 14; Bate, 1888, p. 88, figs. 11, 12.

Palinurellus gundlachi Ortmann, 1891, p. 16; Stebbing, 1893, p. 197; Verrill, 1922, p. 179; Holthuis, 1946, p. 109; Smith, 1948, pp. 47, 79; Holthuis, 1956, p. 113; Hemming, 1958, p. 136; Morice, 1958, pp. 105, 106; Smith, 1958, p. 9; Smith, 1958 a, p. 8, 2 figs.; Morice, 1959, pp. 1, 3; Smith, 1959, p. 9.

Palinurellus Gunlachi Gruvel, 1911 a, p. 8, figs. 2, 3.

Palinurellus gundlachi gundlachi Chace and Dumont, 1949, p. 11; Smith, 1954, p. 463.

Palinurellus gundlachii Smith, 1958, p. 12; Smith, 1959, p. 12.

*Material Examined**Institute of Marine Science, Miami*

Isolated coral head off westernmost tip of N.W. Cay, Hogsty Reef, Bahama Islands; 29 May 1962; Chaplin Bahama Expedition Sta. 580.—1 ♀, cl. 50 mm.

Box Island, N. of Green Cay, Bahama Islands; 14 May 1959; Chaplin Bahama Expedition Sta. 496.—1 ♂, cl. 35 mm.

N. of Green Cay, Bahama Islands; 11 April 1959; Chaplin Bahama Expedition Sta. 513.—1 ♂, cl. 41 mm.

0.5 miles S.S.W. of Alligator Reef Light, Monroe Co., S.W. Florida; at ledge, 15–20 feet deep; 30 April 1961; Walter A. Starck II, Henry A. Feddern, and Terry Starck.—2 ♂♂, cl. 23 and 53 mm.; 1 ovigerous ♀, cl. 38 mm.; 1 juvenile, cl. 11 mm.

Bahia de Yegua, N.E. Puerto Rico; 12 November 1957; John E. Randall and D. S. Erdman.—1 ♂, cl. 48 mm.; 1 ♀, cl. 61 mm.

Yucatan; 22 June 1961; W. A. Starck II.—1 ♂, cl. 31 mm.

Zoological Museum, Amsterdam

Off Parguera Island, Tallaboa Bay near Guayanilla, Puerto Rico; near the margin of the shelf; depth 20–35 m.; collected with rotenone; 3 March 1963; J. H. Stock.—1 ♀, cl. 32 mm.

The present species was considered rare, and so far only four specimens have been reported upon. As shown by the above collections, the specimens of which were obtained by Scuba diving and with the use of rotenone, the species is not rare, but only lives in rather inaccessible places.

Distribution.—The species has been reported from the following localities: Bermuda (Verrill, 1922), West Indies (Bate, 1881, 1888; Boas, 1882), Camaricoia, E. of Matanzas, Cuba (Von Martens, 1878; Boas, 1882), Barbados (Pfeffer, 1881). The present records from the Bahamas, Florida, Puerto Rico, and Yucatan, thus more than double the number of known localities for the species.

Type locality.—Camaricoia, E. of Matanzas, Cuba.

Linuparus White, 1847

Linuparus White, 1847, *List Crust. Brit. Mus.*, p. 70, Type species, by monotypy: *Palinurus trigonus* Von Siebold, 1824, *Spicil. Fauna Japon*, p. 15. Gender: masculine.

Avus Ortmann, 1891, *Zool. Jb. Syst.*, 6: 15, 21. Type species, by monotypy; *Palinurus trigonus* Von Siebold, 1824, *Spicil. Fauna Japon.*, p. 15. Gender: masculine.

Linuparis Ortmann, 1891, *Zool. Jb. Syst.*, 6: 21. Erroneous spelling of *Linuparus* White, 1847.

Limparus Sclater, 1937, *Zool. Rec. Crust.*, 73 (for 1936): 37. Erroneous spelling of *Linuparus* White, 1847.

Linuparus Yoshida, 1941, *Bull. Fish. Exper. Sta. Tyosen*, no. 7, p. 32. Erroneous spelling of *Linuparus* White, 1847.

Several fossil species are assigned to the present genus. Some authors consider such fossil species as belonging to separate genera (*Podocratus* Geinitz, 1850, and *Thenops* Bell, 1858). Only one recent species is known so far.

Linuparus trigonus (Von Siebold, 1824)

Palinurus Trigonus Von Siebold, 1824, p. 15; Von Siebold, 1826, p. 20; Herklots, 1861, p. 143.

Palinurus trigonus De Haan, 1841, p. 157, pls. 39/40; De Haan, 1844, pls. L, M; Von Martens, 1876, p. 142; Heller, 1865, p. 94; Boas, 1880, p. 91; Fauvel, 1880, p. 196; Parker, 1883, p. 190; Parker, 1884, p. 304; Holthuis, 1956, p. 113; Hemming, 1958, p. 136.

Linuparus trigonus White, 1847, p. 70; Thompson, 1901, p. 18; Gruvel, 1911, p. 1351; Gruvel, 1911 a, p. 26, text-fig. 10, pl. 1, fig. 5; Balss, 1914, p. 76; Parisi, 1917, p. 8; Gee, 1925, p. 159; Komai, Akatsuka and Ikari, 1927, p. 294; *Fish. Soc. Japan*, 1935, pl. 58, fig. 1; Oo-U-Kijo, 1936, p. 385, figs. 1-3; Yoshida, 1941, p. 32, text-fig. 14, pl. 8, fig. 2; Holthuis, 1946, p. 121, pl. 11, figs. i, j; Chace and Dumont, 1949, p. 8, fig. 4; Barnard, 1950, p. 820; Okada, 1951, p. 85; McNeill, 1953, p. 89; Anonymus, 1954, p. 760, fig. 2190; McNeill, 1956, p. 53, fig.; Okada, Taki, Sakai and Abe, 1958, p. 143; fig. 258; Tung, Hu. and Yu, 1958, p. 166; Kubo, 1960, p. 101, pl. 50, fig. 1; Liu, 1963, p. 232.

