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STOMATOPODA IN THE BERNICE P. BISHOP MUSEUM

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By Charles Howard Edmondson

INTRODUCTION

The Stomatopoda which represent one of the higher orders of malacostracous Crustacea constitute a clearly defined group and may be recognized by the following characteristics.

The carapace is relatively small and only partly covers the cephalothorax, leaving at least the four posterior thoracic segments exposed. The rostrum is separated from the carapace by a distinct suture. The abdomen is well developed. The eyes are stalked and carried on distinct movable segments, as are also the first pair of antennae. The second pair of thoracic appendages are developed into raptorial limbs in which the terminal segment, called the dactylus, closes upon the preceding one, the manus, like a knife blade. Posterior to the raptorial limbs are three pairs of thoracic appendages constructed on the same general plan as the former but very much smaller. The three posterior thoracic segments bear biramous walking legs. Of the seven abdominal segments each of the first five bears a pair of appendages, the swimmerets, to which are attached tufted gills. The sixth segment also bears a pair of appendages, the uropods, which, with the seventh segment, the telson, serve as a tail fin.

All recent Stomatopoda are included in a single family, Squillidae, the characteristics of which are the same as those of the order.

In this group relationship between the several genera and also between species is based largely upon the peculiar features of the sixth and seventh abdominal segments, the raptorial limbs, the eyes, and the rostrum.

Brooks,[1] in tracing the generic relationship between the species, calls attention to the important significance of the accessory organ of the first abdominal appendage of the male stomatopod.

[1] Brooks, W. K., Report on the Stomatopoda: Voy. H.M.S. "Challenger," Zoology, vol. 16, p. 13, 1886.

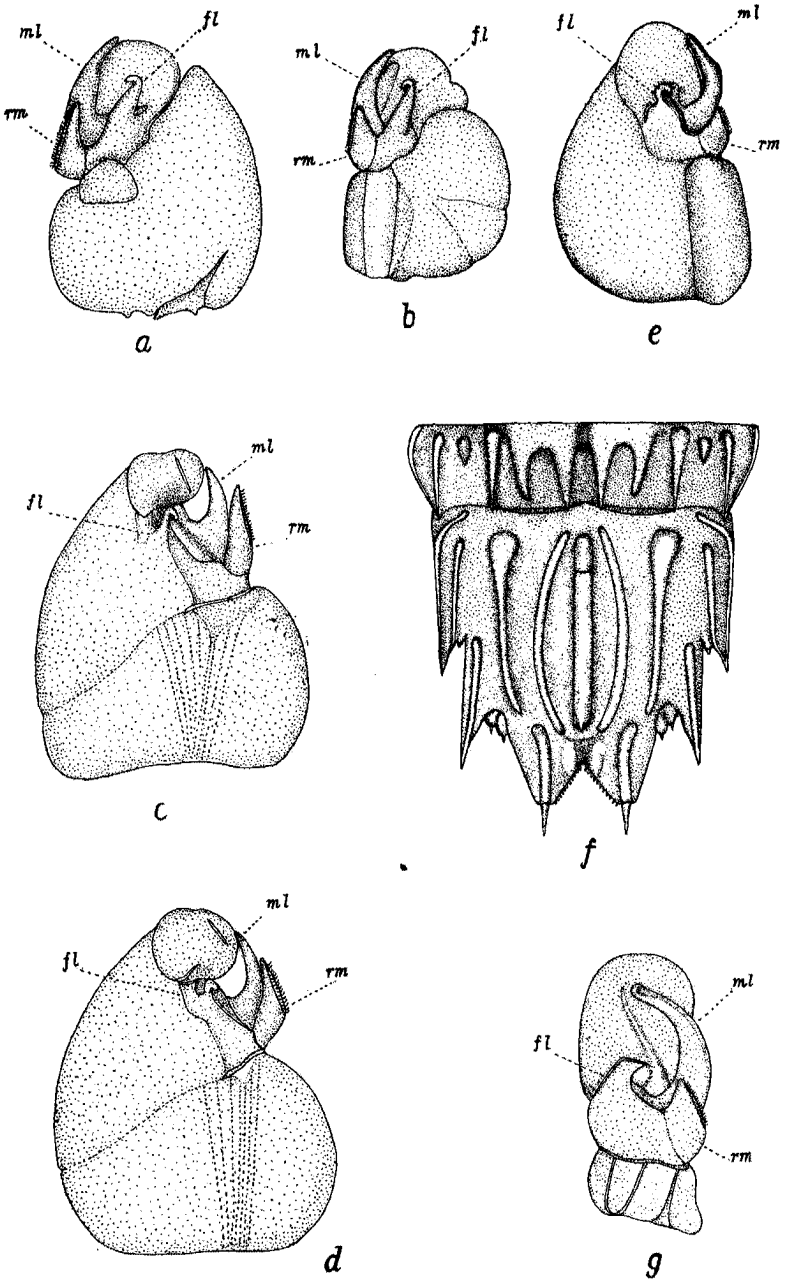

FIGURE 1. Accessory organs and segments of Stomatopoda (*rm*=retinaculum; *ml*=movable limb; *fl*=fixed limb):

a, Right accessory organ of male, *Squilla oratoria* (×5); **b**, right accessory organ of male. *Pseudosquilla oculata* (×10); **c**, left accessory organ of male, *Lysiosquilla maculata*, from Tahiti (×2½); **d**, left accessory organ of male, *Lysiosquilla maculata*, from Honolulu (×2½); **e**, left accessory organ of male, *Odontodactylus hanseni* (×13); **f**, sixth abdominal segment and telson of *Odontodactylus hanseni* (×5); **g**, left accessory organ of male, *Gonodactylus guerinii* (×10).

