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Decapod Crustacea of Bermuda
Part II, Macrura

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DECAPOD CRUSTACEA OF BERMUDA.

PART II—MACRURA.

By A. E. VERRILL.

The collections of Bermuda Macrura, studied in the preparation of this article, came chiefly from the sources already acknowledged in Part I.* Nearly all the species are in the collections of the Museum of Yale University. Much the larger part were collected by myself and companions in 1898, 1901, and 1916. Many were also previously in the collections made by Mr. G. Browne Goode, J. M. Jones, Esq., and others. Many of the more obscure species have been studied, also, by Miss M. J. Rathbun, to whom I am likewise indebted for several photographs of rare species, contained in the U. S. National Museum.

No doubt many more species remain to be discovered, especially of the smaller shrimps. Many of these have very retiring habits, living in holes and crevices in dead corals, etc., or in the oscular cavities of large sponges. Others frequent the quiet waters of lagoons and mangrove swamps, where, owing to their transparency or protective colors, they are not easily seen. We did not have opportunities to use fine meshed seines in such places, which would, no doubt, have given good results. Owing to the absence of fresh-water streams, the various species of fresh-water shrimps and prawns, common in the West Indies, are entirely lacking.

Many more additions to the number of species are to be expected by dredging in deeper water, outside the reefs. Many of the species of Macrura have interesting and remarkable metamorphoses, the free-swimming larvæ (see plates III, IIIa, XII, XVII), being totally unlike the adults. This is particularly the case with the species of *Panulirus* (the common Bermuda lobster), *Syllarides*, *Stenopus*, etc. The Bermuda species have been very little studied in this way. With the facilities of the new Biological

* For Part I: see these Transactions, vol. xiii, pp. 299-474.

Station and public Aquarium, there are excellent opportunities to carry on such researches.

In the important memoir of Brooks and Herrick, on the metamorphoses of the *Macrura* (Mem. Nat. Acad. Sci., vol. v, 1891) the metamorphoses and structures of a few Bermuda species are given; viz., *Stenopus hispidus*; *Alpheus heterochaelis*; *A. packardii* (erroneously identified as *A. minus*), and *Synalpheus brevicarpus*. They found remarkable variations in the larval forms, supposed by them to be of the same species of *Alpheus* and *Synalpheus*. The most notable cases of this kind were due to erroneous identifications of the species of those difficult genera, as shown by Coutiere. Many more studies of that kind should be made on the numerous closely related species of that group.

On account of the existing confusion in the literature, and the inherent difficulties in determining the numerous species of *Alpheus* and *Synalpheus*, I have treated those genera in greater detail than most others, describing and figuring, with many structural details, all the species known to me from Bermuda, as well as some closely allied species from other American localities, hoping that students of their embryology will be enabled by this means to correctly name the species they may investigate hereafter. In other groups general figures, at least, are given of nearly all the species, and in most cases the structures of some of the appendages are also figured.

Hitherto some of these species have not been figured at all; others have been figured only in foreign works, many of them very imperfectly. The photographs and drawings, unless otherwise indicated, are by A. H. Verrill.

Suborder MACRURA. *Crawfishes, Lobsters, Shrimps, and Prawns.*

Key to the Tribes and part of the Families.

A.—Body not compressed. Rostrum depressed, sometimes wanting. First abdominal segment shorter and narrower than the following. Abdominal appendages (pleopods) not oar-shaped. The articulation between the carpus and propodus of the chelipeds is at two fixed points. Branchiæ filamentous.

Reptantia = *Trichobranchiata* = *Astacina* DeHaan.

B.—Abdomen or pleon large and strong with the segments overlapping. Carapace large and firm.

D.—None of the legs have chelæ, except the 5th pair in the adult female. No appendages on 1st segment of pleon; outer antennæ

destitute of a scale. Uropods and telson thin and flexible distally, not spinose. Legs with six functional segments. Larva a phyllosoma.

Tribe *Scyllaridea* or *Loricata*.

E.—Carapace subcylindrical; outer antennæ elongated, with a long, tapered, multi-articulated, and rather rigid spinose flagellum. Orbits not excavated in the dorsal surface of the carapace.

Family *Palinuridae*.

EE.—Carapace much depressed or flattened; orbits excavated in its dorsal surface; outer antennæ short, flat, or squamiform, without a jointed flagellum; 5th pair of legs with small chelæ in the female.

Family *Scyllaridae*.

DD.—First three pairs of legs chelate, the first pair largest. Outer antennæ elongated, usually with a basal scale and a long flexible flagellum. Uropods and telson rather rigid and usually spinose at the ends; outer lamella of uropods have a transverse suture. Legs have seven segments. Branchiæ numerous.

Tribe *Astacidea*.

F.—Last thoracic segment consolidated with the preceding one. First abdominal segment has a pleopod; in the male developed as a genital organ. Spermatheca external. Branchiæ 19 pairs. Larva a zoëa or Mysis-like (marine).

Family *Homaridae*.

FF.—Last thoracic segment movable. Spermatheca in the form of an annulus. Branchiæ 17 or 18 pairs. Larva not a zoëa; similar to adult in form (fresh-water forms).

Family *Astacidae*.

BB.—Abdomen or pleon elongated, weak, with the segments not overlapping. Carapace small. Third pair of legs not chelate; 1st and 2d pairs chelate.

Tribe *Thalassinidea*.

AA.—Body usually more or less compressed. Rostrum usually compressed or slender; sometimes absent. Abdominal appendages—(pleopods) oar-shaped. Articulation between the carpus and propodus of the chelipeds at only one fixed point. Branchiæ various.

Tribe *Natantia* (or *Caridea*, sense extended).

REPTANTIA Boas=TRICHOBRANCHIATA.

SCYLLARIDEA Stebbing=LORICATA Heller (*pars*).

Body convex, either depressed or subcylindrical, with a strongly thickened shell. Antennules usually have two flagella. Antennæ may either have or lack a long flagellum; antennal scale lacking; first joint of peduncle united to epistome. Gills trichobranchiate;

first four legs have a branchial plume or podobranchia on the epipodial plate of the first joint, and also have arthrobranchiæ; last four thoracic segments have pleurobranchiæ. Thoracic legs have but six functional joints; none have chelæ except the last pair of the female. No pleopods on the first abdominal segment in either sex. Telson and urópods have the distal part thin and flexible, not spinose.

The larvæ are remarkable for their large size and thin, foliate structure. They are of the form called Phyllosoma. Their entire body is wide and exceedingly thin and transparent, in life,—hardly thicker than thin paper with long, slender bifid legs, all colorless and transparent except the eyes, which are far apart on long stalks. (See plates 3, 3A.)

They apparently live at the surface a long time in this form and have several moults, changing gradually to forms more like the adult. Such larvæ were frequently taken by us in the Gulf Stream and adjacent waters off our coasts, coming no doubt from much further south.

The most common kinds (plates 3, 3A, figs. 1-3a) are supposed to belong to *Panulirus argus*, but none were taken old enough to prove this. Our figures represent three stages of this species (see under *P. argus*). Another quite different species (plate 3A, fig. 4) may belong to *Scyllarus* or one of the species of *Scyllarides*, but its origin is very uncertain. This differs from the others in having the large thin prethorax or head portion relatively longer, and instead of being regularly elliptical or slightly oval its borders are incurved in front of the middle, so that the anterior part is not half as wide as the widest part; the eye-stalks are longer, the eyes rounder. The thorax proper is wider than in the other species and its posterior incurvature or sinus is much wider and deeper; the abdomen is bud-like with no segments developed in this stage, though the legs are all fully developed and bifid, while in the other species, with the abdomen in a similar state, the fifth pair of legs can be seen only as minute rudiments (pl. 3, fig. 1; pl. 3A, fig. 2A). In this species (pl. 3A, fig. 1) the third maxillipeds (mp''') are shorter and not bifid as they are in the others. The other mouth organs (m) are, however, more developed than in the others, while the antennules and antennæ (a', a'') are less developed and much shorter than in the youngest stage of the other species. The latter will be described under *P. argus*, below.

Family **PALINURIDÆ** Dana. *Spiny Lobsters; Sea Crawfishes.*

Palinurini Latreille, 1802. Leach, 1814.

Palinuridæ Dana, Crus. U. S. Expl. Exped., p. 519, 1852. Gray. Ortmann, 1896. Rathbun, 1901, p. 398, etc.

Body subcylindrical; thorax not depressed. Eyes not enclosed in orbits formed within the edge of the carapace. Antennæ not flattened; furnished with a large and long, rather rigid, multi-articulate and usually spinose flagellum. Fifth leg of female chelate.

Panulirus White. *Spiny Lobsters.*

Panulirus White, List Crust. British Mus., p. 69, 1847.

Ocular segment is exposed and flexible. No rostrum or central tooth. Antennules with rather long, slender exposed flagella. Antennæ long, very large and rigid, spinose; a stridulating organ at their bases. Larva is a *Phyllosoma*. (See plate 3, 3A.)

Panulirus argus (Latr.) White. *Bermuda Lobster; Sea Craw-fish.*

Palinurus argus Latreille, Ann. Mus. Hist. Nat. Paris, iii, p. 593, 1804. Nouv. Dict. Hist. Nat., xvii, p. 296. Olivier, Encyc. viii, p. 663. Lamarck, Hist. An. sans. Vert., v, p. 210, 1815. Desmarest, Consid. gen. sur les Crust., p. 185. H. Milne-Edw., Hist. Nat. Crust., ii, p. 300, (Antilles). Heller, Reise Freg. Novarra., Crust., p. 95, 1865 (Analytical table).

Panulirus argus White, List Crust. Brit. Mus., p. 69, 1847. Smith, these Trans., ii, p. 39, 1869, (Brazil). Rankin, op. cit., 1900, p. 536. Bate, Voyage Chall., vol. xxiv, p., 76, 1888. M. J. Rathbun, Brach. and Macr. Porto Rico, p. 98, 1901. Verrill, these Trans., xi, p. 705, fig. 56, and pl. xciv, fig. 1, 1902; The Bermuda Is., I, p. 293, fig. 56, pl. xciv, fig. 1, 1902, (habits and history).

Palinurus americanus Stone, in Heilprin, The Bermuda Is., p. 149, (? non. M. Edw.)

TEXT FIGURE I, PLATE I: FIGURE I. PLATE II: FIGURES 1, 2. PLATE III: FIGURES 1, 2 (supposed larvæ). PLATE IIIA: FIGURES 2-6 (larvæ). PLATE VIII: FIGURES 2, 2a. PLATE IX: FIGURE I (stridulating organ). By A. H. V.

The following description is mainly from medium sized males (No. 4101, 4102, Yale Mus.) preserved in formol and dried.

The carapace, in large specimens, has the areas well defined by wide grooves; the cervical groove is conspicuous. The frontal

horns are large and strong, compressed, acute, curved forward, and slightly downward at the tips; usually the tips are also somewhat convergent.

The spines of the carapace are not very numerous, but the larger ones are very sharp and are directed strongly forward. The largest are two behind the bases of the frontal horns, and on each side, two near the margin, at bases of the antennæ. Back of the large dorsal pair are four, irregular, dorsal rows, with about five or six in each row, of which the two larger in each row are in front of the cervical suture. On the sides there are two imperfect and interrupted rows and some scattered spines, mostly more strongly appressed and smaller than the dorsal ones. A transverse row of about twelve low conical spines borders the posterior, submarginal groove. In some large specimens these become low denticles. The sides and posterior parts of the carapace are also covered with small, unequal, conical spinules, which are not crowded; on the anterior parts, including the gastric, hepatic, and cardiac areas, they become much fewer and smaller with large, smooth spaces between them.

The eye-stalks and eyes are large and the eyes are prominent. The somite that carries the eyes is very distinct. A strong, rounded rib, arising from the posterior and outer bases of the rostral horns, curves forward to the inner base of the antennæ, and continues as a border to the antennular somite.

The antennular somite is longer than broad, bordered laterally by the strong marginal ribs, just referred to. It curves downward distally, and bears, on its upper surface, four rather small, acute, conical spines, directed somewhat forward. They are not so large as the larger dorsal spines. They form a trapezoid figure, the distance between them longitudinally being considerably greater than the transverse spaces. The anterior pair are close to the front edge, and a little divergent; the second pair are a little smaller and somewhat nearer together. In some specimens, especially the younger ones, there are two or three smaller spines irregularly placed between or near the larger ones. In a medium sized specimen before me (No. 4102), the distance between the tips of the anterior spines is 10mm; between the posterior ones, 7.5mm; between the anterior and posterior ones, 12mm.

The distal joint of the antennal peduncle has three large porrect

spines on the outer margin; three on the inner margin, one of each row being at the distal angles; and three smaller ones on the upper surface, of which the larger is at the proximal articulation;



FIGURE 1. Bermuda lobster. (*Panulirus argus*.)

Side view. About $\frac{1}{6}$ natural size.

there are also four on the under side, of which three are at the distal margin.

The preceding segment has seven large, sharp spines on the upper side of which four are at or near the distal margin; the basal or first movable segment bears one large, suberect, sharp spine, also the stridulating organ.

The antennal flagellum is considerably longer than the entire body. It is covered by whorls of sharp, conical, red or brown spines, with the tips strongly inclined distally. There are usually seven spines in each whorl. The flagella of the antennules are long and slender; the outer one is shorter and has a tuft of hairs near the tip. The legs are long and rather slender. Those of the second pair are much longer than the others; those of the third pair are longer than those of the first; the fifth pair are considerably shorter than the fourth.

All the legs have the dactyli covered, except on the outer edge, with a dense brush of gold-colored hairs; on the first pair the hairs cover also the inner surface of the propodus. The inner surface of all the segments of the outer maxillipeds are densely clothed with similar hairs.

The abdominal segments are crossed by a deep groove; the part back of the groove has an uneven surface, covered with small, conical, hair-bearing spinules, sunk in small, circular pits; the smoother portion has fewer and smaller circumvallate spinules, and many still smaller punctiform pits, easily visible with a lens. The lateral lobes are triangular, acute, and have a single, large, basal tooth on the posterior edge.

The telson and uropods are large and thin, banded with bright colors and covered distally with finely branching riblets and fine striæ, each of the riblets bearing a row of minute, sharp spinules, pointing backward, and terminating in fine marginal spinules. The telson is longer than broad, a little convex on the outer margin, slightly tapered distally with the curves broadly rounded; posterior margin subtruncate and fringed with hairs. The thickened portion is divided by a groove, edged by small spinules, into a basal, four-lobed part, and a wider middle portion. The latter has a broadly triangular middle area, which is covered with longitudinal rows of small, sharp, conical spines; the outer lateral angles terminate, on each side, in a sharp spine.

The male organs are large, broadly reniform or auriculate, with thick, swollen borders, situated on stout projections from the basal segment of the last pair of legs. Larger individuals often have the dorsal spines fewer and many of them may be reduced to low, rounded or blunt tubercles. Smaller and younger specimens are usually more spinose and the spines are sharper.

<i>Measurements of Bermuda Specimens.</i>	No. 4102	No. 4101
Total length including antennæ	840	—
Length from base of antennules to tip of telson	360	490
Length of carapace, dorsal	116	154
Breadth of carapace	90	125
Length of abdomen	114	195
Length of telson	70	67
Breadth of telson	43	35
Length of rostral horns	48	lost.
Length of eyes and stalk	18	21
Diameter of eye	9.5	11
Length of first antennular segment	62	108
Length of second antennular segment	28	38
Length of third antennular segment	26	lost
Length of flagellum, inner branch	190 +	lost
Length of flagellum, outer branch	125 +	lost
Length of antennæ	495 +	lost
Length of first antennal segment (total)	58	63
Length of second antennal segment (dorsal) without spines	40	52
Length of third antennal segment (dorsal) without spines..	43	50
Length of antennal flagellum	370 +	lost
Merus of first leg, total	71	118
Carpus of first leg	30	49
Propodus (total) first leg	52	82
Dactylus	31	45
Merus of second leg	96	168
Carpus of second leg	35	63
Propodus of second leg	77	142
Length of dactylus of second leg	39	63
Length of merus of third leg	86	123
Length of carpus of third leg	35	46
Length of propodus of third leg	75	98
Length of dactylus of third leg	43	54

The flagella of the antennæ and antennulæ of No. 4101 are broken off. The plus sign (+) used after some measurements of No. 4102 indicates that the tips are absent.