Avus trigonus Ortmann, 1891, p. 21; Bouvier, 1899, p. 175.

Linuparis trigonus Stebbing, 1893, p. 197; Doflein, 1902, p. 643; Doflein, 1906, pp. 198, 256; Komai and Ikari, 1929, p. 121.

Puerulus carinatus McNeill, 1949, p. 337, fig.

*Material Examined**U.S. National Museum, Washington*

Kururi District, Chiba Prefecture, Tokyo Bay, Honshu, Japan; April 1894; Mr. Sakumoto.—1 ♂, cl. 97 mm.

Tainan, Formosa; 20 April 1920; M. Ohshima.—1 ♀, cl. 153 mm.

Corregidor Light N. 26° E. 25.50 miles, Philippines, 14° N. 120° 22' 30" E.; mud, shells and coarse sand; 118 fms.; 14 July 1908; "Albatross" Sta. D. 5272.—3 ♂♂, cl. 95-128 mm.; 4 ♀♀, cl. 92-112 mm.

Louis Point Light N. 21° E. 5.5 miles, Philippines, 10° 09' 15" N. 123° 52' E.; green mud; 162 fms.; 23 March 1909; "Albatross" Sta. D. 5412.—1 ♂, cl. 83 mm.

Balicasay Island S. 22 miles, Philippines, 9° 52' 30" N. 123° 40' 45" E.; green mud; 174 fms.; 9 April 1908; "Albatross" Sta. D. 5197.—1 ♀, cl. 117 mm.

Rijksmuseum van Natuurlijke Historie, Leiden

Japan; 1823-1824; P. F. Von Siebold; lectotype of *Palinurus trigonus* Von Siebold.—1 ♂, cl. 146 mm. (dry, reg. no. Crust. D. 5611).

Japan; 1823-1824; P. F. Von Siebold; paralectotypes of *Palinurus trigonus* Von Siebold.—2 ♂♂, cl. 99 and 120 mm.; 1 ♀, cl. 101 mm. (dry; reg. no. Crust. D. 5610).

Japan; 1823-1835; P. F. Von Siebold and H. Bürger.—7 ♂♂, cl. 104-138 mm.; 2 ♀♀, cl. 100 and 120 mm. (dry).

British Museum (Nat. Hist.), London

Japan; 1823-1835; P. F. Von Siebold and H. Bürger; from Leiden Museum.—1 ♂, cl. 124 mm. (dry).

In the collection of the Leiden Museum four syntypes of the present species are preserved. The largest of these, a male (cl. 146 mm.) is here selected the lectotype of the species. The specimen is dry, but in excellent condition.

Distribution.—Before 1949 this large and characteristic species was known only from Japanese and Chinese waters. In 1949 and 1956 McNeill reported the species from off the coast of New South Wales, Australia, while in 1950 Barnard listed a specimen caught off Portuguese East Africa. The present material from the Philippines partly fills the gap between the widely distant localities whence the species was so far known. The records in the literature are: Japan (Von Siebold, 1824, 1826; White, 1847; Herklots, 1861; Bouvier, 1899; Thompson, 1901; Gruvel, 1911, 1911*a*; Parisi, 1917; *Fish. Soc. Japan*, 1935; Holthuis, 1946; Anonymus, 1954; Okada, Taki, Sakai and Abe, 1958; Kubo, 1960), Tokyo (= Yeddo) (Von Martens, 1876), Yokohama (Doflein, 1902; Parisi, 1917), Tokyo Bay (Ortmann, 1891), Sagami Bay (Doflein, 1906), Mie Prefecture (Okada, 1951), Seto near Wakayama, Honshu (Komai, Akatsuka and Ikari, 1927; Komai and Ikari, 1929), Kiushu (Balss, 1914), Omura and Shimabara Bays near Nagasaki, Kiushu, Japan (De Haan, 1841), Korea (Yoshida, 1941), Ningpo, Chekiang, China (Fauvel, 1880; Gee, 1925), Chushan, Chekiang (Tung, Hu and Yu, 1958), Formosa (Oo-U-Kijo, 1936), 16-18 miles East of Newcastle, New South Wales, Australia (McNeill, 1956), off Botany Bay, New South Wales (McNeill, 1949, 1953), off Inhambane, Portuguese E. Africa (Barnard, 1950).

Habitat.—The present Philippine material was collected at depths between 118 and 174 fms. The Australian specimens reported upon by McNeill (1949, 1953, 1956) were taken at depths of 50 and 65 fms., while Barnard's (1950) East African animal came from 180 fathoms. Of most of the material reported upon in the literature the depth of collecting is not given. The records in the literature which report on the bottom on which the animals were taken give it as rocky: "in locis saxonis" (De Haan, 1841), "on rocky ground" (Barnard, 1950). The "Albatross" Philippine specimens, however, were taken from muddy bottoms.