In all Squillidae this complicated organ is borne on the terminal segment of the endopodite of the first abdominal appendage and consists of three distinct portions: first, the retinaculum or external appendicular process (*rm*—fig. 1, *a-e* and *g*), which is medial in position, rounded proximally and pointed distally, with a flattened medial surface provided with rows of hooked spines which interconnect with those of the corresponding organ of the opposite appendage; second, the movable limb (*ml*—fig. 1, *a-e* and *g*) of the forceps of the organ, which projects at an angle across the surface of the endopodite, its free end, in most species, slightly curved and spoon-shaped; third, the fixed limb of the forceps (*fl*—fig. 1, *a-e* and *g*), which also extends at an angle across the endopodite and, in most species, terminates in a hook.

Brooks[2], Borradaile[3], Chilton[4], and others have figured and described the accessory organs of certain species of Squillidae. The characteristic features of the structure in additional species are presented in this report.

Although the Squillidae are known to inhabit the tropical, subtropical, and temperate oceans, yet the greater number of them have been taken from the warmer seas. Some are apparently localized in their distribution or at least have not been reported from widely separated regions, and others within certain latitudinal limits are extensively dispersed throughout the Indian, Pacific, and Atlantic Oceans.

A number of species of Squillidae are known to range considerably below the 100-fathom line. Bigelow reports *Squilla biformis* as having been taken in Panama Bay at 85-259 fathoms, and the "Investigator" took *Squilla leptosquilla* in the Indian Ocean at 370-419 fathoms. The larger number of known species are, however, confined to shallow water where they burrow in the sand or conceal themselves in the crevices of dead coral.

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[2] Brooks, W. K.: Op. cit., Pls. 1, 2, 10, 15, 1886.

[3] Borradaile, L. A., On some crustaceans from the South Pacific, Part 1, Stomatopoda: Proc. Zool. Soc. London, Pls. 5, 6, 1898.

[4] Chilton, C., Notes on the New Zealand Squillidae: Trans. New Zealand Inst., vol. 23, pl. 10, 1890; Revision of the New Zealand Stomatopoda: Trans. New Zealand Inst., vol. 43, p. 136, fig. 2, 1910.

The Stomatopoda are, without doubt, less abundant than some other well-known groups of Crustacea; their great agility when moving freely in the water and their powers of concealment, rendering their capture a difficult task, may, however, partly explain why a larger number of Squillidae have not been described.

Up to the present time the number of species reported is probably below one hundred and fifty and, on consulting the literature, one finds that not a few of this number have been described from one or two specimens.

Although the collection of Stomatopoda in the Bishop Museum is at present not large, yet a considerable degree of interest is attached to it from a distributional point of view.

The collection comprises fifty-three specimens, grouped under six genera and nine species, one of which is new. Of the fifty-three specimens ten are recorded from Guam, four from Tahiti, and two from the Marquesas, the other thirty-seven being from Hawaii.

Representatives from the Hawaiian waters are listed under six genera and eight species. If one may infer from the frequency with which they are taken, three of the species of Squillidae found in Hawaiian waters exist in much greater number on the reefs and in the shallow water about the islands than do the other five species.

Pseudosquilla ciliata Miers, a widely distributed species, is very common on the reefs about Oahu. Another species of the same genus, *Pseudosquilla oculata* (Brullé), previously reported from the Canaries, Madeira, Cape Verde Islands, Mauritius, Chagos, Samoa, and the China Sea, has frequently been taken from the dead coral blocks on Waikiki reef, Honolulu. A third species, *Squilla oratoria* de Haan, more or less common in Chinese and Japanese waters, has several times been found in the Honolulu fish market during the present year, but the writer has never taken the species from the reefs about Oahu and is unable to say where the fishermen obtain it.

Other species of Squillidae taken from Hawaiian waters are, for the most part, represented in the Bishop Museum collection by single specimens.

More thorough and extensive surveys of the reefs and shallow waters about the Hawaiian and other islands of tropical and subtropical seas will, no doubt, greatly increase the number of known species of the group and throw added light on the problem of distribution.

One of the interesting disclosures resulting from a study of the collection of Squillidae in the Bishop Museum is the fact of the occurrence in the Hawaiian waters of *Odontodactylus hansenii* (Pocock), previously reported from the China Sea, and *Squilla alba* Bigelow, known only heretofore as from the Bahamas. More complete knowledge of the Stomatopoda will, no doubt, reveal a much more extensive distribution of many of the species previously believed to be somewhat restricted in their dispersal. The long life of the larvae, together with favorable ocean currents, may possibly explain the presence of the same species in widely separated regions, especially in the same ocean. It is only reasonable, however, to believe that more complete surveys would reveal the species in intervening localities and thereby shorten the links of the distributional chain.

Attention is here called to the structural difference between the male accessory organ of *Lysiosquilla maculata* (Fabricius) in specimens from Tahiti as compared with that in the specimens from Hawaii. A large number of Hawaiian specimens, however, should be examined before conclusions regarding a fixed local variety can be drawn with certainty.

SQUILLIDAE

There are, at the present time, six recognized genera of the Squillidae, all of which are represented in the Bishop Museum collection by one or more species.

The following key, presenting the distinguishing characteristics of the genera, is one formulated by Kemp[5].

I. Articulation between merus and ischium of raptorial claw terminal (normal); merus grooved inferiorly for reception of propodus throughout its length; propodus finely pectinate or with a series of fixed spines along outer edge of dorsal surface; dactylus rarely inflated at base.

A. Carapace with well-marked carinae; cervical groove defined across dorsum of carapace; first five abdominal somites with longitudinal carinae (raptorial dactylus not inflated at base).....**Squilla,** p. 287

B. Carapace without carinae; cervical groove not extending across dorsum of carapace; first five abdominal somites without longitudinal carinae[6].