It grows to great size. It is said that specimens are taken, even now, weighing as much as 22 pounds. The largest that we saw weighed about 18 pounds, but those that are sold in the markets mostly weigh only two to five pounds, or less. The Bermuda lobster is usually rather gaily colored, especially when young, but the colors are quite variable.

Some specimens in life had the carapace mottled with dark green and gray, becoming lighter laterally. The abdomen was deep sea-green, with four, large, conspicuous, round spots of

yellow or yellowish white; a pair of these spots are on the second and sixth segments. Usually there are similar, but much smaller, paired spots on other segments. The surface is also covered with minute, round yellow specks, about the size of a pin-head.

The telson and uropods are brighter green, with a brownish-green band in the middle, bordered with a pale-green band, and then with a blackish or dark purple band, the margin edged with whitish. All the under parts are white, with pale blue markings.

The swimmerets are grass-green with a central, dark brown, dark purple, or nearly black streak, which becomes larger posteriorly. The rostral spines are dark brown or blackish, banded with white. The antennæ are bluish-green, variegated with lavender or pale purple. The flagellum is finely striped with these colors. The under side is pale blue and white. Legs pale blue and light yellow, often banded; lighter beneath. Eye-stalks blackish and white; cornea jet black.

In other specimens the eye-stalk and antennæ are striped with yellow, blue, and purple, and banded at the joints with orange, and the hairs and spines are apt to be orange. In these, the swimmerets are orange with a yellow margin and a blackish purple central streak; their bases variegated with blue. Large specimens generally have the carapace mottled with terra-cotta or brown, yellow, or greenish and white. The round abdominal spots may be pale yellow or nearly white. There is often a large patch of yellowish brown on each side of the carapace. The frontal horns are usually conspicuously banded with dark or blackish brown and whitish.

Many other variations in color were noticed. In general, the very large specimens were much duller in color. That may be due, at least in part, to the length of time following the moulting, for the colors are brightest just after moulting, which is effected more quickly than in the case of the American lobster. This is probably largely due to the absence of large claws, which delay the process in the latter.

Fishermen told me that when the Bermuda lobster is found in its hole, if its long antennæ or "horns" are seized the creature will cast them off, and thus it cannot be pulled out by them, but that they will not cast off the small antennules, so that they can be pulled out by those organs. I had no opportunity to verify this statement.

The densely haired extremities of the legs give those appendages a remarkable appearance. The hairs are evidently sensory and may be of use in collecting small organisms for food. Mr. Louis Mowbray, who has watched this species in the Aquarium of the Bermuda Biological Station, informs me that the hairy tips of the legs are constantly used for cleaning various parts of the body, and seem also to be of great use in enabling the creature to creep softly

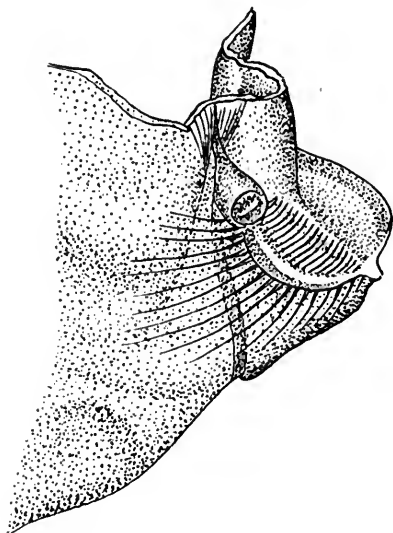


FIGURE 2. Stridulating organ at the base of the antenna of *Palinurus longimanus* from Dominica Island. By A. H. V.

and quietly over the bottom in search of its prey. He states that he has seen it seize and devour a "hind-fish" six inches long, as well as other fishes and crabs. It uses its anterior pair of legs in capturing and holding its prey, although they are not cheliform.

This creature, like all the other species of its genus, and also the species of *Palinurus*, has a "stridulating organ" with which it can make a characteristic sound, either for defence or for a sexual call. It is situated on the first movable segment of the antennæ.

This segment bears, on the concave under surface of its inner base, a small stridulating organ (see figs. pl. viii, figs. 2, 2a; pl. ix, fig. 1), situated near the margin. It consists of a small, concave, elliptical, hard, calcified area or plate, (*st*) covered with fine

transverse riblets, with a longitudinal undulation. Close to this is a small, smooth, oblong knob, which fits into a groove on the inner edge of the smooth rib of the fixed basal segment, along which the stridulating organ slides, when the antenna vibrates, and this serves to hold the organ in position. External to the stridulating plate the basal edge of the segment forms a small, concave, stiff lobe, with a transverse groove. This slides back and forth on the upper side of the smooth rib of the basal segment during stridulation, and like the knob and groove, serves to hold the organ in place.

This organ was described by Dr. G. Browne Goode (op. cit., 1878) as follows: "The 'Bermuda lobster' (*Panulirus americanus* M. Edw.) makes a loud grating noise. Mr. Kent describes the voice of the allied species (*Palinurus quadricornis*) as being produced by the rubbing together of the spinous abdominal segments. In the species observed by me, the sound was produced by means of certain modifications of the lower joints of the antennæ. There is, at the base of each antenna, upon the anterior part of the cephalothorax, a broad elevated ridge, parallel with the axis of the body, which in an adult of eighteen inches would be about two inches long. The rounded crests of these ridges are closely embraced by processes from the sides of the basal antennal segments. The profile of each ridge describes the segment of a circle, the center of which is the center of articulation of its accompanying antenna. When the antennæ are moved forward and backward, their tips waving over the back of the animal, the close contact of the hard, smooth, chitinous surfaces produces a shrill, harsh stridulation, like the sound of filing a saw.

I never heard the noise when the animals were under water, though I have seen them waving their antennæ. I have no doubt that they can thus produce vibrations perceptible to their mates at great distances, especially if their other senses are as acute as that of smell, which I have tested in a very curious manner. Both sexes are provided with the vocal organs."

Living specimens of this species were formerly brought from Bermuda to the New York Aquarium, but they usually lived only a very short time, owing to the impure harbor water then used.

Their bright colors and interesting habits make them very desirable in a public aquarium, but they are very sensitive and need the purest sea water. More recently several of good size were

brought from Bermuda by Mr. Louis Mowbray, for the Aquarium, where they lived for several months, and seemed to be in good condition. The writer watched the casting of the shell of one of them in the aquarium. It was effected quite rapidly and apparently with much less effort than is the case with the American lobster, owing to the absence of large claws.

P. argus has a wide range, from the Florida Keys to Central America and throughout the West Indies to Brazil. It is the common market species in Bermuda and the West Indies.

Florida Keys and Colon (Yale Mus.); Dominica I., 1906 (A. H. Verrill, Yale Mus.). Bahia, Brazil (S. I. Smith).

This crustacean, like the American lobster, is highly prized for food, and like the latter it has greatly diminished in numbers since the early settlement of the islands, and very large specimens are now seldom taken. Most are caught in large baited fish-traps of peculiar construction*, but many are taken in shallow water by means of long-handled spears or "grains." These creatures lie in holes or cavernous places among the submerged ledges and reefs, or under large rocks, but they often come out of their dens and go a short distance in search of food, but retreat very quickly when disturbed. They can be speared by a skillful person when resting half out of their dens or when straying about.

I was told that fishermen sometimes scare them out of their dens by dropping in an arm or part of an arm of the *Octopus*, its natural enemy. We sometimes found young specimens under stones at low tides, as well as in cavernous rocks.

The flesh is excellent for food. It is rather sweeter than that of the American lobster. It is used as food throughout its range.

This species has often been identified as *P. americanus*† of H. Milne-Edwards, to which it is certainly very closely related, if it be distinct.

The latter is said to differ from *P. argus* in having the four spines of the antennular segment larger and equally spaced, so as

* For a figure of one of these traps, and also of a large Bermuda lobster, see Verrill: "The Bermuda Islands," I, p. 293, fig. 56, 1907.

† *Palinurus americanus* M. Edw., Hist. Nat. des Crust. ii, p. 298, 1837. Heller, Reise Frig. Nouvarra. p. 95, 1865. (Analyt. table of all species of the genus).

Panulirus americanus Streets, Proc. Acad. Nat. Sci. Phila., p. 242, 1871. Bate, op. cit. xxiv, p. 76 (analytical table). ? Kingsley, Proc. Acad. Nat. Sci. Phila., p. 410, 1879 (no descr.).

to form a square, while in *P. argus* they are small, situated nearer the median line, and farther apart longitudinally, so that they do not form a square.

In *P. americanus* the lateral angular lobes of the abdominal segments have only a single tooth as in *P. argus*. The basal segment of the antennules is very long, reaching to the middle of the last segment of the peduncle of the antennæ.

The color, as described by Edwards, is very similar to that of *P. argus*. The abdomen has, like some of the latter, yellow, ocellated spots, a pair on each segment, and also some bands of yellow. But it is not stated that there are four larger spots.

None of the numerous Bermuda specimens that I have examined agree as well with Edwards' descriptions of *P. americanus* as with that of *P. argus*. If the two be distinct, probably the Bermuda records of *P. americanus* are erroneous. All of our numerous Florida specimens are also *P. argus*.

It is not possible to tell whether the *P. americanus* of Gibbes and of Kingsley were the same, for they gave no descriptions.

We found a small, parasitic, stalked barnacle attached to the mouth parts, near the efferent opening of the gill cavity of one of the large Bermuda specimens. (See plate XLIII, figs. 5a, 5b.) It appears to be an undescribed species. Dr. H. A. Pilsbry refers it to the genus *Octolasmis*, but it has a more calcified shell than most of the species of that genus.

Octolasmis argus, sp. nov. The body, in a side view, is long ovate, acute distally. It is somewhat swollen proximally; pedicel is short, strongly wrinkled transversely. The scutum is divided into two very unequal plates. The proximal one is large, somewhat oblong, about twice as long as broad, obtuse distally, and with a broad lobe on the carinal edge, defined by two wide shallow emarginations. The distal plate is much smaller, with two emarginations on the proximal margin separated by a triangular lobe. Tergum is elongated with its distal end obtuse and corresponding to the notch in the distal tergal plate. The plates are white and well calcified and not widely separated.

It is related to *O. prototypus* Pilsbry found on a spider crab at Jamaica (Proc. Acad. N. Sci. Philad., 1911, p. 171). The proximal scutal plate is larger, not triangular, and much longer in proportion to its breadth. The tergal plate is not enlarged distally, and the distal scutal plate is smaller and quite different in form.

O. antiqua Stebbing also occurs on the oral appendages of a species of the family *Palinuridae* in the West Indies.

O. forresti Stebbing has been found in the gill cavity of a *Palinurid* from Florida Keys (perhaps *P. argus*). It is a smaller and much less calcified species.

***Panulirus guttatus* (Latr.) White.**

Palinurus guttatus Latreille, Ann. du Mus., vol. iii, p. 393. Lamarck, Hist. nat. Anim. sans Vert., vol. v, p. 210. H. M.-Edwards, Hist. Crust., vol. ii, p. 297, pl. xxiii, fig. 1. Von Martens, Cuban Crust., p. 125 (desc.).

Panulirus guttatus Bate, Voy. Challenger, vol. xxiv, pp. 78-79. pl. xa (var.).

PLATE IX, FIGURE 2. *Stridulating organ.*

Mr. Louis Mowbray informed me, by letter, that he had obtained this species at Bermuda. Personally, I have seen no Bermuda specimens of it. It has a very spiny carapace, and two large conical spines on the antennular segment. Carapace is thickly covered with conical spines, much more numerous than in *A. argus*. The two large "rostral horns" are stouter, but not so long as in the latter and each has a conical spine behind its base. There is a strong conical spine on the anterior margin below the orbits. The large antennæ are much more slender than in *A. argus*; the proximal part of the flagellum is only about half as thick.

Its back is greenish with very numerous small round yellow spots; the propodus of the legs is longitudinally striped with green and yellow.

Its range extends through the West Indies to St. Paul's Rock. (Bate, as a variety.) Bate also records it from the Isle of France and New Holland (var.).

The "variety" described and figured by Bate from St. Paul's Rocks may be a distinct species. It seems to agree very nearly with *P. echinatus* Smith, from the Brazilian Coast.

Bate has figured (his Pl. XA, fig. c), a well formed stridulating organ on the base of the antennal peduncle. (See pl. ix, fig. 2.)

LARVÆ OF PANULIRUS; *Phyllosomæ*.

The *Phyllosoma*-form larva, of which three stages are shown on Plates 3, 3A, is thought to be the larva of this species, chiefly because it is the most abundant species of the group and extends

farthest north (to Beaufort, N. C.), while this form of larva is the most common farther north, but there is no direct evidence of its identity. The earliest stage observed is shown on Plate iiiA., figs. 1, 2. In this the antennules (*a'*) have only a rudimentary secondary flagellum and the antennæ (*a''*) are short, reaching only to the end of the second antennular segment.

There is a distinct median ocellus (*oc*) and the green gland (*g*) is very distinct. The third maxillipeds are long and very slender and the first four legs (pl. III) are fully developed and very long (some are broken off in the figure), but the fifth pair appear only as minute rudiments (pl. IIIA, fig. 2, *pv*). The abdomen (pl. IIIA, fig. 2, *ab*) is rudimentary, bud-like, without segments or appendages.

The next stage, shown on pl. III, fig. 1, is very similar, but has the antennules and antennæ longer and nearly equal in length. The abdomen (pl. IIIA, fig. 2b) is a little more advanced and shows faint segmentation, and the uropods (*u*) appear as rudiments; the telson (*t*) is distinct, small, and nearly semicircular.

The last stage observed (pl. III, fig. 2; pl. IIIA, figs. 3, 3a) has the antennæ considerably longer than the antennules; the fifth pair of legs (*pv*) have become longer and 2-jointed; the abdomen is much larger, well segmented, and has four pairs of small pleopods; the uropods (*u*) have become much larger, ovate, and longer than the telson (*t*) which is now longer than wide, subovate, obtuse. The larvæ were difficult to keep alive in confinement, with only our conveniences on shipboard.

Family SCYLLARIDÆ White.

Scyllaridæ White, List Crust. British Mus., 1847. Dana, op. cit., 1852, etc.

Body wide, depressed more or less; abdomen most so. Covered with a thick, hard sculptured or tuberculose shell. Eyes situated in orbits formed within the margins of the carapace. Antennæ short and broad, with flat, scale-like, stiff segments. Mandibles have a palpus of one joint. None of the legs are chelate except the last pair in the female. Larva is a *Phyllosoma*.

Scyllarides Gill. *Sea Crawfishes; Spanish Lobsters.*

Scyllarides Theodore Gill, Science, new ser., vol. vii, p. 98, 1898. Rathbun, op. cit., 1901, p. 97, etc.

Scyllarus Dana, op. cit., p. 516, 1852 (not of Fabricius, 1775).

The rostrum is prominent. The third maxilliped has an exognath ending in a flagellum. Branchiæ are in 21 pairs. The species are usually of large size and confined to tropical and subtropical seas. The larva is a *Phyllosoma*, perhaps somewhat like Pl. IIIA, fig. 1.

Scyllarides æquinoctialis (Lund), Gill. *Sea Cray-fish; Spanish Lobster.*

Scyllarus æquinoctialis Lund, Skrifter af Naturhistorie-Selskabet, Copenhagen, II, (2) p. 21, 1793.

Scyllarides æquinoctialis Gill, Science, n. s., vii, p. 99, 1898. M. J. Rathbun, *Brachyura and Macrura of Porto Rico*, p. 97, 1901.

Scyllarus æquinoctialis Fabr., Supl. Ent. Syst., p. 399, 1798. Bosc, *Crust.*, ii, p. 19. H. M.-Edw., *Hist. Nat. Crust.*, ii, p. 285, pl. xxiv, fig. 6, 1837. Gibbes, op., cit., p. 193, 1850 (Key West). Smith, *Brazil Crust.*, these Trans., ii, pp. 18, 39, 1869 (Bahia, full description). Rankin, *Annals N. York Acad. Science*, vol. xii, p. 535. (Bermuda.)

TEXT FIGURE 3. PLATE IV.