Type locality.—In the original publication no indication of the type locality is given, otherwise than that it is Japan. Von Siebold was stationed as a physician at the Dutch trading post of Decima, an island near Nagasaki, where he arrived 11 August 1823. He was allowed to enter Nagasaki, but was not permitted outside these two localities, until 1826 when he joined a Dutch delegation to Tokyo. The material that Von Siebold got together was either (1) acquired at the fish market at Nagasaki, (2) collected by himself in the area or (3) obtained through his Japanese friends and pupils. Since Von Siebold's booklet containing the first description of *Palinurus trigonus* was published in 1824, he must have obtained the material very soon after his arrival in Japan. It is very likely therefore that it originated from the neighbourhood of Nagasaki. In the possession of the Leiden Museum is a collection of coloured plates of Japanese Crustacea sent to Holland by Von Siebold's assistant H. Bürger, who was in Nagasaki from 1825 to about 1835. Some of these plates are accompanied by a handwritten descriptive text. The text of the plate showing *Linuparus trigonus* ends with the following remarks; "Zeer schaarsch wordt somwijlen in het voor of najaar op

rotsachtige gronden in de baaijen van Oomura en Simabara gevangen, en ook wel gegeten." (Very rare, is sometimes caught in the spring or autumn on rocky bottom in the bays of Omura and Shimabara; is also eaten). These remarks obviously were used by De Haan (1841) for his locality indication. It seems most likely that the type locality of the species should be one of these two just mentioned bays of the island of Kiushu not far from Nagasaki. The type locality is therefore restricted here to Omura Bay.

Colour.—Bürger in the above-mentioned manuscript text, gave the following account of the colour of the species: The shell of the body is pale red above with several white spots, below it is entirely white; the shell of the tail is also pale red above, with small blue dots and yellowish irregular spots; the swimming plates at the end of the tail (= tail fan) and under the tail (= pleopods) are yellowish with some white dots; the antennae are reddish and white; the legs white with numerous small bluish dots and a few red spots (translation of the Dutch text). Coloured figures of the species have been published by Fish. Soc. Japan (1935), Okada, Taki, Sakai and Abe (1958), and Kubo (1960).

Puerulus Ortmann, 1897

Puer Ortmann, 1891, *Zool. Jb. Syst.*, 6: 15, 37. Type species, selected by Calman, 1909, *Ann. Mag. nat. Hist.*, ser. 8, 3: 442: *Panulirus angulatus* Bate, 1888, *Rep. Voy. Challenger, Zool.*, 24: 81. An invalid junior homonym of *Puer* Lefebvre, 1842, *Mag. Zool.*, ser. 2, 4: expl. pl. 92 (Neuroptera). Gender: masculine.

Puerulus Ortmann, 1897, *Amer. Journ. Sci.*, ser. 4, 4: 290. Substitute name for *Puer* Ortmann, 1891. Gender: masculine.

Belloc's (1959, p. 7) suggestion to use the name *Puer* for the present genus and *Puerulus* for the natant stages of Palinuridae, cannot be followed. *Puerulus* is the valid name for the present genus (*Puer* being preoccupied). It might be much better to avoid using the name *Puerulus* for the young stages of other palinurids altogether.

In a list of Palinuridae known to him at that time the present author in 1946 enumerated 4 species of the genus *Puerulus*, viz., *P. angulatus* (Bate), *P. carinatus* Borradaile, *P. parkeri* (Stebbing), and *P. sewelli* Ramadan (cf. Holthuis, 1946, p. 110). Not included in that list was *Puerulus gracilis* Kubo, 1939, which at that time was not known to me.

Jasus parkeri Stebbing, 1902, which was brought by me in 1946 to the genus *Puerulus*, according to Barnard (1950, pp. 540, 541) does not possess a stridulating organ and therefore cannot be maintained in *Puerulus*. It certainly is not a *Jasus* either. The species at the moment is being studied by Dr. R. W. George of the Western Australian Museum, Perth, and Dr. J. R. Grindley, South African Museum, Capetown, who will soon publish their findings. The species is not further considered here.

A study of the material of *Puerulus* present in the U.S. National Museum made it possible for me to gain a better understanding of the status of the various species, so that a revision of the genus proved to be possible. In all I can recognize three distinct species in the genus, which may be identified with the help of the following key:

1. Post-orbital spine present. No teeth but 6 post-cervical and 6 intestinal tubercles on the median carina of the carapace. Tubercles on carapace low and largely obscured by the pubescence. Eyes large, much broader than long.....*P. velutinus*
- Post-orbital spine absent. Median carina of carapace with 3 or 4 post-cervical and 2 or 3 intestinal teeth. Tubercles of carapace usually distinct and not obscured by the pubescence. Eyes smaller, longer than broad.....2.

2. Median carina of carapace with 3 post-cervical and 2 intestinal teeth. Three teeth between the supra-orbital horns and the cervical groove.....*P. angulatus*
 —Median carina of carapace with 5 post-cervical and 2 or 3 intestinal teeth. Two teeth between the supra-orbital horns and the cervical groove.....*P. sewelli*.

Puerulus angulatus (Bate, 1888)

Panulirus angulatus Bate, 1888, p. 81, pl. 11, figs. 2-4; Holthuis, 1956, p. 114; Hemming, 1958, p. 138.

Puer angulatus Ortmann, 1891, p. 37; Belloc, 1959, p. 9.

Puerulus angulatus Calman, 1909, p. 442 (pp.); Gruvel, 1911, p. 1350; Gruvel, 1911 *a*, p. 7, fig. 1; Bouvier, 1912, p. 78; Balss, 1925, p. 203; Holthuis, 1946, p. 110.

Puerulus carinatus Borradaile, 1910, p. 261, pl. 16, fig. 5; Ramadan, 1938, p. 133, figs. 6, 7; Holthuis, 1946, p. 110.

Puerulus gracilis Kubo, 1939, p. 316, figs. 1, 2.

not *Panulirus angulatus* Alcock and Anderson, 1894, p. 166; Alcock, 1899, p. 33; Alcock, 1901, p. 185; Sewell, 1913, p. 350.

not *Puerulus angulatus* De Man, 1916, p. 36, pl. 2, fig. 5.