1. Abdomen usually compressed; raptorial dactylus not inflated at base with two, rarely three, teeth on inner margin,[7] or unarmed; telson with sharp median carina and (in adults) with other carinae on either side .....**Pseudosquilla,** p. 288

2. Abdomen depressed; raptorial dactylus not inflated at base with at least four teeth on inner margin; telson without median carina, often smooth or with a transverse circlet of spines .....**Lysiosquilla,** p. 292

3. Abdomen depressed; raptorial dactylus with three teeth on inner margin; telson closely studded with fine spineules or large tubercles, with or without a pair of submedian carinae .....**Coronida,** p. 295

II. Ischio-meral articulation of raptorial claw situated at a point anterior to proximal end of merus, which consequently extends backward considerably beyond the joint; ventral surface of merus grooved and hollowed for reception of propodus for not more than three-quarters its length; dactylus inflated at base.

A. Dactylus of raptorial claw with teeth on its inner margin.....**Odontodactylus,** p. 297

B. Dactylus of raptorial claw without teeth on its inner margin.....**Gonodactylus,** p. 299

[5] Kemp, S., Crustacea Stomatopoda of the Indo-Pacific Region: Mem. Indian Mus., vol. 4, p. 16, 1913.

[6] See Kemp's exception and reference in his footnote No. 1.

[7] Kemp excludes the terminal tooth. See his footnote No. 2.

SQUILLA Fabricius

Squilla oratoria de Haan[8].

Squilla oratoria de Haan, in Siebold's Fauna Japonica, Crust., Atlas, Pl. 51, fig. 2, 1844.

Squilla affinis Berthold, Abhandl. Gess. Wiss. Göttingen, vol. 5, p. 26, 1845.—Bigelow, Proc. U. S. Nat. Mus., vol. 17, p. 538, fig. 22, 1894, and synonymy.

Squilla oratoria Kemp, Mem. Indian Mus., vol. 4, p. 66, Pl. 5, figs. 54-56, 1913, and synonymy.

In the Bishop Museum collection of Squillidae are eight specimens of this species, including two females collected at Guam by Alvin Seale in 1901, and six specimens, two males and four females, obtained by the writer from the Honolulu market during 1921.

The specimens from Guam agree in all details with those from Honolulu, and all are in accord with previously published descriptions of the species. Figure 1, *a*, represents the male accessory organ of the first abdominal appendage of a specimen from Honolulu. The color of the specimens obtained from the Honolulu market in a fresh condition was reddish-brown with the uropods marked with black patches. The dactyli were much lighter in color than the carapace and abdomen. The alcoholic specimens from Guam are uniformly light brown above.

The largest specimen in the Bishop Museum collection, a female from Honolulu, measures 165 mm. from the tip of the rostrum to the extremity of the submedian marginal spines of the telson.

The species, represented in the Bishop Museum by the specimens from Honolulu and Guam, is apparently abundant in Chinese and Japanese waters. It has also been reported from Mauritius, Ceylon, New Zealand, and the Philippine Islands.

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[8] The specific name of this species has been the basis of some controversy. I have given preference to de Haan's name instead of that of Berthold as it would seem that Stebbing's view is the correct one. See Stebbing, T. R. R., South African Crustacea: Ann. South African Mus., vol. 6, p. 45, 1908.

Squilla alba Bigelow.

Squilla alba Bigelow, Johns Hopkins Univ. Circular 106, p. 103, 1893; Proc. U. S. Nat. Mus., vol. 17, p. 539, Pl. 22, 1894.

In the collection of Squillidae in the Bishop Museum a single specimen apparently belongs to this species. In so far as the writer can determine, the species has not been reported from the Pacific previously. It was described by Bigelow from two female specimens that he took in Bimini Harbor, Bahamas.

The specimen in the Bishop Museum, also a female, was taken by the writer from dead coral on Waikiki reef, Honolulu, in 1921. In all structural details it agrees with Bigelow's diagnosis of the type specimen, but the symmetrically arranged, minute, black spots mentioned in Bigelow's general description of the species are absent from the Honolulu specimen. The specimen taken at Waikiki was kept alive and under observation by the writer for more than a month, during which period no spots were observed on the carapace or abdomen.

Bigelow says of these markings, "The same number of spots is not always present." It seems apparent from the Honolulu specimen that the spots are not a constant feature of the species.

The color of the Bishop Museum specimen is pure white. The eyes are of a yellowish tint with darker pigment in the concavity of the cornea.

The specimen taken at Honolulu measures 47 mm. from the tip of the rostrum to the extremity of the submedian marginal spines of the telson. This specimen is slightly larger than those in the U. S. National Museum.

The Bishop Museum specimen was taken on Waikiki reef, Honolulu. The type locality is Bimini Harbor, Bahamas, where the specimens in the U. S. National Museum were obtained.

PSEUDOSQUILLA Dana

Pseudosquilla ciliata Miers.

Pseudosquilla ciliata Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. 5, p. 108, Pl. 3, figs. 7, 8, 1880.—Brooks, Voyage of the "Challenger," Zool., vol. 16, Stomatopoda, p. 53, Pl. 15, fig. 10, 1886.—Bigelow, Proc. U. S. Nat. Mus., vol. 17, p. 499, 1894.—Hansen, Engeb. Plank. Exp., II, G. c. p. 86, 1895.—Rankin, Ann. N. Y. Acad. Sci., 12, p. 253, 1898.—Bigelow, Bull. U. S. Fish Comm., vol. 2, p. 154, fig. 4, 1900.—Kemp, Mem. Indian Mus., vol. 4, p. 96, 1913.