This large species is generally reddish-brown, dull orange-brown, or terra-cotta color above, more or less mottled with orange, and with the frontal tubercles and edges of the carapace lighter orange-red. First abdominal segment bright orange, often mottled with purplish, and marked by two large, round spots of bright reddish-purple, or lake-red, surrounded by orange, and joined together anteriorly under the edge of the preceding segment. Succeeding segments dull orange or brick-red, mottled with darker tints; telson and caudal fins (uropods) brownish-yellow, spotted beneath with light brown, pale at the tips. Legs orange with faint purple annulations at the joints and covered with small, round, dark purplish-blue spots, with larger blotches of the same on the propodus. Beneath, all parts are much paler than above and more orange. The larger specimens are duller and darker in color.

The large male, described below, when recently dried and not much changed in color, has the dorsal surface, in general, dull reddish brown and orange-brown, with a large patch of deep red on the cardiac area; on the gastric area is an ill defined medial roundish patch of red, surrounded by six similar but smaller patches of red, separated by orange-brown. First abdominal segment orange-yellow and orange-brown, with the pair of large.

median, dorsal spots dark purplish-brown (lake-red in life) edged with bright orange-yellow.

About midway between these spots and the lateral margins, on each side, there is an ill defined patch of dark brown (red in life). When the abdomen is straightened these four spots are nearly concealed by the edge of the carapace. The eye-stalks are conspicuously longitudinally striped with orange and dark purple. The marginal frontal teeth and granules of the carapace and basal antennal segments are light orange. Distal antennal segments are narrowly edged with brown. Under parts in general are orange and orange-yellow; legs orange and covered with numerous round purple spots, mostly .5 to 1.5 mm. in diameter.

Most of the legs have a broad, transverse patch of dark purplish-brown on the middle of the propodus. Uropods and telson, on the under side, are thickly spotted with roundish spots of light reddish-brown, mostly about 1 mm. in diameter. In some female specimens there is a large, median, dorsal patch of orange on the first four abdominal segments.

The following description is from an adult male from Dominica I. (No. 4097, Yale Univ. Mus., coll., A. H. V.).

The carapace is oblong, distinctly longer than broad (proportions about 1.2:1), widest near the middle, convex in both directions; the borders are only slightly convex; posterior angles thickened, swollen, and obtusely rounded; cervical suture and notch only slightly developed; posterior transverse groove narrow, well marked.

Whole dorsal surface of carapace is coarsely and pretty evenly granulated; the granules are rounded and flattened, unequal in size, but not very closely crowded; the larger ones are often lobed; all bear, when fresh, a few very short, stiff hairs and similar hairs arise sparingly in the interspaces. The edges are thickened, obtuse, bordered by granules similar to those of the back, becoming larger in front of the cervical notch, where there are about ten, in form of small rounded tubercles.

The orbits of the eyes are prominent, above and below, and crenulated by coarse granules; notched on front edge. Eye-stalks short, stout, tapered, conspicuously striped.

The abdominal somites are stout and convex; the third to fifth are rather prominent or humped in the middle, but not carinated.

The telson is wider than long, tapered somewhat, subtruncate; the thickened basal portion is five-lobed, closely granulated and hairy. The thin distal portion is covered with branched riblets, which are covered with short, stiff setose hairs. The uropods have much finer riblets.

The second segment of the antennæ is coarsely granulated proximally, broader than long; the outer edge is slightly convex and forms nearly a right angle with the distal edge, which is nearly straight; the outer angle is formed by a small obtuse tooth; the

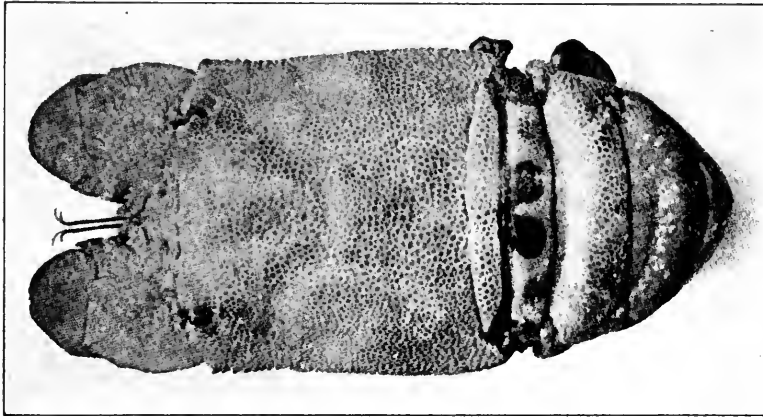


FIGURE 3. Sea Craw-fish, *Scyllarides æquinoctialis*.
Dorsal view, about $\frac{1}{2}$ natural size.

distal median angle is occupied by two larger teeth, and the distal edge has about eight or nine smaller obtuse teeth or crenulations. The inner proximal lobe has four unequal obtuse teeth. The distal segment is broadly and pretty evenly rounded, with the edge crenulated. The basal segment is thickened and coarsely granulated; the inner distal angle bears three prominent, divergent, obtuse teeth enclosing laterally, and nearly meeting in front of, the rostrum. The rostrum is granulated like the carapace, slightly bilobed, widest about the middle; the distal edge is obtuse.

The legs are short and stout, especially the first pair. The merus, carpus, and propodus of the third to fifth pairs have a large, obtuse, granulated carina on the outer surface, bordered posteriorly by a wide sulcus; on the first and second pairs the carina is feeble, except on the merus, where it ends in a prominent tooth. The

legs of the first pair are about twice as thick as the second and third, their propodus is swollen and long-ovate, not angular below. The fifth legs carry the male organs near the inner ventral edge of their basal segment; the organ is nearly circular with a depressed central area, at the summit of a low, verruciform elevation.

The basal segments of the legs are strongly sculptured and verrucose; the verrucae are obtusely rounded and mostly stand in single rows on the summit of the ridges. The sternal somites are much thickened, with deep depressions between them; each bears a pair of rather large, obtuse, conical spines partially covered, like the spaces between them, with low or flattened and relatively inconspicuous granules.

The epimeral grooves of the abdominal somites are well marked. The lateral borders of the second somite are but slightly produced downward, but are large and much thickened on the outer edge and bear about seven blunt tubercles. The next three have short thick lobes, crenulated irregularly. The posterior ventral ridges of the second to fifth somites are sharp and finely serrulate.

Small, slender, thin, biramous pleopods are present on the second to fifth segments, but are very small on the fourth and fifth. The under sides of the legs and of the abdominal somites are covered with small, flattened granules bearing a few very short and small hairs. The under side of the carapace is closely covered with large, rounded granules, diminishing in size anteriorly. The under sides of the antennal segments are covered with small pits or puncta, each bearing one, or very few, very short hairs, too small and too scattered to obscure the surface, and a few small granules on the basal parts.

The females, several of which carried large numbers of small eggs, are smaller, but have essentially the same proportions and ornamentation. Their colors seem to have been rather lighter, with more orange above. The legs of the last pair are relatively somewhat longer, with well-formed chelate tips, in the females.

According to Mr. A. Hyatt Verrill, this species, as observed by him in Dominica I., is very sluggish and walks very slowly, but it can use its powerful abdomen vigorously, for propulsion and defense. It is used there as food by the natives and its flesh is of excellent flavor though somewhat watery. It resembles that of a crab more than that of a lobster.

Comparative Measurements of *S. æquinoctialis* (No. 4097) and
S. braziliensis (No. 4100).

Number	4097	4100
Sex	♂	♂
Total length	292	295
Length to base of rostrum	250	245
Length of carapace	114	90
Length of abdomen to telson	105	100
Length of telson	32	28
Breadth of telson	51	46
Breadth of carapace, in middle	96	84
Breadth of carapace, anteriorly	87	82
Breadth of carapace, between orbits	56	56
Breadth of orbits, transversely	8	6.5
Breadth between orbits and carapace border	14	11.5
Breadth of sixth abdominal somite	59	53
Length of sixth abdominal somite (medial)	16	17
Length of antennæ (total above)	53	62
Length of second movable segment (total)	31	39
Breadth of second segment	41	45
Length of fourth antennal segment (above)	22	24
Length of fourth segment (total below)	25	30
Breadth of fourth segment	34	37.5

This was first recorded from Bermuda by Hurdis. It was also collected by Dr. T. H. Bean (t. Rathbun). It is frequently caught in the lobster traps, in deep water among the outer reefs, and is mostly used at once for lobster bait. It is not commonly sold in the markets at Bermuda, and is rarely used as food there.

A good series of this species is in the collection from Dominica I. (A. H. Verrill, 1906, Yale Univ. Mus.). They were taken in fish traps in 5 to 100 fathoms. Its range is from the Bermudas and Florida Keys to Brazil. Bermuda (Hurdis; T. H. Bean; Rankin). Bahia, Brazil (Smith). Found in many of the West Indies, where it is used as food, more or less, but is much inferior to the spiny lobsters (*Panulirus*). Sold in the markets of Porto Rico (Rathbun).

This species is closely related to *S. braziliensis* Rathbun, with which it is associated at Dominica I., where a few of the latter, some of which are now in the Yale Museum, were taken, with the more common species, by A. Hyatt Verrill, in 1905-06. Possibly both may also occur at Bermuda.

S. braziliensis can be readily distinguished, when recently preserved, by its much brighter red or rosy colors, with the borders

of the antennal joints, etc., bright purple or magenta color, and especially by the absence of the united or approximated, large, round, lake-red or purple-red spots on the dorsal side of the first abdominal segment. But in *S. braziliensis* this segment has a pair of equally large and conspicuous spots of brighter red or magenta, wide apart, or about midway between the center and the margin, where there are also ill defined dull-reddish or light brown spots in many specimens of the common species, in addition to the median pair.

S. braziliensis differs, however, in many other respects, especially in having the whole upper surface more coarsely and roughly granulous and covered much more closely with longer stiff, erect, setose hairs, so abundant as to obscure the granules. The under parts of the carapace, antennal plates, legs, and sternum are more granulose and more hairy. The legs are more slender and more sharply carinate on the dorsal surface, and lack the round, purple spots characteristic of the common species.

The antennæ are longer, especially the distal segment, and their outer edges are more strongly crenulated, but the distal and inner margins are not so strongly toothed. The second to fourth abdominal segments are subcarinate, but not humped. The lateral lobes are much more prolonged ventrally, not so thick, and the margins are more strongly toothed. The fifth and sixth segments are longer, but not so wide.

It was first described from a Brazilian specimen by Miss Rathbun, in 1906.*

Scyllarides americanus, sp. nov. *Spanish Lobster*.

Scyllarus latus (pars) Von Martens. Cuban, Crust., p. 122, 1872.

PLATE V, FIGURE 1. PLATE VI, FIGURE 1.

Carapace coarsely granulated, longer than wide, a little wider in the middle than at the orbital angles; subtruncate in front; external or orbital margins form nearly a right angle terminating with an obtuse tooth; cervical notch and groove well marked; eight or nine small, nearly equal, obtuse denticles on the margin, in front of the notch, that of the angle somewhat larger; margins behind the notch with numerous small denticles, scarcely larger

* Proc. U. S. Nat. Mus., vol. XIX, p. 113, 1906.

than the granules; posterior transverse groove deep and conspicuous. Orbits not far from lateral margins, the space between only one-third more than their diameter. Granulation of the carapace is coarse and somewhat uneven; the granules being larger over the central and posterior portions than anteriorly.

The granules are elevated, obtuse-conic or hemispherical, not crowded, many of them with a pit at the summit, each surrounded by a more or less complete circle or cluster of short stiff hairs. On the gastric area there is a large, broad-based, prominent median ridge, divided into a smaller anterior and a larger posterior part, each portion terminating in an anterior, larger subconical, obtuse or bilobed tubercle, with other similar but smaller tubercles and coarse granules around and behind the apex. The larger tubercles mostly have a crater-like pit in the summit. On the cardiac region there is also a somewhat prominent but less elevated area, on which there are tubercles larger than those adjacent; some of these are in pairs, or they may form a triangular group. A few of these larger tubercles are also scattered elsewhere on the carapace, especially on the branchial areas, but do not form clusters there.

The abdomen is strongly sculptured; the elevated areas are coarsely granulated and hairy, much like the carapace; the second to fourth segments have a median, elevated, obtuse ridge, covered with large granules; the ridge on the fourth is bilobed longitudinally. There is a slight ridge on the fifth, also. The lateral marginal lobes are large, angular, that of the 2d segment larger and broader, subacute, about as long as broad, both edges dentate with many small teeth about equal in size to the adjacent granules. These processes, farther back, are similarly but more minutely dentate on the posterior edge, and nearly smooth or minutely crenulate on the anterior edge.

The telson is broader than long, not much tapered distally, with the distal angles broadly rounded and the distal edge subtruncate. The proximal part is granulated and hairy, like the abdomen, but distally the surface is covered with numerous somewhat divaricate and forked ridges and sulci, becoming very fine near the edges and covered with rows of short hairs. The uropods are very broad, as long as the telson and sculptured in the same way. Under side of bases of legs and sternum are very roughly sculptured, with many angular elevations and deep pits; one larger acute or pyramidal elevation is on the sternum, opposite the base of each leg.

These parts are irregularly granulous and sparsely covered with tufts of short hairs, arising from pits. The outer maxillipeds are large, with the two basal segments very stout, compressed, triquetral, hairy and granulated, with the edges denticulated.

The legs are large and unusually long for this genus, projecting much beyond the edges of the carapace. They are conspicuously banded with red and yellow. The legs of the first pair are considerably stouter than the others, but not so long as the next two pairs. They have the propodus considerably swollen and the dactylus stout. Those of the fifth pair are most slender, especially the propodus. The merus and carpus of all the legs, except the carpus of the first pair, have a dorsal carina, finely serrulate, and ending distally in a sharp tooth; there is also a sharp tooth on each side of the distal end of the merus. The carina is sharply raised on the anterior legs, but rather feebly developed on the fifth pair. The carpus, except of the first pair, has also a carina on the posterior side, ending in a distal tooth. The propodus has, on most of the legs, two slight granulated carinae above, one on the posterior side, and one below. The dactylus is only moderately curved; a sulcus on the posterior side. The legs are all covered with small appressed or flattened granules and small pits, often in short transverse lines, and with sparse clusters of very short hairs. On the dactylus, especially of the fifth pair, the tufts of hairs are much larger.

The distal antennal segment is thin, broader than long; the edges broadly and nearly evenly rounded; the exposed edge forming a half oval, minutely lobulate and crenulate, and fringed with short, close hairs.

On the upper side there is a narrow red marginal band which is nearly smooth but has some small pits and sparse hairs. The rest of the upper surface is covered with small rough granules and small pits carrying tufts of short hairs which cover the surface closely. The under surface of this and the other segments is smoother, but is also covered with short stiff hairs emerging from small pits.

The penultimate movable joint,* which is short, only about half as wide as the distal, is three-lobed beneath, but shows above only

*A suture near the proximal end of the distal segment indicates that the latter actually consists of two ancylosed segments in this and allied genera so that the total number of segments, including the fixed basal, is six.

two lobes; the inner marginal, which is rhombic, with an obtuse distal tooth and denticulate inner edge; and the smaller articular lobe, which ends in a sharp tooth. The second movable segment, which is distinctly wider than long, is broader than the distal segment. Its distal lobe is large and terminates in a thick, angular point, but the adjacent edges form rather more than a right angle. These edges are dentate, with many small teeth, and with a larger stout tooth near the inner curve of the inner margin. The inner lateral lobe is stout, thick, enlarged toward the end, with the inner edge obtusely and unevenly dentate. The inner edges of these lobes, on the two antennæ, are separated by a space about equal to the orbit of the eye. The upper surface is hairy like that of the distal segment, but it is more coarsely granular, the granules increasing in size proximally, where they are nearly as large as those on the basal segment and carapace.

The first movable segment is irregularly 4-lobed above; the small outer lateral lobe bears about three denticles; the median or distal lobe is swollen and coarsely granular; the inner lobe is obliquely oblong, with the inner edge truncate and denticulate; those of the opposite antennæ are separated by a space nearly equal to the length of the edge.