Material Examined

U.S. National Museum, Washington

Malabrigo Light N. 46° W. 20·60 miles, Philippines, 13° 21' 30" N., 120° 30' 33" E.; 220 fms., green mud; 2 February 1908; "Albatross" Sta. D. 5122.—1 ♂, cl. 48 mm.

Jolo Light S. 46° W. 11·90 miles, Philippines, 6° 11' 50" N., 121° 08' 20" E.; 161 fms., fine coral sand; 7 February 1908; "Albatross" Sta. D. 5135.—1 ♂, cl. 41 mm., 1 ♀, cl. 45 mm.

Jolo Light N. 82° E. 6·75 miles, Philippines, 6° 02' 55" N., 120° 53' E.; 186 fms., shells and coral; 5 March 1908; "Albatross" Sta. D. 5173.—3 ♂♂, cl. 23-29 mm.

Escarceo Light N. 59° W. 6 miles, Philippines, 13° 28' 15" N., 121° 04' 30" E.; 180 fms., fine black sand; 23 July 1908; "Albatross" Sta. D. 5293.—2 ♂♂, cl. 26 and 43 mm.

Cape Santiago Light S. 79° W. 4·5 miles, Philippines, 13° 47' 20" N., 120° 43' 30" E.; 180 fms.; 20 February 1909; "Albatross" Sta. D. 5363.—1 ♂, cl. 55 mm.

Cape Santiago Light N. 73° W. 6·7 miles, Philippines, 13° 44' 24" N., 120° 45' 30" E.; 214 fms.; 22 February 1909; "Albatross" Sta. D. 5365.—1 ♂, cl. 58 mm.

Malabrigo Light N. 81° E. 8 miles, Philippines, 13° 34' 37" N., 121° 07' 30" E.; 180 fms., sand; 22 February 1909; "Albatross" Sta. D. 5367.—2 ♂♂, cl. 36 and 36 mm., 2 ♀♀, cl. 39 and 41 mm.

Tayabas Light (outer) N. 9° E. 7·4 miles, Philippines, 13° 46' 45" N., 121° 35' 08" E.; 190 fms., grey mud; 2 March 1909; "Albatross" Sta. D. 5374.—1 ♀, cl. 43 mm.

Louis Point Light N. 21° E. 5·5 miles, Philippines, 10° 09' 15" N., 123° 52' E.; 162 fms., green mud; 23 March 1909; "Albatross" Sta. D. 5412.—2 ♂♂, cl. 40 and 47 mm., 1 ♀, cl. 46 mm.

Macabalan Point Light, S. 35° E. 8·2 miles, Mindanao, Philippines, 8° 37' 37" N., 124° 35' E.; 214 fms., fine sand and grey mud; 4 August 1909; "Albatross" Sta. D. 5501 and 5502.—2 ♀♀, cl. 40 and 51 mm.

Macabalan Point Light S. 39° E. 6 miles and S. 31° E. 7.7 miles, Philippines, 8° 35' 30" N., 124° 36' E. and 8° 37' 15" N., 124° 36' E.; 200 and 220 fms., green mud; 5 August 1909; "Albatross" Sta. D. 5504 and D. 5505.—2 ♀♀, cl. 50 and 60 mm.

Camp Overton Light S. 6° E. 4.9 miles, Iligan Bay, Mindanao, Philippines, 8° 17' 24" N., 124° 11' 42" E.; 270 fms., green mud and fine sand; 5 August 1909; "Albatross" Sta. D. 5508.—1 ♂, cl. 52 mm., 1 ♀, cl. 50 mm.

Point Tagolo Light S. 64° W. 8.7 miles, Philippines, 8° 48' N., 123° 31' E.; 200 fms., grey mud, globigerina; 9 August 1909; "Albatross" Sta. D. 5518.—1 ♂, cl. 45 mm., 1 ♀, cl. 49 mm.

Point Tagolo Light S. 48° W. 6.7 miles, Philippines, 8° 48' 44" N., 123° 27' 35" E.; 10 August 1909; "Albatross" Sta. D. 5523.—1 ♂, cl. 50 mm., 1 ♀, cl. 48 mm.

Apo Island S. 26° W. 11.8 miles, Philippines, 9° 15' 45" N., 123° 22' 00" E.; 279 fms., green mud; 19 August 1909; "Albatross" Sta. D. 5536.—1 ♂, cl. 52 mm.

Mount Dromedario S. 22° W. 17.2 miles, Philippines, 5° 25' 56" N., 120° 03' 39" E.; 277 fms., sand; 23 September 1909; "Albatross" Sta. D. 5576.—1 juvenile, cl. 12 mm.

Description.—The supra-orbital horns are followed by three teeth, which decrease in size posteriorly. On the anterior margin of the carapace at the inner base of either supra-orbital horn one strong sharp tooth is present in all my specimens (sometimes this tooth is 2-, rarely 3-topped). Bate did not figure these teeth, but according to Ramadan (1938, p. 131) they are actually present in the type. The lower orbital tooth is strong, below it there is a single or 2-topped smaller tooth, behind it extends a longitudinal row of three smallish teeth, which decrease in size posteriorly. Between the supra-orbital and the infra-orbital rows of teeth there are two longitudinal rows of minute spinules; the upper of these rows is double and often curved, the lower is single, very short and consisting of 1 to 3 spinules, which sometimes are irregularly arranged. No post-orbital spine is present. In the anterior part of the median region before the cervical groove there are two anteriorly converging rows of 3 to 5 large and numerous small teeth (sometimes the two anterior median teeth are larger than the rest). There are a few scattered very small additional spinules in this area. Behind the cervical groove the carapace is evenly covered with small pointed tubercles and 3 rows (one median and 2 branchial) of teeth. The median of these rows consists of 3 post-cervical and 2 (rarely 3) intestinal teeth, which are well developed and pointed. The branchial row is formed of about 5 to 8 larger teeth and numerous small teeth, most of the latter cannot be distinguished from the pointed tubercles of the rest of the carapace. This branchial row extends practically in one line with the pre-cervical post-orbital row of spines.