The collection of Squillidae in the Bishop Museum consists of twenty-one specimens of this well-known and widely distributed species. Of this number seven, three males and four females, were taken by Alvin Seale at Guam in 1900, one, a male from the Marquesas by the same collector in 1902, five, three females and two males, from the reef near Koko Head, Oahu, by the writer in 1920, and four, two males and two females, from the reef at Waikiki, Honolulu, by J. M. Ostergaard and the writer in 1921. Four other specimens, two males and two females, included in the collection are without data but probably are Hawaiian.

The specimens are, in most details, quite typical. The basal prolongation of the uropod in the specimens from Guam, the Marquesas, and Oahu extends slightly beyond the tip of the endopodite but does not reach the distal extremity of the exopodite, as is indicated in the description of the type specimen by Miers.

All the Bishop Museum specimens agree with the description by Brooks of a specimen from Honolulu, in having the inner spine of the prolongation of the uropod longer than the outer. Brooks states, however, that in the Honolulu specimen the distal segment of the exopodite of the uropod is about as long as the proximal segment. But none of the Pacific forms in the Bishop Museum agree with his description in this feature, the distal segment of the exopodite being slightly less than five-eighths as long as the proximal one. In this respect the specimens correspond more closely with those taken in the region of Porto Rico, according to Bigelow's description.[9]

The presence of postero-lateral spines on the fourth abdominal segment is apparently a variable characteristic of the species even in the same locality. Two of the nine specimens from Oahu show such spines, as do two of the seven specimens from Guam. All bear postero-lateral spines on the fifth abdominal segment.

[9] Bigelow, R. P., The Stomatopoda of Porto Rico: Bull. U. S. Fish Comm., vol. 20, p. 155, 1900.

The color of the specimens from Guam, preserved in alcohol, varies from greenish-black to light brown. Some of them show distinct mottled yellow and white patches on the exposed thoracic and abdominal segments. The dactylus of the raptorial limb is marked by a series of dark spots giving it the appearance of being banded. In the specimens from Oahu, preserved in alcohol, the dactylus has a faint rose color, more intensified near the distal extremity. These latter specimens are of a grayish color above, one of them strongly mottled by dark pigment, the others to a lesser degree. Black patches on the sides of the fifth and sixth thoracic segments and the first abdominal segment, as well as on the lateral margins of the first five abdominal segments, seem to be characteristic of the specimens from Oahu. These black patches on the lateral surfaces of the segments mentioned above are faintly visible in some of the specimens from Guam.

The largest specimen in the Bishop Museum collection, a female from the reef near Koko Head, Oahu, measures 81 mm. from the tip of the rostrum to the extremity of the submedian marginal spines of the telson. The largest specimen from Guam, also a female, measures 60 mm. in length.

The Bishop Museum specimens are from Guam, the Marquesas, and Hawaii.

This species is one of the most widely distributed of the known Squillidae. It ranges from Mauritius to the Red Sea, Malay Archipelago, Japan, through the South Seas to Hawaii. It has also been taken from the Florida Keys, Bermuda, the Bahamas, and at numerous localities about Porto Rico.

Pseudosquilla oculata (Brullé).

Squilla oculata Brullé, in Webb and Berthelot, Isles Canaries, Zoology, Crust., p. 18, 1836-1844.

Pseudosquilla oculata Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. 5, p. 110, 1880.—Bigelow, Proc. U. S. Nat. Mus., vol. 17, p. 500, 1894.—Borradaile, Trans. Linn. Soc. London, vol. 12, p. 214, 1907.—Kemp, Mem. Indian Mus., vol. 4, p. 102, 1913.

This species may be distinguished from the more common *Pseudosquilla ciliata* in having club-shaped eyes, a small median

spine on the rostrum, and in the presence of eight carinae besides the median ridge on the telson.

Miers also indicates the truncated lateral margins of the second and third exposed thoracic segments, and the presence of a distinct circular spot, green in color, bordered by a pale margin, on each side of the carapace, as specific characteristics distinguishing both this species and *Pseudosquilla ornata* Miers from *Pseudosquilla ciliata.*

Of the eleven specimens of this species in the Bishop Museum, six, four males and two females, were taken from Waikiki reef, Honolulu, during 1920 and 1921. One specimen, a female, was taken in Kahana Bay, Oahu, in 1921. Four other specimens, one male and three females, although without data are probably from Waikiki reef.

Figure 1 represents the male accessory organ of the first abdominal appendage of this species. On comparing this with the male accessory organ of *Pseudosquilla ciliata,* as figured by Brooks, the similarity of these structures in closely allied species is obvious.

The color of the living specimens obtained on Waikiki reef in August, 1921, was dark green above, with a narrow line of pink color on the posterior border of the exposed thoracic and first five abdominal segments. The fringe of the uropods, antennal paddles, and swimmerets was deep pink. In the largest specimen the right raptorial limb was bright pink in color while the left was green with only a faint indication of pink on the dactylus. The deep green spots on the carapace were very evident in the living specimens. The alcoholic specimens in the collection have, without doubt, lost their natural color. They are light brown, a few of them nearly white except the eyes, which have remained dark brown.

The largest specimen in the Bishop Museum collection, a female, is 55 mm. in length from the tip of the rostral spine to the extremity of the submedian marginal spines of the telson. A specimen in the British Museum is reported by Miers to be 3¼ inches in length.

The eleven specimens in the collection of the Bishop Museum are all from Oahu.

The species has been previously reported from the Canaries, Madeira, Cape Verde Islands, Mauritius, Chagos, Samoa, and the China Sea.

LYSIOSQUILLA Dana

Lysiosquilla maculata (Fabricius).

Squilla maculata Fabricius, Ent. Syst., vol. 2, p. 511, 1796.