The prefrontal or rostral lobe is a little broader than long, widest distally, swollen laterally, with concave sides, and with a median sulcus, each lobe terminating in a somewhat raised subacute tooth; upper surface coarsely granulated and hairy. The front edge of the carapace, between the orbits and beyond them, is covered with small, irregular, obtuse teeth, mostly of the same size and shape as the adjacent dorsal granules; about midway between the orbits and center there is on each side a cluster of rather larger ones making a small lobe; nearer the center there is a pair of denticles rather larger than the others; also a large one on each side close to the orbits. The median or rostral denticle is scarcely distinguishable by its size, but there is a median row of slightly larger granules on the carapace back of it.

The orbits are large, with prominent and thick borders. On the upper side there are two large, angular lobes, subdivided by granules, especially below, and with a conical lobule back of them; the posterior and inferior margins are surrounded by small obtuse teeth, the anterior notch is wide and deep.

The general color of a dried specimen, above, is dull terra-cotta, with the larger naked tubercles and marginal denticles orange-red. The first abdominal segment has a median, large, round, red spot, bordered laterally with orange-yellow, and a fainter reddish spot, midway between the middle and the margin. The antennal joints have a narrow border of bright orange-red; teeth the same. Under parts of body and antennæ are dull pale yellow.

Telson and uropods are finely mottled or speckled with orange and yellow. Legs bright red, banded at both ends of each segment with light yellow, so that there is a wide band of red in the middle of each segment. Tips of the claws are blackish. Eye stalks are bright red. They are very thick at base, narrower distally. The cornea is smaller than the stalk and looks upward.

Measurements of Bermuda Specimens of S. americanus

Total length	—	350
Length of carapace, without rostral lobe	75	110
Breadth at anterior angles	68	107
Breadth of carapace in middle	73	110
Breadth between orbits	48	66
Diameter of orbit	6	11
Orbit to outer angle	8	15
Length of rostral lobe	9	14
Length of first antennular segment	—	7
Length of second antennular segment	8	11
Length of third antennular segment	15	22
Length of antennal segments, collectively	38	67
Length of second movable antennal segment	22	39
Breadth of second segment	32	49
Length of exposed part of last segment	12	22
Breadth of last segment	30	44
Length of leg of first pair, total	—	112
Length of leg of first pair, carpus, below	—	20
Length of leg of first pair, propodus, below	—	22
Length of leg of first pair, dactylus, below	—	28
Height of leg of first pair, propodus	—	17

The American form, which hitherto has been identified with *S. latus** of the Mediterranean, appears to me to be a distinct species, or at least a well-marked subspecies.

**Scyllarides latus* (Latreille).

Scyllarus latus Latreille, Hist. Nat. Crust., vi, 182, 1803; Tabl. Encyc. Meth., xxiv, pl. cccxiii, 1818. Guerin, Icon. Regne. Anim., pl. xvii,

Miss M. J. Rathbun already noticed some of the differences, several years ago, when she sent me the following memoranda concerning a Bermuda specimen (see figure), now in the U. S. National Museum, collected by Dr. T. H. Bean:—

“This specimen differs from a male *S. latus* of equal size from Fayal, Azores, and contained in the National Museum, as follows: The surface is much more uneven, the tubercles are less crowded and the hairs less numerous, the width between the orbits is greater; in the shape of the rostrum, the outer corners do not project in front of the points at the middle; the antennulæ are longer, their peduncles exceeding the antennæ. The basal segments of the antennæ meet in front of the rostrum in the Fayal example of *S. latus*, but are widely separated in the one from Bermuda. The last three joints of the antennæ are longer and more distinctly dentate. The abdominal protuberances are much stronger; the lateral margins of the abdominal segments are indistinctly dentate, even those of the second segment. The feet are longer and narrower. These characters are sufficient to warrant the formation of a new species, were it not that specimens from the coast of Florida show intermediate characters, especially in regard to the antennæ.”

The American form has not yet been figured, so far as I know, and most of the few figures of the European species are inexact. It has been taken at Bermuda by Dr. T. H. Bean, who probably obtained it by means of lobster traps, off the outer reefs. The type specimen described above was from Bermuda and was kept alive in the New York Aquarium for a short time. The American species has been recorded from Cuba by Von Martens.

Miss Rathbun has furnished the following additional localities: Off Pensacola, Florida, in fish stomach, Silas Stearns, coll. (U. S. Nat. Mus.); along the coast between Savannah, Ga., and Cape Canaveral, Fla., collected by Capt. Silas B. Latham, 1890, and received through the U. S. Fish Commission (U. S. Nat. Mus., M. J. Rathbun).

fig. 1. Savigny, Egypt, Crust., pl. viii, fig. 1. Desmarest, op. cit., p. 182. H. M.-Edw., Hist. Crust., ii, p. 284, 1837.

The true *S. latus* is found in the Mediterranean and adjacent parts of the Atlantic; at the Azores; Canaries; and St. Helena.

Scyllarides sculptus, sub. sp. **bermudensis**, nov. *Small Spanish Lobster*.

Scyllarus sculptus Latreille, Tabl. Encycl. Meth., xxiv, pl. cccxx, f. 2, 1818. H. Milne-Edwards, Hist. Nat. Crust., ii, p. 283, 1837. Heilprin, Proc. Acad. Nat. Sci. Philad., 1888, 321, The Bermuda Is., p. 150.

PLATE VII, FIGURE 1.

The carapace is scarcely wider than long, widest at the orbital angles; posterior margin sinuous with a wide median sinus and deep transverse groove.

The granulation of the carapace is crowded and pretty uniform. There is a single, small, conical spine behind each eye and about on a level with the upper margin of the orbits, but no large, acute median denticles on the gastric and cardiac areas, described as present on the true *sculptus*. The lateral margins have, behind the cervical suture, about 11 sharp teeth, directed strongly forward, decreasing in size posteriorly, and six in front of the cervical notch, of which the two anterior, at the orbital angle, are much larger than the rest and very sharp.

The second movable segment of the antennæ is acute, angular, convex externally, about as long as broad, with a very large acute tooth at the end; back of this tooth, on the outer margin, are six sharp teeth or spines, inclined strongly forward, and decreasing backward, the last obscure; on the anterior edge there are four sharp spines with dark tips. The distal segment is broader than the second, broadly rounded, with a small emargination in the outer margin; the anterior and outer edges are divided into numerous angular teeth and closely fringed with short hairs.

The abdomen is strongly convex and deeply sculptured with oblique and transverse grooves, and it is coarsely granulated. Eyes large, rather close to the lateral border; orbits surrounded by unequal sharp teeth.

The legs are larger and longer than in most allied species; the merus joints project considerably beyond the sides of the carapace.

The colors, in life, are clouded with various shades of light brown, terra-cotta, and dull yellowish, mostly in irregularly placed patches. This species seems to be rare at Bermuda. It is taken in lobster pots off the outer reefs. A specimen in the Yale Museum (No. 814) was in the early Bermuda collections sent by J. M. Jones, about 1876. It was first recorded from Bermuda by W. Stone as in Heilprin's collection (as *S. sculptus*).

Measurements of a Bermuda specimen.

No. 814

Total length, from base of antennules	—
Length of carapace	45
Breadth of carapace, anteriorly	44
Breadth of carapace, in middle	40
Breadth of carapace, between orbits	30
Diameter of orbits	5
Length of anti-penultimate antennal segment	18
Breadth of anti-penultimate antennal segment	17
Length of distal segment (part exposed)	7
Breadth of distal segment	24
Sex	male

I have had an opportunity to study a living specimen in the aquarium at Agars Island, Bermuda. Miss Rathbun states (in a letter) that there is a Bermuda specimen in the U. S. Nat. Mus. collected by Dr. T. H. Bean. I am much indebted to her for the photograph of Dr. Bean's specimen, which I have reproduced.

Tribe **ASTACIDEA** Dana (emend.). *Lobsters; Craw-fishes.*

Astacidea (pars) De Haan, 1850.

Astacidea (pars) Dana, 1852. Heller, 1863.

Homaridea Ortmann, 1891. Rathbun, op. cit., 1901, p. 98.

Nephropsidea Ortmann, Syst. Crust., p. 429, 1896.

Three pairs of legs are chelate; the first pair largest. Antennules have two long, slender, multiarticulate, not spinose, flagella. Antennæ have a large scale and a very long flexible flagellum. Telson is large and strong, usually with terminal spines. Uropods are large; the outer branch usually has a distal articulation; margin rather stiff. Legs have seven functional segments. First segment of the abdomen (pleon) bears a pair of appendages in both sexes, with few exceptions. The last thoracic segment is consolidated with the preceding one. The female commonly has an external spermatheca.

Family **HOMARIDÆ** Huxley, 1883, *Lobsters.*

Astacidea (pars) Dana, 1852. Heller, 1863.

Homaridæ Bate, Voy. Chall. vol. xxiv, Macrura, pp. 56, 170, 1888. M. J. Rathbun, op. cit., 1901, p. 98.

Nephropsidæ Stebbing, Hist. Crust., p. 201, 1893. Ortmann, Syst. Decap. Crust., 1896. Stebbing, Crust. S. Africa, part I, p. 33, 1900.

The marine genera included in this family differ from the fresh-water genera of crawfishes (Astacidæ) chiefly in the number and arrangement of the branchial plumes. The latter, however, differ considerably among themselves in that respect.

Nephopsis Wood Mason, 1873.

Form of body similar to that of *Homarus*, but more slender. Chelæ of first pair of legs moderately large and equal, or nearly so, not carinated. Antennæ with a long flagellum; no antennal scale. Eye-stalks and eyes small; rostrum long, with carinate and dentate margins. Second and third pairs of legs much more slender than first, and with small simple chelæ. Telson with two ribs or ridges ending in two terminal spines; uropods large, ribbed. Branchiæ nineteen on each side, arranged like the posterior nineteen pairs of *Homarus*. No branchiæ on the second maxillipeds. Inhabitants of deep water.

Nephopsis rosea Bate.

Nephopsis rosea Bate, Voy. of the Challenger, Macrura, vol. xxiv, p. 178, fig. 39, pl. xxiii, figs. 1, 2, 1-i; pl. xxiv, fig. 1, b-z, 1888. Faxon, op. cit., p. 157, 1896.

PLATE IX, FIGURES 3, 3A, 4-4C.

This is a very slender species. The epimeral processes of the abdominal segments are very acute-angular; those of the first two segments are bidentate, as seen from below. The rostrum is long, acute, carinate; with raised margins, strongly contracted proximally; at about the distal third there is a sharp spine on each margin, at the wide base there is another pair of spines; a short distance back of these on the carapace and joined to them by a slight carina there is a third pair of smaller spines; anterior margin of the carapace has a pair of strong antennal spines.

Antennular peduncle is slender with the third article much the longest; its outer flagellum is thickened distally; inner one is about the same length, but much more slender. Antennal peduncle is shorter and stouter. Larger chelipeds elongated; chela simple, not much smaller; palm longer than fingers; carpus has a terminal and a subterminal spine; merus has a distal spine on the outer side.

Tribe **THALASSINIDEA.**

The species included in this group are adapted for burrowing, having habits similar to *Squilla*. The body, especially the abdomen, is elongated and weak, with the segments not overlapping. The carapace is short and feebly developed; rostrum small or lacking. Third pair of legs not chelate; chelæ usually present on the first pair and often on the second. Antennules and antennæ are elongated, peduncle of antenna is 5-jointed, usually without a scale. Last segment of thorax is movable.

Family **CALLIANASSIDÆ** Dana, 1852.

Rostrum is very small or lacking; eye-stalks are flattened. First pair of legs have unequal chelæ; third and fourth pairs are not chelate. Uropods and telson are large. Gills are filamentous.

Glypturus Stimpson.

Glypturus Stimpson, Proc. Chicago Acad. Science, vol. 1, p. 46, 1866.
Annals Lyc. Nat. Hist. N. York, vol. x, p. 120, 1871. M. J. Rathbun,
Brach. and Macr. Porto Rico, p. 93, 1901 (descr.).

This genus is closely related to *Callianassa*. It is most readily distinguished by the form of the outer maxilliped, which has the propodus dilated and about as broad as the merus and ischium, while in the latter it is distinctly narrower than the two preceding segments.

Glypturus branneri M. J. Rathbun.

Glypturus branneri Rathbun, Branner-Agassiz Exped. to Brazil, Proc. Wash. Acad. Sci., vol. i. p. 150, pl. viii, figs. 5-8, 1900 (descr.);
Brachyura and Macr. of Porto Rico, p. 93, 1901 (descr.).

PLATE I, FIGURE 2. PLATE VIII, FIGURES I-IA—E.

Front with a short, acute, depressed rostrum and with a shorter inconspicuous, obtuse lobe on each side above the bases of the antennæ, but without spines. Dorsal suture deep. Larger cheliped is compressed, very smooth above, polished, finely and inconspicuously denticulated on its lower margin and on the distal articular edges. The cutting edge of the dactyl has two unequal, lobe-like teeth. The larger chela has the palm nearly as wide as long; the dactyl is smooth and polished, denticulate below; the

fingers cross when closed; the carpus is sometimes twice as wide as long and nearly as wide as the palm; in other specimens the length exceeds the breadth. The smaller cheliped usually has the carpus and merus less than half as wide as in the larger one. Both fingers have tufts of elongated hairs on the margins, but no spines. Uropods large, with the outer lamellæ coalesced; outer lobe only slightly the shorter; inner branch shorter, longer than telson. Telson short, broader than long, tapered and broadly rounded distally; two small proximal pits and a median distal fossa. Color white.

Length of type from Brazil, 52.2 mm., without antennæ; length of carapace, 14.9 mm.; of carpus and propodus together, 15.5 mm. (M. J. R.)

This species has been taken only once at Bermuda. It burrows in the mud below low-tide level and may be nocturnal in habits. Mamanguepe Reef, Brazil, and Porto Rico (M. J. Rathbun.) Bermuda at St. David's Island (T. H. Bean, Field, N. Hist. Mus. Exped., 1905).

Suborder **NATANTIA** Boas. *Shrimps and Prawns.*

Key to the families of Natantia hitherto found at Bermuda.

A.—The epimera of the first abdominal segment are not covered by those of the second. Third pair of legs chelate; usually the first and second pairs also; branchiæ not foliaceous.

B.—Branchiæ filamentous (trichobranchiate), not branched; body not compressed nor carinate; pleopods not segmented.

Tribe *Stenopidea*.

BB.—Branchiæ branched and plumose.

Tribe *Penaidea* or *Dendrobranchiata*.

b.—Three pairs of chelæ nearly equal and not very strong, the third pair of legs longest. Rostrum usually long and dentate; carapace carinated dorsally; an epipodite on the second maxillipeds.

Family *Penaidea*.

c.—Ocular segment without styliiform spines beneath.

Subfamily *Penæina*.

cc.—Ocular segment with a pair of styliiform spines.

Subfamily *Sicyonina*.

bb.—First pair of legs reduced and without chelæ. Chelæ of second and third pairs minute, sometimes lacking on second pair. Rostrum usually small and simple.

d.—Cephalon and pleon not abnormally elongated; podobranchiæ lacking or present only on second maxillipeds; arthrobranchiæ few, sometimes present on the second and third maxillipeds and first to third legs; branchial filaments are flat. Last two pairs of legs small and feeble, the fifth sometimes absent.

Family *Sergestidæ*.

dd.—Cephalon and pleon generally much elongated; branchiæ lacking; fourth and fifth pairs of legs absent; no exopodites nor epipodites on the legs.

Family *Leuciferidæ*.

AA.—The epimera of first abdominal segment are covered by those of the strongly developed second segment. Third pair of legs not chelate. Branchiæ are phyllobranchiate, composed of thin, flat lamellæ and not branched. Antennules usually have two flagella, the outer one thickened and distally branched.

Tribe *Caridea* or *Phyllobranchiata*.

C.—Second pair of legs long and slender, with the carpus subdivided into few or many articles or annuli, and with very small chelæ. First pair larger, with stronger chelæ and undivided carpus.

Group *Polycarpidea*.

D.—Eye-stalks very short; eyes usually nearly or entirely covered by lobes of the carapace; rarely exposed. First pair of legs large, with large unequal chelæ, one usually very large, rarely equal. Rostrum usually small and simple, acute, sometimes obsolete. Carpus of second pair of legs with five articles. A cardiac pit in carapace.

Family *Synalpheidæ* (formerly *Alpheidæ*).