The median carina of the first abdominal somite is short and interrupted in the middle. The segment shows a broad transverse groove, which is filled with a short pubescence. In the following four somites the exposed posterior half bears a median carina which is twice interrupted forming thereby three ridges, the second of which bears a posterior tooth in the fourth and fifth, and sometimes also in the third somite. In the second somite the posterior of the three ridges is more or less distinctly divided in two, in the fourth and fifth somites the first interruption may be obscure. Apart from the wide transverse groove, which separates the anterior part of the somite (namely the part which disappears under the previous somite when the abdomen is fully stretched) from the posterior part, there is a second transverse groove, which passes between the second and last of the median ridges. On each half of the dorsal surface of the abdominal somites II to V there are three oblique rows of tubercles, the inner of these becomes almost transverse in the fourth and fifth somites. The next extends from the posterior point of the base of the pleura forward and inward, while the third starts at the anterior point of the base of the pleura and runs posteriorly and outward. Sometimes the tubercles end in an acute tip. The pleura of somites II to V end in two sharply pointed teeth which are small and of about equal size in the male; in the female they are larger while the anterior usually is slightly longer than the posterior, especially so in the second somite. The anterior margin of the pleuron of somite II shows two denticles. The sixth somite bears 2 submedian rows of 4 to 6

posteriorly pointing denticles. The posterior margin of this somite bears a single small median tooth. An often irregular row of denticles extends over the base of the pleura and an oblique row may be seen on the pleura themselves. The pleura end in two posteriorly directed sharp teeth, the outer of which is the stronger. The lateral margins of the calcified portion of the telson each bear two spines: one in the middle and one at the end; on the dorsal surface there are two diverging rows of 2 to 6 spines, the last of which are strongest; furthermore there is a pair of submedian spines in the extreme anterior part of the telson. The abdomen is covered with a short pubescence which is most distinct in the grooves.

The eyes are longer than broad. The peduncle is constricted in the middle. The cornea is rounded, its breadth being less than the length of the eye.

The antennular plate bears one or two pairs of small spines which are somewhat curved outward at the top; these spines may be preceded by a row of 1 to 5 smaller spinules. In the juveniles these spines and spinules may be indistinct. The lateral ridges of the antennular plate form a stridulating organ with a process from the third antennal segment that slides over it.

The third (actually the fused second and third) segment of the antennal peduncle shows a strong tooth on the anterior margin just above the stridulating process; also the outer and lower parts of this margin are provided with teeth. Two, rarely three, teeth are placed on the outer margin and several smaller denticles on the lower surface. This surface also bears a rather large sub-distal tooth. The fourth segment bears four strong teeth on the outer margin, two oblique rows of 3 to 7 denticles on the upper surface, two longitudinal rows (one of 3 to 6 and one of 0 to 3 denticles) on the lower surface, and a strong inner antero-lateral tooth, which at its inner lower side bears a smaller tooth. The lateral margins of the fifth segment each bear three (seldom 2 on the outer or 4 on the inner margin) teeth, the anterior margin bears a dorsal and a ventral tooth, while some denticles are present on both upper and lower surface.

The epistome ends in a single strong median tooth.

The meri of the third maxilliped and the first two pereopods bear distinct ventral teeth. The first two legs are far more heavy than the following. Their dactyli are more than half as long as the propodi, and about as long as the carpi; they bear scattered hairs. The last three legs are very slender and bear no ventral teeth on the merus. The dactylus of the third pereopod is about $\frac{2}{5}$ as long as the propodus and slightly shorter than the carpus, like in the following legs it bears two distinct longitudinal rows of hair dorsally. The following leg are much longer than the third; the fourth of both sexes and the fifth of the males reach with the dactylus and part of the propodus beyond the third. In the fourth the dactylus is distinctly less to somewhat more than $\frac{1}{3}$ as long as the propodus while this ratio in the fifth leg is somewhat less to slightly more than $\frac{1}{4}$, being somewhat more than $\frac{1}{2}$, and $\frac{1}{2}$ or somewhat more than $\frac{1}{2}$ as long as the carpus respectively. In the female the fifth leg is proportionally shorter and ends in a small but distinct chela, which is less than $\frac{1}{5}$ as long as the propodus. In all the legs the merus bears an antero-dorsal spine.

The thoracic sternum bears a sharp median tooth on all somites; furthermore one sharp tooth is present at the bases of the second and third legs, while two or three such teeth are placed at the bases of the fourth and fifth legs.

In the males the vas deferens protrudes from the genital opening as a fleshy pointed organ.

The first abdominal sternite in both sexes bears two submedian and two lateral spines. In the second to fifth somites of the males only the submedian spines are present, while in the females even those are absent or most inconspicuous. In the sixth abdominal somite of the males there are three transverse rows of spines: the anterior consists of two submedian spines, the second of 6 spines and the third of 4 larger spines. In the females the first two rows are visible each as a pair of tubercles, the third row is as in the males. There are no pleopods on the first abdominal somites; in both sexes the pleopods of the second to fifth abdominal somites are very similar. In the males the endo-

pod is absent, while the exopod is large and leaf-shaped. In the females the exopods of the pleopods also are large and leaf-shaped, but endopods are present here. The endopods are very similar to those of *Linuparus*: the endopod itself is very slender with a long and narrow protuberance in the basal part of the inner margin; on this protuberance a narrow and slender stylamblys is placed. The endopod proper and the stylamblys both are directed forward, they are of about the same length and width. The uropods in both sexes have the propod ending in an outer tooth; the diaereses of the exo- and endopods are spinulose.