Cancer (Mantis) arenarias Herbst, Nat. Krabben u. Krebse, vol. 2, p. 96, 1796.

Lysiosquilla maculata Miers, Proc. Zool. Soc. London, p. 158, 1877; Ann. and Mag. Nat. Hist., ser. 5, vol. 5, p. 5, 1880.—Brooks, Voyage of the "Challenger," vol. 16, Stomatopoda, p. 45, Pl. 10, figs. 1-7, 1886.—Bigelow, Proc. U. S. Nat. Mus., vol. 17, p. 508, 1894.—Kemp, Mem. Indian Mus., vol. 4, p. 111, 1913.

Five specimens of this species are in the collection of the Bishop Museum. Four of these, two males and two females, were taken by Alvin Seale at Tahiti in 1901, the other, a male, was obtained by J. W. Thompson from the Honolulu market in 1917. Unfortunately the dactyli of this latter specimen have been removed.

All of these specimens are apparently typical, agreeing in structural details with descriptions previously published. Of those from Tahiti, the largest one, a female, has nine lateral teeth on the dactylus of the raptorial limb, including the terminal one, while each of the other specimens from that locality bears ten teeth on the dactylus.

The matter of sexual dimorphism, mentioned by Miers, Brooks, Bigelow, and others, is very evident in these specimens, the lateral teeth of the dactyli of the males being longer and stouter than those of the females.

Brooks describes and figures[10] the accessory organs of the first abdominal appendage of the male of this species. In order to present in more complete detail the general features of this

[10] Brooks, W. K., Report on the Stomatopoda: Voy. H.M.S. "Challenger," Zoology vol. 16, Pl. 10, 1886.

structure, and to point out some differences between the Tahiti and the Honolulu specimens with respect to this organ, figures of the endopodites bearing the accessory organs of individuals from each locality are introduced, figure 1, *c*, representing a male from Tahiti, and figure 1, *d*, a male from Honolulu.

It will be observed that the retinaculum (*rm*) in each specimen is prominent but less angular in the Tahiti specimen. In each case the movable limb of the forceps (*ml*) is slightly curved and well developed, while the fixed limb (*fl*) is much smaller and terminates in a distinct hook. In the Tahiti specimens a prominent ridge continues from the base of the movable limb of the forceps diagonally to a point just distal of the hook of the fixed limb then bends abruptly fusing with the small inner lobe of the endopodite. In the Honolulu specimen this ridge is only slightly developed and lacks the angular character. This difference is not one of maturity as the Honolulu specimen is the larger, being 24.7 cm. in length. In each specimen a thin, fleshy ridge extends diagonally across the small, inner lobe of the endopodite. This ridge (unlabeled in the figures) is more prominent in the examples from Tahiti.

The careful examination of a larger series of perfect specimens of this species from different regions would probably result in the determination of distinct local varieties.

The color of the Honolulu specimen, preserved in alcohol, is much lighter in color than that of the Tahitian specimens. The ground color of the dorsal surface of the former is pale yellow with three bands of dark pigment extending transversely across the carapace, and similar bands at the sutures of the segments of the hind body. Large black spots mark the uropods. A dark Y-shaped patch, having a large, black spot on either side of it, occupies the posterior half of the medial region of the telson with a large, black spot on either side of it. A broad, pale-yellow stripe marks the hind body in the mid-dorsal line as far as the sixth abdominal segment. The terminal segments of the raptorial limbs are marked with broad spots of dark brown.

The specimens from Tahiti, which have been preserved in formaldehyde for some time, are, in general, marked like the