DD.—Eye-stalks and eyes not covered by the carapace; carpal segments various; no cardiac pit.

E.—First pair of legs chelate, or at least one is chelate.

F.—Eyes very small on long slender stalks. Female has a thelecum; uropods are excurved. Legs of second pair have the carpus divided into three or four articles; both of first pair chelate; third maxillipeds slender, last article shorter than preceding one; rostrum small and short.

Family *Ogyridæ*.

FF.—Eyes large, on short stalks; no thelecum; uropods not excurved; carpus of second pair of legs has few or many articles; third maxilliped usually has the last article longer than the preceding.

G.—Rostrum usually of notable size and serrate. First pair of legs with rather small equal or subequal chelæ, larger than those of second pair; second pair slender, with few or many carpal articles.

Family *Hippolytidæ*.

GG.—Rostrum small. First pair of legs commonly with only one leg chelate; those of second pair very slender, unequal in length; carpal articles numerous, more than five. Mandible has no palpus.

Family *Processidæ*.

EE.—First pair of legs not chelate; second pair more slender, chelate, with the carpus divided into numerous articles. Rostrum elongated and usually serrate, sometimes movably articulated with the carapace; mandibles have a jointed palpus.

Family *Pandalidæ*.

CC.—Second pair of legs usually larger than the first, with the carpus not subdivided, and the chelæ larger than those of the first pair, often much larger.

H.—Third maxillipeds more or less leg-like, with the articles not greatly dilated nor operculiform.

I.—Rostrum elongated and usually serrated on one or both edges; second pair of legs commonly very much longer and larger than the first; both pairs chelate; base of antennules excavated above, and usually with a scale. Eyes large, usually with a small accessory ocellus. Mandibles with or without a palpus.

Family *Palæmonidæ*.

I, I.—Rostrum usually small, not serrate, sometimes lacking, sometimes (as in *Periclimenes*) elongated and serrate; first pair of legs usually equal; one chela sometimes much enlarged; all legs without exopods or mastigobranchs; mandibles have no palpus; third maxillipeds often with some articles widened, more or less. Many species are commensals with Mollusca, etc.

Family *Pontonidæ*.

H, H.—Third maxillipeds with the third article much dilated or operculiform, the pair completely covering the oral area. Chelæ equal in both pairs; second pair larger; rostrum short serrate above; mandibles simple without a palpus or cutting edge.

Family *Gnathophyllidæ*.

Tribe **STENOPIDEA** Bate, 1888. *Oceanic Shrimp*.

Stenopidea Stebbing, History of Crustacea, p. 211, 1893.

Three anterior pairs of legs are chelate; those of the third pair are the largest and longest; fourth and fifth pairs have the carpus subdivided. Branchiæ are filamentous. Appendages of the first segment of the pleon are unbranched and differ little or not at all in the sexes. Podobranchiæ are lacking, except on the first pair of maxillipeds. Mandibles have a three-branched palpus.

Family **STENOPIDÆ** Huxley, 1883.

Stenopida A. M.-Edw. and Bouvier, Mem. Mus. Comp. Zool., vol. xxvii.

The characters of the family are the same as for the tribe above.

Stenopus hispidus (Oliv.) Latr.

Palæmon hispidus Olivier, Encyc. Meth., Insects, vii, p. 666, 1811, pl. 319, fig. 2, 1818.

Stenopus hispidus Latreille, in Desmarest, Dict. Sci. Nat., vol. xxviii, p. 321, 1823. Illust. Ed. Cuvier, Reg. Anim., iv, p. 93. Dana, Crust. U. S. Expl. Exped., p. 607; Atlas, pl. 40, fig. 8 (colored). Bate, Voy. Chall., Zool., xxiv, p. 211, pl. xxx, 1885. Brooks and Herrick, Johns Hopkins Univ. Circulars, xi, p. 66, 1892 (life history). Herrick, Life History of *Stenopus*, Mem. Nat. Acad. Sci., vol. v, pp. 339-352, pl. v (colored), plates vi-xiii (structure and metamorphoses, 1892, full descr.). Rankin, Ann. N. Y. Acad. Sci., xi, p. 240, pl. xxix, fig. 1, 1898 (descr.). Borradaile, Stomat. and Macr. brought home by Dr. Willey from South Seas, Zool. Results, iv, p. 407, 1900.

PLATE IX, FIGURES 5-5B. PLATE XI, FIGURE I. PLATE XII, FIGURES 1, 2.

This large and handsome species can be recognized at once by its bright colors and very long legs and antennæ, and the spinules that thickly cover its body; the bases of the legs and antennæ; and the whole of the large (third) pair of legs. On the anterior part of carapace the spines point forward; posteriorly they point back; on the large legs the spines are closely arranged in rows and directed distally; the fixed finger of the chelæ is bifid at the tip, the simple dactylus fitting into the notch. The first two pairs of legs are slender and have small chelæ. The fourth and fifth pairs are slender and have the carpus and propodus subdivided.

The published figures show considerable differences, however, between specimens from widely separated localities. Perhaps two or more species have been confused under this name. The large chelæ, especially, are represented as differing widely in form and proportions. Professor Herrick (Mem. Nat. Acad., v.) has given a very full description, with numerous measurements, of the Bahama specimens (op. cit., pp. 348-352), as well as excellent figures, including details of the appendages (pl. xiii, etc.). He also figured various stages of its remarkable larvæ. He discussed its identity with the Pacific Ocean form, but left it undecided, for want of material, as I must do, for our museum has no examples of the oriental species. The latter has the same form and the same remarkable coloration.*

It is perhaps the most beautiful of all the shrimps and prawns, and is also graceful in its motions. According to Prof. Herrick it is conspicuously marked with red, white, and blue, in life. The

* Borradaile (op. cit., p. 407, 1900) states that three specimens, both male and female, from New Britain I., agree precisely with the description given by Brooks and Herrick.

ground-color is nearly white; the head region and front of carapace, two broad bands on the abdomen, and four wide bands on the cheliferous legs are bright red; the bases of the legs are bright blue. Dana's colored figure shows the red bands, but no blue. It is usually found swimming, with its appendages widely outspread, near the surface, and most often in pairs.

It was first reported from Bermuda by Bate (Voy. Challenger). His figure was from a Bermuda specimen. Two fine adult specimens studied by me were taken by the Field Natural History Museum party in 1905. They were found in tide-pools at Cooper's Island.

It is widely distributed in all tropical seas. Reported from the Indian Ocean, Australia, Philippines, Fiji Islands, Cuba, Bahamas, Porto Rico, etc.

One of the singular larval stages is figured on Plate xii; after Herrick; earlier stages are still more peculiar.

Its bright coloration undoubtedly has a protective value when living among bright red sponges and algæ, so frequent on all tropical reefs.

Tribe **PENÆIDEA** Dana. *Prævns.*

Penæidea Dana, op. cit., 1852.

Dendrobranchiata Bate, op. cit., 1888.

Branchiæ are branched, with slender filaments; usually eight pairs. Legs of the three anterior pairs are nearly always chelate and slender; those of the third pair longest and always chelate; first pair shortest; fourth and fifth pairs of legs are slender and simple, the last sometimes abortive; outer maxillipeds are long and leg-like; second and third maxillipeds have an exopodite. Sides of the carapace extend farther back than the dorsal margin. Rostrum is usually long, dentate and carinate; the carina usually extends back more or less on the carapace. Fourth, fifth and sixth abdominal segments are compressed and usually carinate; sometimes also the second and third. Eyes usually large, on two-jointed stalks. Mandibles have a two-jointed palpus. Antennæ long, with a broad foliaceous scale.

Antennules are biflagellate; basal segment of the stalk is excavated and modified to accommodate the eyes; there is a basal antennular spine. Sternum usually has complex sexual organs.

That of the female, called the *thelycum*, serves as a spermatheca. That of the male, called the *petasma*, is supposed to aid in the transfer of the spermatophores. The eggs are not carried attached to the pleopods, as in most macrura, but are held by the legs in a cluster under the body.

Family **PENÆIDÆ** Dana, 1852. *Prawns*.

Body is usually compressed and curved. The carapace extends further back on the sides than dorsally; usually it is carinated dorsally; a carina is usually present also on some of the posterior abdominal segments; the carina is often dentate. The legs of the third pair are the longest; the chelæ of first three pairs are small, all similar in form and size.

Antennæ are long, with a large basal scale. Antennules are biflagellate, with an external basal spine and an inner unjointed appendage, excavate on the upper side. The eye-stalks are usually two-jointed. The lateral lobes of the first abdominal segment are broad and project forward, overlapping the margin of the carapace, while posteriorly they overlap the margin of the second abdominal segment.

In most of the genera the female has, on the under side of the sternum, a peculiar sexual organ, called the "*thelycum*," serving as a spermatheca. The male usually has, in the same region, an organ called the *petasma*.

The gills are dendrobranchiate, consisting of a central stem, sending off on each side a row of branches, which divide and subdivide in various ways, according to the genus, thus forming a dense plume of slender filaments. There are eight or more pairs of gills.

Analytical Key to Bermuda Genera of Penæida.

- A.—Dorsal carina not crest-like and dentate; subocular, median, anterior spines lacking; Pleopods biramous. Sexual orifices coxal in both sexes. Subfamily *Penæinae*
- B.—Rostrum with teeth above and below; exopodites on all the thoracic legs, except sometimes the last; epipodites on all except the fourth and fifth; pleurobranchiæ at the last pair of legs; endognath of first maxilla long and segmented. *Penæus*.
- BB.—Rostrum without teeth below; no epipodite on the outer maxillipeds; endognath of first maxillæ shorter, not segmented.
- C.—No pleurobranchia at the base of the fifth legs; no epipodites on the fourth and fifth legs.

- D.—Exopodites on all the maxillipeds and legs, except rarely the last.
Penaeopsis.
- DD.—No exopodites on the legs. *Parapenæus (restr.)*, extralimital.
- CC.—No pleurobranchiæ at the bases of either the fourth or fifth legs.
Epipodites lacking at least on the fourth and fifth legs; exopodites present on all the legs; antennular flagella short. . . . *Trachypenæus*.
- AA.—Dorsal carina crested and dentate. Anterior legs without exopodites. Abdominal segments sculptured and carinated. A pair of slender median subocular spines. Male orifices subcoxal. Pleopods uniramous. Subfamily *Sicyoniinae*; genus *Sicyonia*.

Penæus Fabricius (restricted). *Large prawns*.

Penæus Fabr., Entom. Syst., vol. v, 1798 (*pars*). Desmarest, Consid. gen., p. 224, 1825. Milne-Edw., Hist. Crust., vol. ii, p. 411, 1837 (*pars*). Stebbing, Hist. Crust., p. 214 (restricted). Bate, Voyage Challenger, vol. xiv (restricted). Smith, S. I., on some Genera and Species of Penæidæ, Proc. U. S. National Mus., vol. viii, pp. 170-190, 1885 (restricted). Report on Decapod Crustacea from Albatross dredgings in 1884, p. [80], 1886. Rathbun, M. J., Crust. of Porto Rico, p. 100, 1901.

The rostrum is long and serrated on the upper margin, sometimes also on the lower margin. The pereopods on legs of the first three pairs have exopods and small equal chelæ; the third pair of legs are the longest. The outer maxillipeds or third gnathopods are leg-like, elongated, and have an exopod. Podobranchiæ are lacking. Usually 18 pairs of gills. The eye-stalks are two-jointed or three-jointed. The antennular flagella are not longer than the carapace. The mandibles have a two-jointed palpus.

Pleopods, except the first pair, have two thin foliate branches; those of the first pair, in the male, have a large, membranous basal appendage known as the "petasma" or curtain; it is rudimentary in the female. The female has a thelycum.

Prof. Sidney I. Smith, in his important work on the *Penæida* (op. cit., 1886), gave the following additional characters for the restricted genus *Penæus*, as limited by him (type *P. caramote*). Viz.:—

The antennular flagella are very short. The distal segment of the mandibular palpus is much larger than the proximal one. It is very broad and is not prolonged into a narrow tip. The endognaths of the first maxillæ are greatly elongated and segmented. The endopod of the outer maxilliped is slender and composed of four segments, and the exopod is lamellar and

unsegmented; second and third maxillipeds have well developed epipods and large exopods; all the pereopods have small exopods, but only the first, second and third are furnished with epipods; there is a well developed pleurobranchia on the fourteenth somite.

The number and arrangement of the branchiæ and epipods are the same for the six species named, including the type, with *P. braziliensis*, *P. setiferus*, etc. Viz.:—Epipods, 6 pairs; podo-branchiæ, 1 pair; arthrobranchiæ, 11 pairs; pleurobranchiæ, 6 pairs. Altogether there are 18 pairs of branchiæ.

***Penæus braziliensis* (Latr.) Large Prawn. Market Shrimp.**

Penæus braziliensis Latreille, Nouv. Dict. d' Hist. Nat. xxv, p. 156, 1817. H. M.-Edw., Hist. Nat. Crust., ii, p. 414, 1877. Stimpson, Notes on N. A. Crust., iii, p. 132, 1871. Smith, these Trans., ii, p. 27 (Brazil). Von Martens, Cuban Crust., p. 140, 1872 (descr.). Miers, Proc. Zool. Soc. London, 1878, pp. 299-306. Kingsley, Bull. Essex Inst. xiv, p. 106 (2), 1883 (distr.). R. Rathbun, Fishes and Fish Industries U. S. Sect. 1, text, p. 822, 1884. Benedict, Proc. U. S. Nat. Mus., xvi, p. 540, 1893 (W. Africa). Verrill, these Trans., x, p. 580, 1900 (Bermuda). Smith, Proc. U. S. Nat. Mus. vol. for 1885, p. (80), 1886.

Palaemon serratus Hurdis, Rough Notes, p. 361, 1897, "The common prawn."

Penæus brevirostris Kingsley, Proc. Acad. Nat. Sci. Philad. for 1878, p. 98 (10), t. Kingsley, op. cit., 1879, p. 427 (Nicaragua).

Penæus braziliensis Edwards and Bouv., op. cit., p. 239, pl. vi, figs. 11-12, 1909.

Penæus braziliensis Hay and Shore, Bulletin Bureau Fisheries, vol. xxxv, p. 377, pl. 25, fig. 6, 1918.

PLATE XIII, FIGURES 1-3. PLATE XVI, FIGURES 1, 2, 2A. PLATE XVII, FIGURE 10. D. E. F. (DETAILS AFTER EDWARDS.)

This species can be easily distinguished by the wide and deep sulcus that extends along each side of the prominent dorsal carina, nearly to the posterior border of the carapace, while the posterior half of the carina also has a dorsal sulcus, or is bicarinate. The highest part of this carina is above the orbits. The carina and rostrum have about nine teeth above (8-11); the rostrum usually has two or three below, sometimes but one. About three or four of the upper teeth are on the rostrum and five or six on the carapace, the last one being considerably separated from the next; toward the anterior end the rostrum is straight and without teeth.

It is about one-third as long as the carapace. There is also a well developed antennal groove and spine, and a hepatic spine. The fourth, fifth, and sixth abdominal segments are sharply carinated with a groove each side of the carina on the sixth. The telson tapers to a sharp, acuminate point, without lateral spines; it has a deep dorsal sulcus.

The color of a young specimen in life was translucent whitish, with faint irregular brown markings on the abdomen.

Length of body of large females may be 160 to 170 mm. (or about 7 inches), including the rostrum; carapace about 60-64 mm; rostrum 22-24 mm. Most specimens do not exceed 100-125 mm. Those occasionally found in our northern waters are generally small and immature.

This large species is undoubtedly the one recorded as "The common prawn" of Bermuda, by Hurdis. He mentioned having specimens 5.3 inches long and that they had six chelate legs, characters that could apply to this species alone, of those now known at Bermuda. It was taken later by Mr. G. B. Goode, C. M. Allen, and by others. More recently it has been taken by the Yale parties in 1898 and 1901. Young were dredged by me in Great Sound, in 3 to 5 fathoms, May, 1901. Larger specimens were taken in a fish-seine, in 1905, at David's Island, by The Field Museum Expedition.

Penæus braziliensis: Dental formula of rostrum and measurements in millimeters.