In the very young specimen from Sta. D. 5576 there are only two teeth behind the infra-orbital tooth, while the anterior margin of the carapace shows no teeth between the supra-orbital horns. The two submedian rows of spines in the anterior part of the carapace consist of three spines each, the rows are slightly diverging anteriorly and no spinules are present. There are three high post-cervical and two prominent intestinal teeth, which are relatively more conspicuous than in the adults. Also on the branchial ridges the teeth are relatively larger.

Each of the median ridges of the abdomen is visible in this specimen as a high and compressed pointed tooth; only the posterior ridge of the first somite is blunt. The tubercles of the abdomen are spinous and the two teeth at the end of the pleura are rather widely diverging.

The spinules on the antennular plate are hardly visible. On the antennal peduncle there are numerous small spines besides those found in the adults.

The epistome, instead of having a single median tooth which is directed forward, has two strong submedian spine-like teeth which are directed ventrally.

The propodi of the last three pereopods are relatively shorter. The thoracic sternum shows no median spines and bears only one spine at the base of each leg. The uropods have very long and slender exo- and endopods.

The type specimen of *Panulirus angulatus* Bate is somewhat larger than the smallest specimen collected by the "Albatross". Ramadan (1938, p. 133) gave the carapace length of Bate's specimen as 16.5 mm. The spinulation of Bate's type agrees quite well with that of the present specimens, although in Bate's fig. 4 showing the animal in lateral view, the median teeth of the fourth and fifth abdominal somites and the pleuron of the third probably are not quite correctly represented. The epistome shows already the median spine, though traces of the submedian spines may also be seen. There cannot be any doubt that Bate's specimen and the present material belong to the same species.

Puerulus carinatus Borradaile has been very superficially described by its author. It is very difficult to decide from this description and the figure whether or not the species is distinct from *P. angulatus*. Borradaile's specimen is very large, its carapace length being about 70 mm. The differences from *P. angulatus* seem to be the following: (1) There are only two teeth behind the supra-orbital horns instead of three. (2) According to Borradaile's description two teeth are placed behind the infra-orbital teeth, but the figure shows three there. (3) The figure shows fewer dorsal median ridges on the abdomen than in *P. angulatus*, but this may be due to inaccuracy of the illustration; this feature is not discussed in the text. (4) The fourth antennal segment bears five outer teeth instead of four and the fifth segment is figured with four outer teeth, though the text indicates three there. The specimen which Ramadan (1938) assigned with some doubt to *P. carinatus* in all the just mentioned points agrees with *P. angulatus* and there can be little doubt that his specimen indeed belongs to the latter species. For the time being it seems safe to consider *P. carinatus* a synonym of *P. angulatus*.

The specimens collected by the Siboga Expedition and identified by De Man (1916) as *Puerulus angulatus* are different from that species and have recently been made the types of a separate species *P. velutinus*.

Balss (1925) described the specimen which he brought to *Puerulus angulatus* as having five teeth on the median carina of the carapace behind the cervical groove. This shows that that specimen

indeed belongs to Bate's species and not to either of the other two species of this genus, which at times have been confused with *P. angulatus*.

Ramadan (1938) made it clear that the Indian specimens dealt with by Alcock and Sewell actually belong to a separate species which he named *P. sewelli*.

Kubo (1939) gave a good description and excellent illustration of a supposed new species, which he named *Puerulus gracilis*. His account clearly shows that his specimens belong to the present species, agreeing in all details with it. Kubo considered his species distinct as in *P. gracilis* a "longitudinal series of four teeth including supra-orbital spine" extends "backward almost to the cervical groove as in *P. carinatus*", but this is exactly the situation found in *P. angulatus* and correctly figured by Bate in his pl. 11, fig. 4. In Bate's fig. 3 the last of these teeth evidently is drawn too large. The other difference mentioned by Kubo is the absence of teeth on the frontal margin of the carapace between the supra-orbital horns in *P. angulatus*; as shown above these teeth have been erroneously omitted by Bate, while moreover they sometimes are absent in juvenile specimens. There can be little doubt therefore that *Puerulus gracilis* is nothing but the adult stage of *Puerulus angulatus* so that the two names should be synonymized.

Distribution.—The species has been reported from the following localities: E. of Zanzibar, 5° 34' 24" S., 39° 14' 06" E.—5° 37' 00" S., 39° 14' 36" E. (Ramadan, 1938) near Saya de Malha Bank, Western Indian Ocean (Borradaile, 1910), W. of Nicobar Islands, 7° 49' N., 93° 10' E. (Balss, 1925) N. of New Guinea, 1° 54' S., 146° 39' 40" E. (Bate, 1888), off Kominato, Bōsyū province, Honshu, Japan (Kubo, 1939); the present material all originated from the Philippine Islands. The species was taken at depths between 150 and 293 fms. on a bottom of mud (green mud, grey mud, coral mud), or sand (fine coral sand, fine black sand, fine sand, sand), only once it was taken from a bottom of shells and coral.

Type locality.—N. of New Guinea, 1° 54' S., 146° 39' 40" E., depth 150 fms.

Puerulus sewelli Ramadan, 1938

Panulirus angulatus, Alcock and Anderson, 1894, p. 166; Alcock, 1899, p. 33; Alcock, 1901, p. 185. (not *Panulirus angulatus* Bate, 1888).