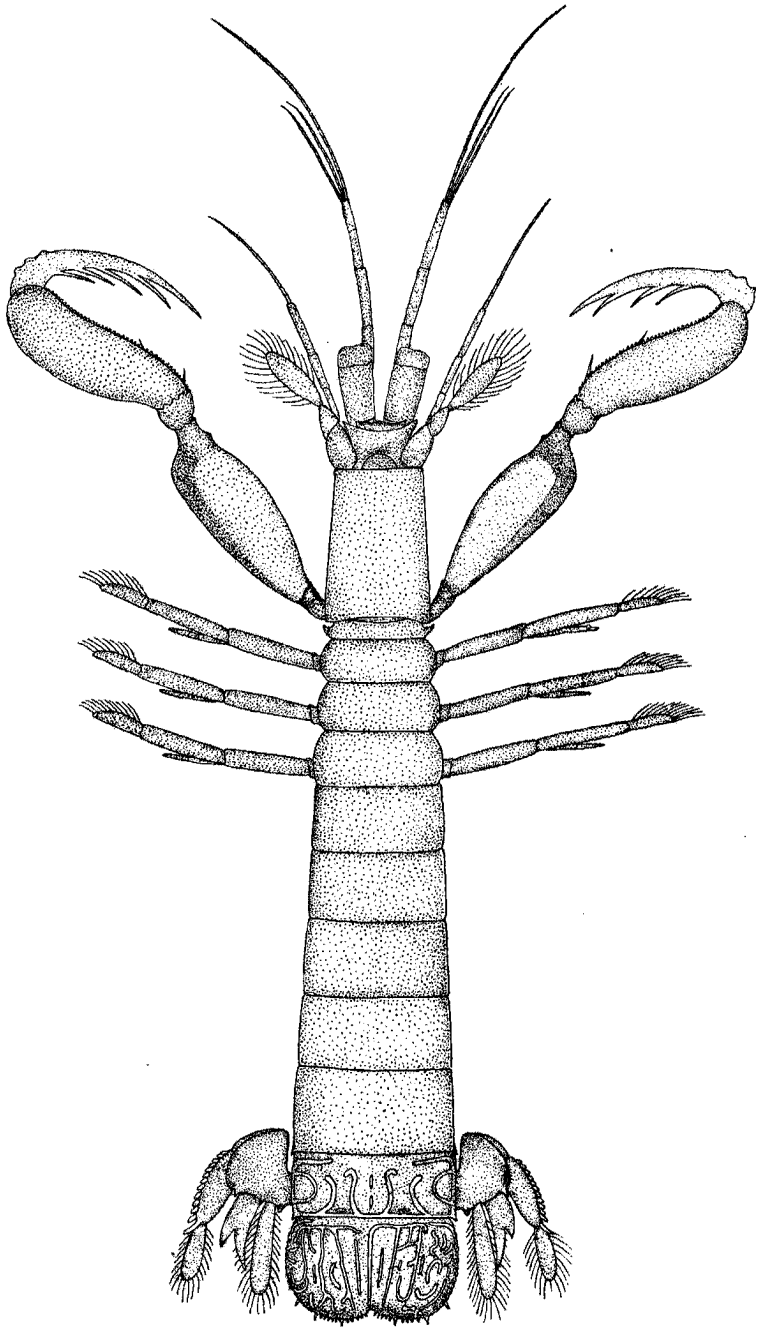

FIGURE 2. *Coronida sinuosa*, new species (×7).

one from Honolulu but are very much darker in color. A crescent-shaped, black patch on either side of the median ridge of the telson is distinct in these specimens.

The largest specimen in the Bishop Museum collection, a male from Honolulu, measures 247 mm. from the tip of the rostral spine to the posterior border of the telson. The largest of the four specimens from Tahiti, a female, is 218 mm. in length.

The Bishop Museum collection includes specimens from Tahiti and Honolulu.

The species is widely distributed throughout the Indo-Pacific region from Japan to South Africa. It is apparently confined to shallow water where it burrows in the sand.

CORONIDA Brooks [11]

Coronida sinuosa new species. Figure 2.

A minute form, evidently a new species, taken from Waikiki reef, Honolulu, has been referred to this genus. The specific characteristics are as follows:

Eyes narrow, elongated and flattened; rostrum short, smooth, and evenly rounded; antennular somite elongated[12]; dactylus of raptorial limb with three or four curved teeth on the inner margin and three blunt teeth on the outer surface near the proximal extremity; carapace smooth with corners rounded; posterior border of carapace concave; fifth thoracic segment with lateral process acute and curved anteriorly; lateral margins of sixth, seventh, and eighth thoracic segments narrowed but evenly rounded; exposed thoracic segments and the first five abdominal segments without carinae; lateral margins of first five abdominal segments rounded anteriorly and posteriorly; postero-lateral margins of the fifth and sixth abdominal segments produced into short, sharp spines; dorsal surface of sixth abdominal segment ornamented by a series of sinuose, scroll-like carinae, nearly symmetrical in arrangement; dorsal surface of telson marked by numerous linear, curved, and scroll-like carinae which lack symmetry on the two sides except in the medial region where it is maintained in a slight degree; posterior border of telson notched; telson with six short marginal spines, the submedian pair having movable tips; eight or ten denticles between the submedian spines and four or five between each submedian and intermediate spine.

[11] Op. cit., p. 79.—Kemp, Crustacea Stomatopoda of the Indo-Pacific region: Indian Mus. Mem., vol. 4, pp. 129-130, 1913.

[12] This feature may represent a postlarval condition. See Kemp, op. cit., p. 93.

This small species, of which there is a single specimen in the collection of the Bishop Museum, was taken by the writer from among dead coral on Waikiki reef, Honolulu, in 1921.

It is apparently somewhat closely allied to *Squilla multituberculata* of Borradaile,[13] but differs from that species in the form of the rostrum, and in the ornamentation of the sixth and seventh abdominal segments.

The species under consideration may easily be recognized by the ornamentation of the sixth and seventh segments of the abdomen. The sinuose character of the carinae has suggested the specific name by which this species may be designated.

On the sixth abdominal segment the carinae may be recognized as median, submedian, intermediate, lateral, and marginal, all of which, except the median, unite with a transverse carina extending along the posterior border of the segment. The medial carina is broken into two sections and does not reach the transverse carina mentioned above. The submedian and intermediate carinae of this segment are curved and the lateral with the marginal enclose an oval area on either side. A short, blunt elevation is located on either side near the posterior border between the submedian and intermediate carinae. By referring to figure 2, it will be observed that there is an approach to symmetry in the arrangement of the carinae on the right and left sides of the sixth segment.

The telson is also ornamented by numerous carinae, a few of which are straight while others are sinuose and scroll-like. In addition to these, blunt tubercles are interspersed with the carinae especially near the posterior border. There is a linear, median carina and immediately on either side there is some appearance of symmetrical arrangement among the carinae, but it is not maintained on the remaining surface of the telson.

Each uropod consists of a large subtriangular basal segment which has a lateral and a medial tooth produced from the posterior border. The distal segment of the expodite is elongated,

[13] Borradaile, L. A., On some crustaceans from the South Pacific. Part 1, Stomatopoda: Proc. Zool. Soc. London, No. 3, p. 38, Pl. 6, figs. 7, 7 *a-c*, 1898.

narrow, almost equaling in length the proximal segment which bears eleven cylindrical spinules on its lateral border, the terminal one of which is large and curved outward. The distal segment of the endopodite is long and narrow. Two spinous processes terminate the basal prolongation of the uropod, the inner one of which is much the longer and reaches slightly beyond the middle of the terminal segment of the endopodite.

In this specimen lack of symmetry is seen not only in the carinae of the telson but also in the dactyli of the raptorial limbs. On the left dactylus there are four teeth on the inner border, besides the terminal one; on the right dactylus there are but three teeth. The terminal one of the three teeth on the outer border of the dactylus is bifid when observed from a proximal or distal point of view.