No.	Teeth above and below	Specimens examined		♀	Length.
		♂	Length.		
7570a	$\frac{4 \quad 5}{2}$	16	(45-75)	20	(40-75)
7570b	$\frac{4 \quad 4}{2}$	3	(50-60)	4	(45-67)
7570c	$\frac{4 \quad 6}{2}$	2	(50-53)	5	(50-80)
7570d	$\frac{4 \quad 7}{1}$	1	(65)		
7570e	$\frac{4 \quad 5}{1}$	1	(40)		
7523a	$\frac{3 \quad 5}{2}$			2	(67-85)
7523b	$\frac{4 \quad 6}{2}$	1	(68)		

Nos. 7570 *a* to 7570 *c*, were from Sabanilla, N. G. Nos. 7523 were from Key West, Florida, tabulated by Professor S. I. Smith.

This is one of the common large marine prawns (also called "shrimp," especially when young), sold extensively in the markets of the Southern United States, from Louisiana and Texas to North Carolina. It is widely distributed, from Martha's Vineyard and Long Island Sound to Rio de Janeiro, Brazil, and West Africa (Miers, Edw., etc.) Hudson River at Sing Sing, New York (Stimpson); Rio Grande de Sul, Brazil (Ortmann); off Cape Hatteras, 11-14 fathoms (Smith); West Africa; Porto Rico, 7-76 fathoms; Katama Bay, Martha's Vineyard, Sept. 8, 1900 (Rathbun); Sarasota Bay, W. Florida, and W. coast of Nicaragua (Yale Mus.), Bahia, Brazil (Smith). Abundant at various places on the W. coast of Africa (Edw. and Bouvier).

It often occurs in vast schools in the estuaries of our southern coasts, from North Carolina to Texas. It is sometimes found many miles up the rivers. I have seen specimens taken in the western end of Long Island Sound. Whether it ever occurs in Bermuda waters in numbers sufficient for commercial use I do not know. It is used as food wherever it occurs in abundance.

It is often associated on our southern coasts with another similar large species (*P. setiferus*) of which large quantities are also collected for food* and both are sold, fresh and canned, under the name of "shrimp." Young ones are often sold as "prawns."

Both species, in the cooked condition, may frequently be found in the markets of New York and other northern cities. Large quantities are canned and widely distributed.

Penæopsis Bate.

Penæopsis (A. M.-Edwards, MSS.), Bate, Ann. Mag. Nat. Hist., ser. 5, vol. viii, p. 182, 1881 (Type, *P. serratus*).

Parapenæus (*pars*) Smith, op. cit., p. [81], 1886.

Penæopsis M.-Edw. and Bouvier, op. cit., p. 220, 1909.

Metapenæus Wood-Mason, 1891 (t. Bouvier).

Archipenæopsis Bouvier, 1905 (t. Bouvier).

The rostrum is rather long, without teeth below. The last thoracic segment lacks pleurobranchiæ; epipodites are lacking on

* See Richard Rathbun, Fish and Fisheries of the United States, vol. v, pp. 799-807, 1884, for statistics and methods of fishing for them.

the fourth and fifth pairs of legs. Endognath of first maxilla is short and not segmented.

Penæopsis goodei (Smith). Edw. and Bouv.

Parapenæus goodei S. I. Smith, Proc. U. S. Nat. Mus., vol. viii, p. 177, 1885; M. J. Rathbun, Branner-Agassiz Exped. to Brazil, p. 152 (no descr.).

Parapenæopsis rathbuni and *Archipenæopsis vestitus* Bouvier, C. R. Acad. Sci., vol. cxli, pp. 748, 757, 1905 (t. Bouvier).

Metapenæus goodei Alcock, Ann. Mag. N. Hist., ser. 7, vol. xvi, p. 519, 1905.

Penæopsis goodei M.-Edw. and Bouv., op. cit., p. 226, pl. iv, figs. 6-10, 1909.

PLATE XV, FIGURES 1A—1Aiv. PLATE XVI, FIGURE 3.

The carapace and pleon are densely covered with short plumose hairs. There is a dorsal gastric spine behind the rostral carina, which rises abruptly; the rostrum, which is directed a little obliquely upward, is shorter than the carapace. It has eight to ten dorsal teeth, all in front of the posterior margin of the orbit. There are two small denticles on the posterior margin of the orbit, and a much larger, angular, acute antennal spine just below it; also a small acute spine at the lower margin of the antennal sinus; hepatic spine small, acute, appressed.

The legs of the third pair reach as far forward as the tip of the rostrum, being longer than the second pair by at least the length of the chelæ; the chela is two-fifths the length of the carpus and scarcely thicker. Fifth legs are longer than the fourth.

The third to sixth segments of the pleon have a dorsal carina; on the fourth and fifth segments the carina is divided by a median incision at the posterior end into a pair of denticles; sixth segment strongly compressed. The telson is regularly tapered to an acute tip, which has an elongated spine on each side; three pairs of movable spines, the posterior much the largest, arise in front of the lateral spines and reach beyond their tips.

The length of the Bermuda type-specimen (female) was 57 mm; length of carapace and rostrum, 19.4 mm; length of rostrum, 9; of carapace, 7.5; of third peræopods, 18.2; of antennal scale 10.0 mm.

Bermuda (type, G. Brown Goodé coll.); Panama (Bradley,

Yale Mus. coll., t. S. I. Smith); off U. S. Coast, Albatross sta. 2606, 1885, in 25 fathoms (S. I. Smith); Maceio, Brazil (M. J. Rathbun); Florida (Stimpson).

This species resembles *Parapenæus velutinus* (Dana, sp.) and may, perhaps, be the species recorded under the latter name by Mr. W. Stone (coll. Heilprin).*

It differs from Dana's species (see below and figures) in having the second and third pairs of legs decidedly unequal, the third pair being much longer, instead of subequal; and in having the fourth pair much shorter than the fifth, instead of subequal; also in having the telson armed with longer spiniform lateral processes and movable spines; and in some other details.

Prof. Sidney I. Smith (op. cit.) gave a very full description of this species with detailed measurements of a specimen from Bermuda (coll. G. B. Goode), which must be considered the type (see our pl. xvi, fig. 3).

M.-Edwards and Bouvier described later a much smaller and more slender specimen under the same name, with good figures. This seems to me to be a distinct variety. (See our pl. xv, figs. 1, A-A iv, 1a.) From lat. 24° 43'N., in 37 fathoms, Blake Expedition. It differs in various details as shown by the figures.

Trachypenæus Alcock, 1901.

Parapenæus (pars) Smith, Proc. U. S. Nat. Mus., vol. viii, p. 171, 1885; Annual Report U. S. Com. of Fish and Fisheries for 1885, p. [80], 1886.

Trachypenæus Alcock, Ann. and Mag. Nat. Hist., Ser. 7, vol. xvi, p. 523, 1905.

This genus is separated from *Penæus* and *Parapenæus* mainly by lacking pleurobranchiæ on the fourth and fifth pereopods and by the presence of exopodites on all the legs. The flagella of the antennæ are shorter than in the allied genera.

Trachypenæus constrictus (Stimp.) Edw. and Bouv.

Penæus constrictus Stimpson, Ann. Lyc. Nat. Hist. N. Y., x, 135, 1871. Kingsley, Bull. Essex Inst., x, p. 69; Proc. Acad. Nat. Sci. Philad., 1878, p. 330; Am. Naturalist, xxxiii, p. 719, 1899.

Parapenæus constrictus Smith, Proc. U. S. Nat. Mus., vol. viii, p. 174, 1885; Ann. Rept. U. S. Comm. Fish and Fisheries for 1885, p. [81],

* That species is not mentioned by Mr. Sharp as now in the collection of the Philad. Acad. Sci. (See Bibliography below.)

1886 (descr. and branchial formula). Rathbun, M. J., *Brachyura and Macrura of Porto Rico*, p. 101, 1901.

Trachypeneus constrictus Edw. and Bouvier, *Mem. Mus. Camp. Zool.*, vol. xxvii, p. 232, pl. vi, figs. 1, 2, 1909. Hay and Shore, *op. cit.*, p. 378, pl. 25, fig. 9, 1918.

PLATE XIV, FIGURES 1-4. PLATE XV, FIGURES 2, 2a, 3-5.

The rostrum is straight or only slightly bent; on the upper edge are seven to nine regularly spaced teeth, the distal ones smaller; a single spine is back of the base of rostrum; carapace not pubescent, except on special areas, the hairs are short and soft; abdomen smooth and glossy; carapace carinated more than half its length; abdomen carinate on the fourth to sixth segments; hepatic and antennal spines present.

The antennular stalk is longer than the rostrum, about as long as the scaphocerite, not very stout; the penultimate article is rather elongated. The preceding joint reaches a little beyond the eye. The eye is large, a little emarginate on the upper side; stalk is short and thick.

Telson tapers to the acute tip, with a small, sharp distal spine on each side; upper side with two obtuse carinae. Length of body of adult females 60-65 mm, including rostrum. The color of a small specimen, in life, was translucent bluish white, faintly and irregularly marked with brown on the abdomen. According to Hay and Shore it is "translucent white with purplish gray cloudings and blotches; appendages pinkish."

This was taken at Bermuda by Mr. Goode in 1877, and by the Yale Expedition in 1901. The latter was young, dredged in Great Sound, in 3-5 fathoms. Its range extends from off Chesapeake Bay to Porto Rico. Off Chesapeake Bay, 18 fathoms; off Cape Hatteras, 7 to 27 fathoms; and Fort Macon, N. C. (Smith); Beaufort, N. C., 4 fathoms, and Charleston Harbor, S. C. (Stimpson); Pensacola, Fla., and Porto Rico (Rathbun); Bahamas (Rankin). Marcou Pass, Fla. (Kingsley).

Parapeneus Smith (restr.).

Parapeneus Smith, *Proc. U. S. Nat. Mus.*, for 1884, vol. viii, p. 170, 1885 (type *P. longirostris*); *op. cit.* for 1885, p. (81), 1886. M.-Edw. and Bouvier, *Mem. Mus. Comp. Zool.*, vol. xxvii, p. 228 (restr.), 1909.

Neopenæopsis Bouvier, 1905.

This genus, as restricted, differs from *Penæopsis* in the absence of exopodites on all the pereopods* and in having a lateral line on the carapace extending from the infra-orbital angle to the posterior edge of the carapace.

Parapenæus velutinus (Dana) Smith. *Velvety Oceanic Prawn.*

Penæus velutinus Dana, U. S. Expl. Exped., Crust., p. 604, 1852; Atlas, pl. xl, fig. 4, 1855. Stimpson, Proc. Acad. Nat. Sci. Philad. for 1860, p. 44 [115]. Bate, Voy. Chall., Zool., xxiv, p. 253, pl. xxxiii, fig. 1, 1887. Witmar Stone, in Heilprin, Bermuda Islands (Bermuda). Rankin, op. cit., p. 544, 1900.

Parapenæus velutinus Smith, Proc. U. S. Nat. Mus., viii, p. 117, 1885.

PLATE XVI, FIGURE 4.

Body covered with a close velvety pubescence. Rostrum stout, laterally carinate, acute, slightly curved up at tip, with about seven or eight teeth above, beginning opposite orbit; none below; one on the dorsal carina of carapace; lower margin nearly straight, fringed with hairs. Telson narrow, acute, not sulcate, terminating in a slender, sharp, median spine; a small lateral spine and a smaller intermediate one; denticulate, with three lateral spinules, and fringed on the margins distally; third to sixth abdominal segments strongly carinate; carina on the third is sulcate; on sixth it ends in a small dorsal spine. The dorsal rostral carina, which is strong anteriorly, scarcely extends beyond the middle of the carapace.

Eyes large, on short stalks. The antennular peduncle is short. The antennal scale has a stout spine, of about the same length as, or slightly longer than, the antennular peduncle; it has two small, acute, basal spines.

The first leg is stouter and more hairy than the second and third, with a larger chela; it reaches a little beyond the base of the chela of the second. The second reaches the chela of the third; fourth leg reaches the base of the dactyl of the fifth; fifth leg is equal to second and reaches the chela of the third. The above description is of adult males from Zanzibar.

It is widely distributed in the Pacific and Indian Oceans. Hawaiian Is. (Dana); China and Ousima (Stimpson); Japan; E. Indies; New Guinea; Australia (Bate); West Africa (Miers).

* Rudimentary exopodites sometimes occur on some individuals of *P. paradoxus* (Edw. and Bouv.) and on the young of other species.

Bate records this species from eight stations (Voy. Challenger) ranging from 6, 8, and 26 fathoms to 2675 fathoms. It is altogether probable that it is strictly a surface or shallow water species which, as often happens, was sometimes picked up by the deep-sea trawl when the net had nearly reached the surface. The specimen obtained by Heilprin, at Bermuda, and identified by W. Stone was, perhaps, *Penæopsis goodei*. It has not been recorded from this region by anyone else.

Subfamily **SICYONINÆ** Ortm.

This group includes only the genus *Sicyonia*.

Sicyonia H. M.-Edw., 1830. *Crested Shrimp*.

Sicyonia Dana, op. cit., p. 602, 1852. Stebbing, Hist. Crust., p. 218 (critical remarks). Edw. and Bouvier, op. cit., p. 243, 1909.

The carapace has a rather high, crest-like, and dentate carina. Rostrum carinate, toothed above, sometimes one tooth below near tip. Abdomen carinated dorsally and sculptured by furrows. Thoracic legs have no exopods. Abdominal appendages are not biramous, except the sixth. No internal antennular scale. Ocular segment with two submedian spines directed forward. Last two pairs of feet have flattened dactyls. Telson pointed.

The four recognized Florida and West Indies species of this genus are pretty closely allied, but differ in the length of the rostrum and arrangement of the rostral and carinal teeth.

They may be distinguished as follows:

Key to North Atlantic species of Sicyonia.

I.—Three carinal teeth.

A.—Rostrum long, truncate, with two or three terminal denticles.

B.—Rostrum with two teeth above, and also terminal spinules; none below; abdomen feebly sculptured.*lævigata*.

BB.—Rostrum truncate with two minute teeth above, one of which is close to the tip; one below; carina with two larger teeth. Abdomen strongly sculptured.*carinata*. E. Atlantic.

AA.—Rostrum pointed, very short and narrow, with three large teeth above, none below.*bracvirostris*=*cristata* Saus.

II.—Two carinal teeth; rostrum not truncate; abdomen strongly sculptured.

C.—Rostrum exceeding the eyes, with three teeth above and a very small one below, near the tip; carina with two teeth, widely separated.

dorsalis.

CC.—Rostrum with the tip simple not exceeding the eyes; two or three small teeth above; none below; two subequal, evenly spaced carinal teeth.

edwardsi Miers.

Sicyonia dorsalis Kingsley.

Sicyonia dorsalis Kingsley, Proc. Acad. Nat. Sci. Philad., xxx, for 1878, p. 97 (9); Bull. Essex Inst., x, p. 69. Verrill, these Trans., x, p. 580, 1900 (Bermuda). M.-Edw. and Bouvier, op. cit., pp. 244, 253, pl. viii, figs. 4-13, 1909. M. J. Rathbun, Brachyura and Macrura of Porto Rico, p. 103, 1901.

Sicyonia stimpsoni Bouvier, C. R. Acad. Sci. y. 141, p. 748, 1905.

Sicyonia carinata (?) Rankin (*non* Olivier, *nec* Bate), Ann. N. Y. Acad. Sci., xii, p. 543. The figure (pl. xvii, fig. 6) which was copied from Bate, with credit, was *edwardsii* Miers.

PLATE X, FIGURES 1—11; 2, a-c; 3; 4; 5.

The two teeth on the dorsal carina of the carapace are widely separated, the posterior one being the larger, acute, hooked, and situated at about the posterior fourth of the carapace; the other is close to the base of the rostrum, near the first rostral tooth, and similar to it in size. The rostrum is subacute, small and rather short; longer than the eyes, often slightly bifid, with three teeth on the upper edge; it usually has one minute tooth, close to the tip, on the under side, but this may be lacking. Abdominal segments are strongly carinate and sculptured.

Length of a large adult female, 90 mm; carapace with rostrum, 21.5 mm; rostrum, 5 mm; abdomen, 6.85 mm. One young specimen, taken by us in 1898, was determined by Miss Rathbun. It agrees well with the description and figures. The specimen recorded as *S. carinata* by Rankin was taken in shallow water in Harrington Sound, on white sand. His copied figure represents *S. edwardsii*. Otherwise the latter has not been recorded from Bermuda.