Puerulus angulatus Calman, 1909, p. 442 (p.p.); Sewell, 1913, p. 350.

Puerulus sewelli Ramadan, 1938, p. 128, figs. 3–5; Holthuis, 1946, p. 110; Sewell, 1955, pp. 200, 201, 203.

Puer sewelli Belloc, 1959, pp. 7, 8, 9, fig. 6.

Material Examined

U.S. National Museum, Washington

13.5 miles N. 64° W. of Colombo Light, Ceylon; 142–400 fms.; brown mud; 4 December 1893; "Investigator" Sta. 151; don. Indian Museum.—1 juvenile paralectotype cl., 18 mm.

British Museum (Nat. Hist.), London

Gulf of Aden, 11° 53' 42" N., 51° 13' 12" E.; 73–220 m. deep; coarse sand and shells; 9 October 1933; John Murray Expedition Sta. 24.—1 ♀, paralectotype cl., 74 mm.

Gulf of Aden, 13° 16' 00" N., 46° 20' 24" E.—13° 16' 36" N., 46° 14' 00" E.; 220 m. deep; green mud; 7 May 1934; John Murray Expedition Sta. 194.—1 ♂ lectotype cl. 63 mm.

Ramadan (1938), when describing this species, did not distinguish between *P. angulatus* and *P. velutinus* and therefore some of his comparisons between *P. sewelli* and *P. angulatus* do not hold good. I found the following differences when comparing my material of *P. angulatus* and *P. sewelli*;

1. The spines and teeth in *P. angulatus* are far sharper and more conspicuous than in specimens of *P. sewelli* of the same size.
2. The body of *P. sewelli* shows less pubescence.
3. Behind the supra-orbital horns there are two teeth in *P. sewelli* instead of three.
4. The abdomen (telson excluded) in *P. sewelli* is as long as or shorter than the carapace (the ratio abdomen/carapace being 0.9 to 1.0). In *P. angulatus* material measured by me the abdomen (without telson) is longer than the carapace (the ratio abdomen/carapace in this material being 1.1 to 1.3).
5. The region before the cervical groove is relatively shorter in *P. sewelli*; the ratio length post-cervical area/length pre-cervical area is 1.4 to 1.8 in *P. sewelli*, while in my material of *P. angulatus* it varies between 1.1 and 1.4.
6. Behind the lower orbital tooth there are two teeth in *P. sewelli*, three in *P. angulatus*.
7. The median carina behind the cervical groove in *P. sewelli* bears 5 post-cervical and 2 or 3 intestinal teeth. The second of the post-cervical teeth is double and smaller than the rest.
8. In the adults of *P. sewelli* the anterior of the two spines at the distal margin of the pleura of the abdominal somites II to V is far longer than the posterior; this is especially distinct in the female, where both spines are much longer than in the male; in the male the posterior spine is reduced to a mere tubercle. In the juvenile the two spines do not differ much in size.
9. No denticles are seen on the anterior margin of the pleura of the second abdominal somite in the adults of *P. sewelli*; in the juvenile they are present.
10. The spines on the antennal peduncle are smaller than in *P. angulatus*, and in the adults they are entirely lacking on the dorsal surface of the distal segment.
11. The pereopods are less slender than in *P. angulatus* and in the adults they have no antero-dorsal spine on the merus; such a spine is present in the young.
12. The sternum of the male is much narrower and shows a median ridge which extends over the first 4 sternites and is produced into a low blunt tooth between the bases of the first to third legs, no other such teeth are present, except for a minute one at the end of the sternum. In the female these teeth are present on the first four sternites. In both sexes a transverse depression is visible on the sternum at the end of the fourth and fifth sternites.
13. In the adult there are no spines on the sternite of the sixth abdominal somite; they are present, however, in the juvenile.

Puerulus sewelli is closely related to *P. angulatus*, but the differences enumerated above in my opinion are sufficiently important and constant for the two forms to be considered good species.

Distribution.—The present species has been reported from the following localities: Gulf of Aden, 13° 16' 00" N., 46° 20' 24" E.—13° 16' 36" N., 46° 14' 00" E. and 11° 53' 42" N., 51° 13' 12" E. (Ramadan, 1938), Arabian Sea off Travancore, India (Alcock, 1901; Sewell, 1913), 13.5 miles N 64° W. of Colombo Light, Gulf of Mannar, Ceylon (Alcock, and Anderson, 1894; Alcock, 1899, 1901; Calman, 1909; Sewell, 1913). It was taken at depths between 73 and 1309 m. on bottoms of mud and coarse sand and shells.

Type locality.—Ramadan (1938), who based his new species both on his own material and that brought by Alcock (1901) to *Puerulus angulatus*, did not indicate a holotype so that all these specimens are syntypes. I now select the male specimen (cl. 63 mm.) from John Murray Expedition Sta. 194 listed above, as the lectotype of *Puerulus sewelli* Ramadan, 1938, the other specimens thus

becoming paralectotypes. The type locality is restricted by this action to the Gulf of Aden, 13° 16' 00" N., 46° 20' 24" E.—13° 16' 36" N., 46° 14' 00" E., 220 m. deep. The lectotype is preserved in the collection of the British Museum (Nat. Hist.).

Puerulus velutinus Holthuis, 1963

Puerulus angulatus, De Man, 1916, p. 36, pl. 2, fig. 5. (not *Panulirus angulatus* Bate, 1888).

Puerulus velutinus Holthuis, 1963, p. 55.

Material Examined

U.S. National Museum, Washington

Point Tabonan S. 89° E. 33·5 miles, Palawan Passage, Philippines, 10° 57' 45" N., 118° 38' 15" E.; 375 fms., coral and sand; 27 December 1908; "Albatross" Sta. D. 5348.—1 ♀ paratype cl. 62 mm.