In life the color of the animal is uniformly white with the corneal area of the eye black. The specimen, preserved in alcohol, is yellowish-white with no change of color in the corneal region of the eye.

The total length from tip of the rostrum to the extremity of the submedian spines of the telson is 17 mm. Length of carapace, including rostrum, 3 mm.; of exposed thoracic and first five abdominal segments, 11½ mm.; of sixth abdominal segment and telson, 2½ mm.

There is no certainty that the individual described is mature. It was kept under observation for more than a month during which time it moulted once. No appreciable increase in size was observed during this period.

Type locality, Waikiki reef, Honolulu, among dead coral. Sex, female. Type specimen in Bishop Museum (Catalogue No. 526).

ODONTODACTYLUS Bigelow

Odontodactylus hansenii (Pocock).

Gonodactylus hansenii Pocock, Ann. and Mag. Nat. Hist., ser. 6, vol. 11, No. 66, p. 477, Pl. 20, B., June, 1893.

Odontodactylus hansenii Bigelow, Proc. U. S. Nat. Mus., vol. 17, p. 496, 1894.—Kemp, Mem. Indian Mus., vol. 4, p. 140, 1913.

In 1894 Bigelow formed a new genus[14] to include a number of species previously described under the generic term Gonodactylus and having the dactylus of the raptorial limb dilated at the base and provided with lateral teeth. *Gonodactylus hansenii*, described by Pocock, is such a species.

There are in the collection of the Bishop Museum three specimens, one male and two female, which correspond closely with Pocock's description of the type specimen and apparently belong to this species. In Pocock's description it is said that the sixth abdominal tergite and telson resemble the corresponding segments in *Odontodactylus scyllarus* (Linnaeus). In the description of the latter species, Miers[15] mentions the sixth abdominal segment as having eight ridges which usually terminate in spinelets, with two smaller prominences near the base. In the specimens in the Bishop Museum but six of the carinae of the sixth abdominal segment terminate in spines, and Pocock's figure seems to indicate a similar condition.

Figure 1, *e*, is a drawing of the male accessory organ of the first abdominal appendage of the same species. Figure 1, *f*, represents the details of the sixth abdominal segment and the telson of a Bishop Museum specimen.

The color of the Bishop Museum specimens, preserved in alcohol, is uniformly light-yellowish above with a light-pink posterior margin on each of the exposed thoracic and first four abdominal segments. There is a dark-brown patch on the basal half of each uropod. The eyes are dark brown and the flagella of the antenna are pink.

Pocock refers to the color of the type specimen as yellowish-pink.

The largest specimen in the Bishop Museum collection, a female, measures 43 mm. from the tip of the rostrum to the extremity of the submedian marginal spines of the telson. According to Pocock the type specimen measures 60 mm.

[14] Bigelow, R. P., Report on the Stomatopoda in the U. S. Nat. Museum: Proc. U. S. Nat. Mus., vol. 17, p. 495, 1894.

[15] Miers, E. J., On the Squillidae: Ann. and Mag. Nat. Hist., ser. 5, vol. 5, p. 115, 1880.

The Bishop Museum specimens were dredged off Waikiki, Honolulu, by D. Kuhns, at depths ranging from 30 to 50 fathoms.

Pocock records the species from Macclesfield Bank, China Sea, at 35 fathoms.

GONODACTYLUS Latreille

Gonodactylus guerinii White.

Gonodactylus guerinii White, Proc. Zool. Soc. London, 1861, p. 43, Pl. 7; Ann. and Mag. Nat. Hist., vol. 7, p. 476, 1861.—Miers, Ann. and Mag. Nat. Hist., ser. 5, vol. 5, p. 121, 1880.

Prostosquilla guerinii Brooks, Voyage of the "Challenger," Zool. vol. 16, Stomatopoda, p. 75, Pl. 16, figs. 1 and 6, 1886.

Gonodactylus guerinii Kemp, Mem. Indian Mus., vol. 4, p. 192, 1913.

This species was first described in 1861 under the genus Gonodactylus by Adam White of the British Museum from a specimen taken at Matuka, Fiji Islands. In 1880 E. J. Miers, also of the British Museum, in a descriptive list of the known Squillidae described the same specimen.

W. K. Brooks in 1886 established the genus Protosquilla and published a detailed description of this species, including it under the new generic term. The specimen described by Brooks was taken by the "Challenger" at Honolulu.

More recent investigators,[16] however, are of the opinion that the genus Protosquilla formed by Brooks is unsound and, therefore, have again referred the species to the original genus Gonodactylus.

The two specimens mentioned above are the only ones of this species previously reported. Descriptions by White, Miers, and Brooks are sufficiently explicit in most of the details of this remarkable species. Figures supplement the technical descriptions of White and Brooks.

There is a single specimen of this species, a male, in the Bishop Museum collection. It is a typical example of the species, agreeing in all essential features with previously published descriptions.

[16] Kemp, S., The Crustacea Stomatopoda of the Indo-Pacific region: Mem. Indian Mus., vol. 4, p. 145, 1913.

The "Challenger" specimen was a female. Miers states that the dried specimen in the British Museum is a female. The Bishop Museum specimen is a male.

Figure 1, *g*, represents the endopodite of the first abdominal appendage of a male *Gonodactylus guerinii,* the explanation of which will make plain the main features of the accessory organ in this species. There will be seen, in addition to the parts of the accessory organ mentioned in the introduction, a slightly elevated ridge extending across the endopodite between the fixed and movable limbs of the forceps and approximately as long as the latter. In this species the hooked fixed limb of the forceps is very much shorter than the movable one.