Dr. Rankin stated that in his Bermuda specimen there is one tooth behind the gastric region; the rostrum has four teeth close together on the dorsal edge and none below, which is not the case in *S. carinata* Bate (= *edwardsii* Miers), as Dr. Rankin observed. His two specimens had lost their thoracic appendages. According to his description it differs both from *S. dorsalis* and *S. edwardsii*,

as well as from the other Atlantic species, but he probably counted the anterior carinal tooth as a rostral tooth. It agrees more nearly with *dorsalis* than with any other. There seems to be no good reason for referring it to *S. brevirostris* Edw. For parts of the latter, see our figures (pl. xx, figs. 2-2c; 6-6k).

Off Cape Hatteras, 16 fathoms (Smith); Fort Jefferson, Fla. (type locality). Off Key West, 45 fathoms, station 2318 (Albatross); off Havana, 230 fathoms, station 2321 (Albatross); Sabanilla, U. S. Columbia, (Albatross); Bermudas (Verrill); Porto Rico, Mayaguez Harbor, 12 to 18 fathoms; Pensacola, Fla.; Gulf of Mexico, 30 to 88 fathoms (Rathbun). Many localities in the West Indies, in 36 to 120 fathoms (Blake Exped.). Other West Indian species of the genus are likely to occur at the Bermudas when looked for at suitable depths.

Family **SERGESTIDÆ** Dana, 1852. *Phosphorescent Oceanic Shrimp*.

Sergestidæ Bate, op. cit., 1888. Stebbing, Hist. Crust., p. 221. Faxon, op. cit., p. 208, 1895. Ortmann, Plankton Exped., p. 29, 1893.

This family includes many oceanic species, often noteworthy on account of their bright colors or their brilliant phosphorescence. The rostrum is usually very small and simple. The eyes are often very large and prominent, on long stalks, but they are sometimes much reduced. The legs are very slender. The chelæ are lacking on the first pair of legs, which are usually short, and sometimes also on the second pair; on the third pair they are very minute. The fifth legs are usually very small and slender, and often, also, the fourth pair; one or both may be rudimentary or absent. The legs bear long plumose hairs. Branchiæ are much reduced, sometimes lacking; never present on all the legs. The species undergo a complicated metamorphosis and have very singular larval forms which are often taken in surface nets.

Sergestes H. M.-Edw., 1830.

Several species of *Sergestes* have been taken in the North Atlantic Ocean, some of them in the region of Bermuda. Any of these are likely to occur near the Bermuda shores. The species are free-swimming forms, widely distributed, and are often taken at or near the surface, away from the land. Though often brought up by the deep-sea dredges and trawls, apparently from

great depths, they certainly do not always come from the bottom. Some species have been taken in the Gulf-weed (*Sargassum*) in the North Atlantic.

Bate, in the Voyage of the Challenger, vol. xxiv, pp. 389-418, described the following species from the central or western parts of the North Atlantic.

Sergestes atlanticus M.-Edw.* Many localities in the North Atlantic; West Indies to Greenland. S. Africa; Japan; Fiji Is.; S. of Australia.

S. edwardsii Kroyer, off Cape Verde Is. to Greenland and Pacific Ocean.

S. oculus Kroyer, Mid-Atlantic to Greenland; North and S. Pacific.

S. ovatoculatus Bate, North Atlantic.

S. parvidens Bate, Tropical Atlantic; Pacific Ocean; off Australia.

S. longirostris Bate, Mid-Atlantic.

S. longispinus Bate, Mid-Atlantic; North Atlantic.

S. penerinkii Bate, North Atlantic.

Other North Atlantic species have been recorded by various authors. Several of these species are liable to occur in Bermuda waters.

Family LEUCIFERIDÆ Dana.

Leuciferinae (subfamily) Bate, *op. cit.*, p. 443, 1888.

Body slender and much elongated. Antennal and ocular segments (cephalon or "neck") greatly prolonged so that the antennæ and eyes are inserted relatively far forward of the oral appendages and mouth. Eyes on long stalks. Third maxillipeds leg-like. The abdominal (pleon) segments are especially much elongated, forming more than half the body. Thorax short. No exopods on legs. First two pairs of legs are slender, not chelate; rudimentary chelæ on the third pair; fourth and fifth pairs lacking. No branchiæ on the thoracic segments. Pleopods of second to fifth pairs have two large ciliated branches; a small third branch, also, on second pair of male, and clasping organ on first pair.

The eggs are carried beneath the thorax of the female, without special organs for attachment. Young hatch in a nauplius form

* This is the *Sergestes arcticus* of Kroyer, 1855. See also *S. arcticus* S. I. Smith, Dec. Crust. Albatross Dredgings of 1884, pp. 6, 93, pl. xx, figs. 1, 2, 1886. C. Hatteras, northward, 235 to 2516 fathoms (?). It has, however, been repeatedly taken at the surface.

(pl. 18, fig. 6) and undergo extensive metamorphoses, passing through protozoa and zoea stages. (See Brooks, op. cit., 1882.)

Leucifer H. Milne-Edw.*

Lucifer V. Thompson, Zool. Res., p. 58, pl. vii, fig. 2, 1869 (name pre-occupied). W. K. Brooks, op. cit., vol. 173, pp. 57-157, structure and development, 1883. Bate, op. cit., pp. 442-467, pl. 79-85, structure and development, 1888.

Leucifer H. M.-Edw., Hist. Crust., ii, p. 469, 1837. Dana, op. cit., p. 662.

TEXT FIGURE 4. PLATES XVII and XVIII.

Integument thin, transparent. Cephalic region or neck (cephalon) long, cylindrical; pleon very long, about two thirds of body; its sixth segment much longer than the others, which are subequal; pleopods long; uropods large, branches unequal, usually much longer than telson. Telson small, narrow, tapered, with three spines at each angle and, in the male a ventral lobe; four spinules above.

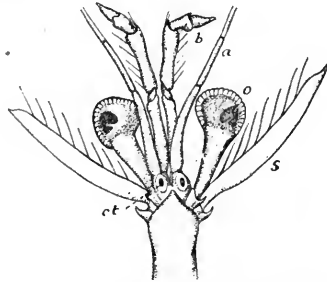


FIGURE 4. *Leucifer*. sp. ?; a, antennule; b, antenna; o, eye; ot, oötocyst; s, antennal scale. Enlarged.

Eye-stalks long; eyes large; oötocysts well developed. Antennules with a slender three-jointed peduncle and a single slender flagellum. Antennæ have a long flagellum and a narrow subacutate scale; basicerite small, bicuspid. A clasping organ (petasma) on anterior side of first pleopods of male and the second pleopod has

* The name of this genus was first written *Lucifer*. It was changed to *Leucifer* by M.-Edwards, but he gave no reason for the change. It has been said that it was because the former was preoccupied, but as he quotes Thompson as spelling it *Leucifer*, he probably intended it as a more correct form. However, as *Lucifer* was really preoccupied, the change should be adopted.

a third small sexual branch. Mandibles lack a palpus. Rostrum small, or sometimes lacking.

Sexes differ decidedly. The male has a conspicuous petasma on the first pleopods and a special organ on the second; two conspicuous ventral spines on the sixth abdominal segment; and a prominent tubercle on the under side of the telson, all of which are lacking in the female. In the latter, at least in some species, the third maxillipeds are shorter than the first legs, and there are apparently differences in the second maxillipeds and other organs. The lateral abdominal processes are more acute in some species.

In our species the male, at least, appears to have a pair of phosphorescent organs in the first five abdominal segments, and perhaps the tubercle on the under side of the telson is also a phosphorescent organ.

Leucifer faxoni Borr.

Lucifer typus (?) Faxon, Chesapeake Zool. Labr. Studies, Johns Hopkins Univ. Biol. Labr., (iii), p. 113, pl. 7, figs. 1-3, 1879 (*non* Thompson). (?) Bate, Voy. Challenger, Zool. Crustacea, vol. xxiv, p. 464, pl. 71-83, 1888 (descrip. and metamorphoses)=*L. affinis* Borrodaile.

Lucifer, sp., W. K. Brooks, op. cit., vol. 173, pp. 57-137, pl. i-ix, 1883 (anat. and metamorphoses).

Lucifer faxoni Borrodaile, Ann. and Mag. Nat. Hist., Ser. 8, vol. xvi, pp. 228, 230, 1915.

(?) *L. affinis* Borrodaile, op. cit., pp. 228, 230, 1915 (based on Bate's species).

Leucifer faxoni Hay and Shore, op. cit., p. 381, text-figure 4, pl. xxvi, fig. 10, 1918.

PLATE XVII, FIGURES 1-7. PLATE XVIII, FIGURES 1-13.

The specimens of *Leucifer* taken by my party at the surface at Bermuda have been lost. The following description is based on a large lot (several hundred) taken at one time in the Gulf Stream at the Albatross station, No. 2711, and unusually well preserved.

Owing to the extreme delicacy and tenuity of the species of this genus various organs are liable to be lost or damaged; others are often contracted or distorted by preservatives. Therefore it is advantageous to have large numbers for any careful study of their structure. The sexes differ much in several respects and are readily distinguishable, as stated in the generic description.

Probably more than one species of *Leucifer* will be found in Bermuda waters, but the following species is likely to be the most frequent, for it was taken at many places in the Gulf Stream region by the U. S. Fish Comm. steamers, Fish-hawk and Albatross.

The neck is rather slender, about twice as long as the thorax and about equal in length to the uropods and to the sixth segment of the abdomen. The thorax has a small spine on each side of its front edge. The first five abdominal segments contain a relatively large, apparently phosphorescent organ, similar to those in *Thysanopoda*, etc.

The rostrum is small, acute-triangular, acuminate with a small acute terminal cusp, often broken off. The eye is moderately large, round; its stalk is elongated, nearly half as long as the neck, obconic, tapering to a small base. The antennular peduncle is slender and long; its first article much the longest, as long as, or longer than eye-stalk and eye; flagellum is long and slender. The antennal peduncle is about half as long; it reaches about to end of eye-stalk, minus eye, and is not as long as first article of antennule. Its scale is very long and in most cases not very narrow, though often appearing so, owing to its position in mounted specimens. It is often wider than the antennal peduncle, or twice as wide as the antennule; it reaches about to the end of the second article of the antennular flagellum; its edges are nearly parallel for the proximal half; inner edge distally curves gently to the obtuse end, which carries a small spine on the outer angle. It is about twice as long as the antennal peduncle. The basocerite is small, with two acute, spiniform cusps, the lower one the longer; it is placed behind and below the bases of the eye-stalks. The antennal flagellum is very long and slender, about as long as the body when entire (usually broken); its articles are elongated.

The second maxillipeds are elongated, strongly incurved, covered on the inner side with long slender hairs; none of the articles are notably thickened in the female; in the male the penultimate article is somewhat enlarged in the middle. The third maxillipeds are similar to the first pair of legs in size and form, and in the male of about the same length; in the female they only reach the penultimate article of the first leg, which is much shorter than the others, which are very long; the propodus and dactyl are fringed on the inner edge with long hairs.

The third leg is blunt and tipped with a small claw or hook and

numerous incurved hairs; the claw is wide at base and acuminate, with a sharp incurved tip; opposed to it there are two small spinules. The pleopods are elongated; in the male those of the first pair bear a petasma, which is prominent, convex, somewhat cap-shaped, inner end with an overhanging top; outer end with a prominent tubular lobe, often nearly touching a small tubercle standing in front of it. It has internal muscles and is capable of considerable changes in form. The distal tubular part can be protruded or withdrawn more or less. (See pl. 18, figs. 6-9.)

The second pleopod of the male has a third branch, or male organ (pl. 18, figs. 5, 5*a*), which is about as thick as the other branches, and about half as long; its outline is slightly sigmoid, with a basal enlargement, distal to which there is a group of about three short curved setæ on the outer side, otherwise it is not hairy; other branches are very hairy. The sixth abdominal segment is about as long as the sum of two preceding; distally it is rapidly narrowed; in the male the lateral ventral side bears two conspicuous spines, the second about twice as long as the first, both somewhat directed backward; second not acute at tip; distance between the spines about equal to distance of the second to end of segment; dorsal median distal edge bears a small acute spinule; distal ventral edge in some, at least, bears a pair of small spinules, often blunt.

In the female the sixth segment has a constriction or slight transverse groove, in the middle, as if composed of two articles; its ventral side, further back, bears a pair of very small acute spinules, close together.

The uropods of both sexes are relatively large and long; they have two acute basal spines; the outer lamella is about one-third longer and twice wider than the inner, long-elliptical, with the end obtusely rounded or slightly emarginated near the base of the small acute spinule on the outer distal edge, which is equal to or a little longer than the tip of the lamella, sometimes projecting its entire length; the inner edges of both lamellæ have a fringe of long slender hairs; inner one is about half as wide and two-thirds as long as outer, and more acute. The telson is narrow; in the male about half as long as the inner uropods, one-third the outer branch; seen in profile it is thickened proximally, and has the proximal half of the edge turned up. In the male it bears at about the distal fourth, on the under side, a rounded tubercle (perhaps a

phosphorescent organ) in front of which there is a small round internal organ (ganglion?); on the upper side are two pairs of minute appressed spines (pl. 18, figs. 3, 4a), a pair before and one behind the ventral tubercle. The tip is narrow and bears three pairs of spines; the outer one more than twice as long as the next inner; third minute. (See pl. 18, figs. 11, 12.)

The female has no tubercle on the under side of the telson, and the telson is relatively a little longer in proportion to the uropods (fig. 13). The terminal and dorsal spines of the telson are very liable to be broken off in preserved specimens, as well as various frontal organs, such as the antennal scales, etc.

Length of the larger males, 12 to 13 mm, including rostrum and uropods; length of neck, 2 mm; of thorax, about 1.4 mm; of uropods, 2 mm. Females are usually somewhat larger than the males.

Some of our specimens give the following ratios of the length of the neck to that of the rest of the thorax:—No. 1 ♀; ratios 1.4:1; No. 2 ♂, ratios 1.36:1; No. 4 ♂, ratios 1.2:1; No. 25, ratios 1.04:1. The ratios of the neck to the total length was in No. 1, 1:6.4; No. 2, 1:6.94; No. 25, 1:6.8.

Measurements of No. 1 were as follows: length of neck, 1.2 mm; of thorax, 0.88; of abdomen, 4.5 to base of telson; sixth segment, 1.25; outer uropods, 1.3; telson, 0.60; eye and stalk, 0.36; longest legs, 1.65; third maxilliped, 0.46.

I have referred this species to *L. faxoni*, although it differs somewhat from the figures of Faxon, and the later description by Hay and Shore, as shown below. It agrees almost as nearly in most respects with Bate's figures, renamed *L. affinis* by Borradaile, the slight differences being due, perhaps, to the modes of preparation and to errors in the drawings. (See pl. XVIII, figs. 8-8d.)

According to Borradaile *L. faxoni* has the following diagnostic characters:—Neck-like portion longer than the rest of the cephalo-thorax. Eye and stalk rather more than a third and not more than half the length of the neck, the stalk rather stout. The last (third) leg reaches to the end of neck or beyond it. Sixth abdominal segment not much, if at all, longer than the uropods; exopods of uropods rounded at the end, less than five times longer than wide; its spine projects beyond the end. Ventral lateral spine of 6th abdominal segment of the male sharp, not followed by a pair of spinules.

Hay and Shore give a fuller description* of the species, as found at Beaufort, N. C., which does not agree in all respects with that of Borradaile, which was probably based on the figures of the West Atlantic specimens.

The more specific characters given by them are as follows: The neck-like portion is 1.5, the length of the rest of the cephalothorax; rostrum small; a spine on each side behind the eye-stalk, and a knob-like suborbital lobe.

Posterior part of cephalothorax with a small spine on each side in front. Eye-stalks conical, about one-third as long as the neck. Antennular peduncle long and slender. Antennal peduncle about half as long as the first antennular segment; its flagellum longer than that of antennules; its scale almost linear.