Makyan Island (S.) N. 67° W. 8·9 miles, northern Moluccas, 0° 12' 15" N., 127° 29' 30" E.; 288 fms., fine sand and mud; 29 November 1909; "Albatross" Sta. D. 5624.—1 ♂ paratype, cl. 65 mm.

Zoological Museum, Amsterdam

Bali Sea, Indonesia, 7° 35·4' S., 117° 28·6' E.; 521 m., coral; 1 April 1899; "Siboga" Sta. 38.—11 ♂ paratypes, cl. 31–47 mm., 12 ♀ paratypes, cl. 19–61 mm. (5 ovigerous ♀♀ cl. 47–61 mm.).

Between Roti and Timor, Lesser Sunda Islands, 10° 39' S., 123° 40' E.; 520 m., soft grey mud with brown upper layer; 27 January 1900; "Siboga" Sta. 297.—1 ♂ holotype cl. 53 mm., 2 ♂ paratypes cl. 43 and 50 mm., 2 female paratypes cl. 39 and 43 mm.

This species has been extensively described and figured by De Man (1916), who considered it to be identical with *Puerulus angulatus* (Bate). The differences between *Puerulus angulatus* and the present form, however, are so numerous and striking that there can be not the least doubt that De Man's specimens represent a distinct species. The most important features of *Puerulus velutinus* are:

The body is far less spinous than in *Puerulus angulatus*, most of the spines are reduced to mere spinules and are obscured by the dense pubescence of the carapace. The supra-orbital horns are more flattened, and in the large male do not have an additional spine on the anterior margin; in the female and the juvenile male three or four such spines are present, the outer being the larger. Behind the horns there are two teeth only, the last of these is extremely small. The lower orbital tooth is strong, behind it there are two very inconspicuous spinules. Below the lower orbital tooth there is a rounded lobe, which is unarmed in the large male, but carries two to four teeth in the female and young male. A strong post-orbital spine is placed behind the eye; this spine is entirely lacking in *Puerulus angulatus* and *P. sewelli*. Behind and slightly below this post-orbital spine a small additional spinule may be present. Above and behind it two rows of spinules similar to but far smaller than those of *P. angulatus* may be seen. In the anterior part of the median region before the cervical groove there are two almost parallel rows of about 5 small blunt spinules. There may be some other still smaller spinules, which, however, are usually obscured by the strong pubescence of the carapace. The median carina behind the cervical groove bears a longitudinal row of blunt tubercles. The line between the post-cervical and intestinal tubercles is very obscure. There are 4 to 7 post-cervical and 6 or 7 intestinal tubercles. An irregular row of about 18 tubercles extends over the branchial region.

The median carina of the first abdominal somite is inconspicuous and bears a small anterior tubercle. A transverse row of still smaller tubercles extends along the posterior margin. Similar transverse rows of tubercles also are found on the second and third somite, and are very incon-

spicuous on the fourth. The median carina is like in *P. angulatus*, only it is less distinct. Also the three rows of tubercles on each half of abdominal somites II to V are present here, but are less pronounced and may consist of more tubercles; the inner rows on the fourth and fifth somites are not transverse, but more longitudinal, while the second row as a rule is split into two more or less parallel rows. The pleura of abdominal somites II to V end in two teeth, the anterior of which is much longer than the posterior. In the male these teeth are far shorter than in the female, in the second somite they even are hardly discernible, becoming larger in the following somites. The sixth somite and the telson are like in *P. angulatus*, but with the spines much smaller. The abdomen is thickly covered with pubescence.

The eyes are far larger than those of *P. angulatus*. The breadth of the cornea far exceeds the entire length of the eye.

The antennular plate does not bear any spine, being only covered with pubescence.

There is no spine above the process of the third antennal segment which forms part of the stridulating organ. The fourth antennal segment is far broader than that of *P. angulatus*, its upper surface bears a few inconspicuous spinules. Its outer margin bears 5 teeth, the proximal of which is very small; the inner antero-lateral tooth is very strong in the female, less so in the male.

The meri of the legs often do not have an antero-dorsal spine. The propodus of the fifth leg possesses an antero-ventral process, which in the female forms a chela with a ventro-proximal process of the dactylus; in the male the dactylus does not possess any process. In *P. angulatus* the males do not show any process on the propodus.

The thoracic sternum in the males is more elongate than in *P. angulatus*. Its median line shows only low teeth, while also the lateral teeth are low. The last median tooth is flanked on each side by two tubercles which are placed in a transverse row.

The spines on the abdominal sternites are far smaller and less conspicuous than in *P. angulatus*. The pleopods of the smaller males (cl. about 35 mm. or less) show traces of the endopod and its stylamblys; these disappear in the adults. In the pleopod of the second abdominal somite of the female the stylamblys is distinctly more slender than the endopod, in the following pleopods this difference becomes gradually less distinct.

One of the males of "Siboga" Sta. 38 carried a lepadid on the dorsal surface of the telson.

In the relative length of the abdomen and the two parts of the carapace (*viz.*, that before and that behind the cervical groove) the present species agrees quite well with *P. angulatus*. It, probably, is the similarity in this character that made Ramadan decide that De Man's (1916) specimens indeed belong to *Puerulus angulatus*.

Distribution.—The species is only known from the specimens enumerated here. Its known range embraces the Lesser Sunda Islands, the Moluccas and S.W. Philippines. It is known from depths between 520 and 683 m., and has been found on bottoms of mud, sand and coral.

Type locality.—Lesser Sunda Islands, Indonesia, 10° 39' S., 123° 40' E., depth 520 m.

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