The color of the Bishop Museum specimen, after having been preserved in alcohol for five years, is pale brown above with the fifth, sixth, and seventh abdominal segments, the antennae, attennules, and the raptorial limbs very much lighter in color.

Both White and Miers mention the marbled color of the dried specimen, and Miers adds that it is "light yellowish brown varied with darker colour." According to Brooks the "Challenger" specimen, in alcohol, is marked with brown pigment, the carapace having a broad, transverse, light band across it.

The size of the specimen in the Bishop Museum collection is 40 mm. from the tip of the rostrum to the extremity of the telson, not including the marginal spines of the latter. The length of the British Museum specimen, as given by White and Miers, is 2½ inches. The "Challenger" specimen, according to Brooks, is 1.12 inches, from the tip of the rostrum to the distal extremity of the telson.

The Bishop Museum specimen was taken off Waikiki, Honolulu, at a depth of 50 fathoms, by D. Kuhns during January, 1916. The British Museum specimen was taken at Matuka, Fiji Islands. The "Challenger" specimen was collected at Honolulu.

Gonodactylus chiragra (Fabricius), var. **acutus** Lanchester.

Gonodactylus chiragra (Fabricius), var. *acutus* Lanchester, Fauna and Geography of Maldive and Laccadive Archipelagoes, vol. 1, p. 444, Pl. 23, 1903.

For a very complete discussion of this widely distributed species and its varieties the above reference may be consulted. Attention is also called to Kemp's treatment of this species.[17]

Lanchester recognizes numerous varieties including those considered as distinct by previous investigators and points out the presence of intermediate forms that obliterate the structural distinctions heretofore regarded as specific.

Two female specimens are in the collection of the Bishop Museum, both of which may be assigned to the above variety.

The specimen from Guam corresponds in all details of the telson with Lanchester's var. *acutus*. The three carinae of the telson are sharply defined, the median one descending abruptly at its distal extremity. No appearance of lateral marginal teeth is evident. The specimen from the Marquesas may be considered an intermediate form between var. *tumidus* Lanchester and var. *acutus*, although it more closely approaches the latter. As to the carinae of the telson it closely resembles the latter variety, but traces of lateral marginal teeth are to be observed in the Marquesan specimen.

The color of the Bishop Museum specimen from Guam, preserved in alcohol, is yellowish in color with faint evidence of greenish mottlings. The lateral borders of the carapace, the posterior margins of the exposed thoracic and the abdominal segments as well as the summits of the carinae are green. The posterior edge of the sixth abdominal segment on the ventral surface is distinctly marked by the same color. The dactylus of the raptorial limb is greenish-white. A pink band marks the outer surface of the manus near its distal extremity. The alcoholic specimen from the Marquesas is greenish-brown above, with the sixth abdominal segment and the telson considerably lighter in color. The raptorial limbs are almost white. Lanchester's specimen is recorded as "variegated green and white."

The largest of the Bishop Museum specimens, the one from Guam, measures 80 mm. from the tip of the medial rostral spine

[17] Kemp, S., The Crustacea Stomatopoda of the Indo-Pacific Region: Mem. Indian Mus., vol. 4, p. 150, 1913.

to the extremity of the submedian marginal spines of the telson. Lanchester's largest specimen is recorded as being 62.5 mm. in length.

The Bishop Museum specimens were taken by Alvin Seale, one at Guam in 1900 and the other at the Marquesas in 1902. Lanchester records the variety from the reef of Minikoi.

PUBLICATIONS RELATING TO THE STOMATOPODA

A brief list of some of the more important publications that every investigator of the Stomatopoda should consult is given below. Several of the reports include very complete bibliographies up to the date of publication. The report by Bigelow lists all of the more valuable publications on the Squillidae up to 1894, and Kemp's comprehensive work (1913), by reason of the very complete bibliography which it includes, is of special assistance to the student of this group.

The list includes a few papers published since 1913 that contain subject matter on the Stomatopoda.

Miers, E. J., On the Squillidae: Ann. and Mag. Nat. Hist., ser. 5, vol. 5, pp. 2-30 and 108-127, 1880.
(Descriptions of known species up to 1880.)

Brooks, W. K., Report on the Stomatopoda collected by H.M.S. "Challenger" during the years 1873-76: Report of the scientific results of the voyage of the "Challenger," Zoology, vol. 16, 1886.

Bigelow, R. P., Report upon the Crustacea of the order Stomatopoda collected by the steamer "Albatross" between 1885 and 1891, and on other specimens in the U. S. National Museum: Proc. U. S. Nat. Mus., vol. 17, pp. 489-550, 1894.
(A consideration of American species with a bibliography up to 1894.)

Giesbrecht, W., Stomatopoden: Fauna u. Flora d. Golfes von Neapel, Mon. 33, pp. 25, 34, 40, 44, 131, Pls. 1-6, 1910.
(A monograph of Mediterranean species.)

Kemp, S., Crustacea Stomatopoda of the Indo-Pacific region: Mem. Indian Mus., vol. 4, pp. 1-214, Pls. 1-10, 1913.
(Includes a very complete bibliography on Stomatopoda up to 1913.)

Rathbun, Mary J., Stalk-eyed Crustaceans collected at the Monte Bello Islands: Proc. Zool. Soc. London, vol. 2, pp. 653-664, Pls. 1, 2, 1914.

Kemp, S., On a collection of Stomatopoda Crustacea from the Philippine Islands: Phil. Jour. Sci. D, vol. 10, pp. 169-187, Pl. 1, 1915.

Kemp, S., Fauna of the Chilka Lake, Stomatopoda: Mem. Indian Mus., vol. 5, pp. 193-197, figs. 1, 2, 1915.