Last two pairs of legs nearly equal in length, and reaching forward almost to end of neck. Abdomen much compressed; segments deepest at insertions of pleopods and there ending in a spiniform angle. Sixth segment as long as two preceding combined, its postero-lateral angles spiniform; posterior dorsal margin with a small median spine. In the male two strong ventral spines, the posterior one about twice as long as the other and recurved. Telson slender, about half as long as the uropods, with a stout spine on each side and a prominent projection on the ventral side near the middle. Uropods about as long as the sixth segment. Color when alive almost perfectly transparent. Length 10 to 12 mm.

According to Prof. Brooks it lays its eggs at night and they are very small and entirely transparent.

Off Chesapeake Bay (Faxon); Beaufort, N. C., in the harbor and more abundant outside, at the surface (Hay and Shore). Carried eggs June 30th. Prof. Brooks took it in large numbers at Beaufort, N. C., near an inlet, during ebb tide in the evening. The females carried eggs there. It is probably to be found at or near the surface, chiefly at night. Though often brought up, apparently from great depths, in dredging, species of this genus may enter the dredge only near the surface, like many other oceanic species.

* Hay and Shore describe their species as having *four pairs* of legs. This was probably an accidental error due to counting the third maxillipeds as legs, for they state that the two anterior pairs are equal.

Part of the work on this genus by Prof. Brooks was done on Beaufort material, but most of his embryological work was done on Bahama specimens. He does not give the special locality of specimens figured. He gives, of the adults, only a few figures of parts, such as the sixth segment, uropods, telson, and reproductive organs; also a third maxilliped and mandibles. From these figures and no description of the adult it is not possible to identify his species with certainty.

The petasma as figured by him is unlike that of my specimens and unlike the figures of Bate and Faxon. If correctly drawn, it would indicate a distinct species. It is smaller, simpler, and farther back from the opposed tubercle than in any of the others figured. The telson is represented as smaller and its armature somewhat unlike that of my specimens, but he may not have taken much pains in drawing such details.

Species of *Leucifer* are widely distributed in the warmer parts of all the oceans. One species was recorded from Georges Bank, off Massachusetts, by Prof. S. I. Smith, but was not identified. It may have been *L. faxoni*.

Three stages of the larvæ, of a species from G. O. Sars' work, are reproduced on pl. 18, figs. 6-8. These may belong to "*L. typus*" of Europe. Similar larvæ were taken by us at Bermuda in 1898.

Borradaile records several other species from the Atlantic. Among them are *L. acicularis* Dana (Brazil); *L. affinis* Bor.= *L. typus* Bate (all tropical seas); *L. batei* Bor. (Atlantic and Pacific).

According to Borradaile, in the true *L. typus* the eye and stalk are much longer than the rest of the cephalothorax. The exopods of the uropods are tapered distally. Rostrum is lacking. Ventral spine of sixth abdominal segment is pointed. It inhabits the tropical Atlantic.

The differences between *L. faxoni* and *L. affinis*, as diagnosed by Borradaile, are slight and are mostly minor variations in proportions of parts. As his *L. affinis* seems to be based on the figures given by Bate, such differences may be due partly to imperfections in the drawings, or to variations due to age, sex, mode of preservation, etc. It seems to me probable that they represent only one species.

The only differences that seem to be of much importance, aside

from the longer neck of *affinis*, are in the form of the petasma and the male organ of the second pleopods. If correctly drawn in Bate's figure (his pl. 80, our pl. 18, fig. 8*b*), the petasma is larger and more complicated than in our specimens (pl. 18, figs. 6-9) or in Faxon's figures (pl. 18, fig. 7). The same organ, as figured by Brooks, is quite unlike either of the other figures. It seems somewhat variable in form in the large number of specimens examined.

The male appendage of the second pleopods in Bate's figure (pl. 18, fig. 8*d*) has a wide, oblique, terminal part, while it is narrow and subacute in our species (pl. 18, figs. 5, 5*a*). The female in our species does not have such sharp spiniform terminations to the angular lobes of the abdominal segments, at the bases of the pleopods, as shown in Bate's figure (his pl. 83). In our species they are angular, as in the male, but not dentiform nor spiniform, but Bate's figure may be erroneous in this respect.

The "neck" is relatively longer in Bate's figures (see pl. 18, fig. 8) than in Faxon's and in my specimens (pl. 18, fig. 1), while the uropods and telson are shorter. In Bate's figure, the proportion of uropods to neck is about 1:1.6; in Faxon's they are practically equal. In Bate's figure the neck is nearly equal to the combined length of the thorax and first two abdominal somites; in our specimens it is less than the thorax and first abdominal somite.

Borradaile refers to the figures given by Bate on his pl. 83 (our pl. 18, figs. 8, 8*d*) as illustrating his *L. affinis*. These figures differ from the later description by Hay and Shore as follows:—

Proportion of eye and stalk to neck is 1:3.5, not 1:3. Antennal peduncle to first article of antennular peduncle is 1:1.25, not 1:2. Second and third legs reach to about the distal third of the neck of the female, or distal fourth of the male, not almost to the end. Sixth abdominal segment is rather longer than the sum of the two preceding. The telson of the female is less than one-half the length of the uropods. The various spines, spinules, and forms of the appendages agree closely.

It seems to me that the above variations in the figures are too small and uncertain for the positive differentiation of species. In one lot, before me, containing several hundreds of specimens, greater variations in some of the proportions occur. These were from the region of the Gulf Stream, Albatross Station 2711, No. 12015. Both forms are likely to occur at the Bermudas.

CARIDEA (Dana) or PHYLLOBRANCHIATA.

Caridea Dana, Crust. U. S. Expl. Exped., 1852.

Eucyphidea Ortmann, Syst. der Decapoden-Krebse, Zool. Jahrb., 1896.

Normalia Bate, Macrura, Voy. Challenger, vol. xxiv, p. 480, 1888.

Caridea M. J. Rathbun, Brach. and Macrura of Porto Rico, p. 104, 1901.
Stebbing, Hist. Crust., p. 224, 1893.

This extensive group, which includes about fifteen families, corresponds precisely with the division named *Caridea* by Dana in 1852. Therefore there seems to be no good reason for adopting either of the later names. Six of the families are found in Bermuda.

The most important character, probably, is the nature of the gills. The branchial plumes are lamellate, composed of thin, foliaceous laminae, attached to a central stem. The legs of the third pair are never chelate; those of the first and second pairs are usually chelate, though chelæ are lacking on the first pair in the *Pandalidæ*. The ova are carried attached to the hairs of the pleopods. The branchiæ are well developed on most, or on all the legs.

Family **SYNALPHLEIDÆ** V., new name. *Snapping Shrimps*.

Alpheidea DeHaan, 1850.

Alpheinæ Dana, op. cit., p. 534, 1852. Kingsley, List Caridea, p. 57, 1878.

Alpheidæ Randall, op. cit., vol. 8, p. 141, 1839. White, Trans. Zool. Soc. London, XV, p. 118, 1847. Bate, Voy. Chall., xxiv, p. 528, 1888. Stebbing, Hist., p. 230. Ortmann, Syst. Decap., op. cit., p. 423, 1896. M. J. Rathbun, op. cit., p. 104, 1901. Coutière, Annal. des Sci. Nat., Ser. 8, Zoology, vol. ix, pp. 1-559, pl. I-V, 1899 (classification, morphology, anatomy, etc.).

Crangonidæ M. J. Rathbun. Shore and Hay, 1918. Name preoccupied. (*non* Dana, *nec* Bate.)

The eye-stalks and eyes are usually entirely or partly covered by thin lobes of the front edge of the carapace. Eyes are exposed in *Automate*. Rostrum small, acute, often triangular, not serrate, sometimes abortive. First pair of thoracic legs (chelipeds) much larger than the second, strongly chelate, the chelæ usually very unequal in both sexes, sometimes subequal; the carpus is usually short, often cup-shaped or hemispherical.

Second pair are slender with small, more simple chelæ; the carpus is elongated and divided into several segments (usually

five, never more). The telson is strong and has four small dorsal spines usually, nearly in a quadrangle, and two at each distal angle; the apex is occupied by a median and several pairs of long plumose hairs or setæ, often numerous. The uropods are usually broad, rounded distally, the edge bordered with long pinnate hairs with some longer setiform hairs intermingled; usually there is also a submarginal row of small acute setæ or spinules. The outer lamella of the uropods generally bears a distal movable spine at the sutural notch (rarely two) and usually the angle is also spiniform. In our figures of these parts the abundant plumose hairs are usually partly or entirely omitted, or only indicated. (See pl. 27, fig. 15.)

Mandibles are deeply forked, of various forms; always having a two-jointed palpus; inner antennæ (antennules) are unequally biflagellate; the outer flagellum is usually bifurcate. Scale of outer antennæ is usually well developed, but not very large, sometimes abortive; it is supported by a strong, external, marginal spine, and bordered on the inner edge with long pinnate hairs; a smaller basal spine (basicerite) is usually present on the outer angle of the second article of the peduncle; it is sometimes bilobed; sometimes nearly or quite abortive.

The two principal genera, *Alpheus* (of authors) and *Synalpheus*, are able to make a sharp snapping sound by suddenly closing the dactyl of the large chela. Most other genera lack this power. A dorsal cardiac notch or pit is always present near the posterior edge of the carapace, and it is eminently characteristic of the family.

The epipods of the first and second maxillipeds are undivided, without pleurobranchiæ. Third maxilliped always has an exopod; the median article of its endopod is always the shortest; third to fifth legs are short, compressed, fifth smallest; propodite spinulose; the dactyl is generally either simple or biunguiculate, rarely triunguiculate; the fifth pair have an oblique brush of hairs and spines on the propodus. Two retinules are present on the second pleopod of the male, except in *Synalpheus* and *Automate*.

Third abdominal segment is short, not abruptly bent down. The telson often has a pair of anal tubercles beneath, and corresponding cups which serve as a pair of adhesive suckers, to hold the telson and uropods bent in position. Five pleurobranchiæ are always present; other branchiæ various.

Development is various; most species have small eggs and a zoëa stage at first; others hatch in the *mysis* stage; some have few large eggs and hatch in a very advanced condition. Most of the species, if not all, retain the larval median ocellus through life.

The species are numerous in all tropical and semitropical seas. Most of them live in holes in rocks, dead corals, sponges, etc. or under stones; some make burrows for themselves in mud or sand; few live more or less free and exposed. Nearly all live in shallow water. Many have protective colors. All are predacious and usually pugnacious, often killing one another, in aquaria, by means of the large chela.

In moulting the large chela, carpus, and some of the other articles split in moulting to facilitate the operation.

Alpheus Fabr. or **Crangon** Weber. *Snapping Shrimps.*

Alpheus Fabricius, Supl. Ent. Syst., p. 38, 1798. H. M.-Edw., op. cit., 1837. Dana, op. cit., 1852. Coutière, op. cit., p. 336, 1899.

Dienesia Woodward, Ann. and Mag. N. Hist., 1835, p. 552.

Crangon Weber, p. 94, 1795 (pirated name). M. J. Rathbun, op. cit., 1904 p. 170.

This is a very extensive genus very diversified in structure and forms. The eyes are usually completely covered by a thin lobe of the carapace, separated from the rostrum by a sinus or groove. Rostrum plain, small, usually acute, spiniform or triquetral, and longer than the ocular lobes; sometimes nearly or quite abortive.

Chelæ of the first pair of legs are very unequal; one is very large in both sexes, usually notched, often deeply grooved, sometimes plain. It has the dactyl short, variously arched, stout, and often blunt, furnished on the inner surface, near the base, with a prominent lobe or plunger that fits into a pit or socket of the thumb when closed. This is used in producing a sharp click or explosive sound when disturbed. (See pl. 22, figs. 3, 6a; pl. 24, figs. 3-6; pl. 21, fig. 3.) It is present also in *Synalpheus* and *Amphibetaeus*.

On the posterior end of the dactyl, above the hinge; there is in most, if not all the species of this genus, a small, firm, more or less circular ring, enclosing a flexible disk. This perfectly matches a similar organ on the anterior articular surface of the palm. They seem to serve as suckers to receive and hold back the dactyl at the opening of the claw when the plunger is suddenly withdrawn

from its socket. These organs are particularly large and well developed in *A. candei* and *A. packardii*, both of which make a loud noise. (See figures of the chelæ, pl. 19, figs. 3a, 3b', pl. 24, fig. 2.)

This structure is lacking in *Synalpheus*, but present in *Amphibetaeus*. Carpus of large chela is short, hemispherical, not cup-shaped; merus is short, triquetral.

Second pair of legs slender; carpus with five unequal articles, the first rarely longest. Other legs stouter, usually compressed, generally with a simple dactyl; sometimes biunguiculate; sometimes without a hook; propodus strongly spinose; fifth pair smallest, with a brush of hairs and spines on the propodus.

Second pleopod of the male has two retinules on the inner edge of the inner lamella; the lower one has the distal part covered with minute curved hooks, dilated at the tips (*cincinules*). These also occur on the single retinules of the succeeding pleopods of both sexes and serve to hold together the pleopods of the right and left sides.

Uropods large. Telson stout; the end is wide, usually obtusely rounded, without prominent angles, and bordered by numerous long plumose hairs with spinules at the bases* (see pl. 27, fig. 1s); dorsal surface has four spines. Anal tubercles well developed. Five pleurobranchiæ; one arthrobranchia; eight epipods; sometimes an additional arthrobranchia. The larvæ usually hatch in the mysis-stage. Some of the species become 75 to 80 mm long. Colors are often conspicuous; they may be in stripes, bands, ocelli, etc.

All the species of this genus and *Synalpheus* are notable for the loud snapping noise that they make.†

This is a very remarkable habit, doubtless developed for defensive purposes. When collecting these crustaceans by turning over stones or breaking up dead corals one often hears an almost continuous fusillade, even when but few individuals are visible. Some species make a much louder noise than others, independently of their size. We find much difference in the relative size and form

* These hairs and the similar ones of the uropods and antennal scales are usually omitted in the figures.

† A similar sound is made by the species of *Gonodactylus*, of the family *Squillidæ*, often living in the same places, though the claw is entirely different in structure.

of the plunger and socket, which seem to be special organs used in making the sound. The sound has been erroneously said to be made by the sudden withdrawal of the plunger, like drawing a cork from a bottle.

This was the view held by Saville Kent and by Wood Mason. Mr. Louis Mowbray, who had charge of the Bermuda Aquarium, wrote to me that this is also in accordance with his observations. But Professor Brooks (Mem. Nat. Acad. Science, v, p. 329) stated that the noise is made by suddenly shutting the claws together, and says that he has repeatedly seen them make it in this way. Mr. G. Brown Goode, in his earlier account, implies the same method. My own attention was not particularly directed to this subject, when in Bermuda, though I often saw many species alive, both in aquaria and in the sea, but it appeared to me that the sound was made by closing the claw very suddenly, as if by a spring, something like the snapping of a gun lock.

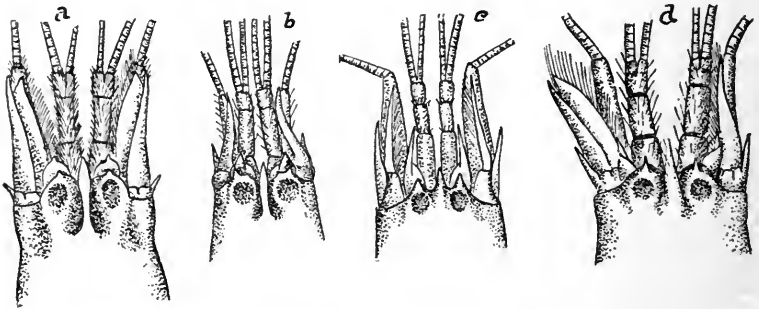


FIGURE 5. *a*, *Alpheus armillatus* Edw.—*A. lancirostris* Rankin; *b*, *A. candei* Guerin; *c*, *Synalpheus goodei* Cout.; *d*, *A. formosus* Gibbes. All from Bermuda. Enlarged. By A. H. V.

M. Coutière (1899) who had unusual opportunities to study numerous Red Sea *Alpheidæ*, demonstrated that the sound is produced by suddenly closing the claw. He has also shown that the adductor muscles of the dactyl are very strong and so arranged as to produce the effect, while the opposing muscles are slender. He believes that the sucker-like structures on the posterior end of the dactyl and opposite part of the palm, as described above, are for the purpose of holding back the dactyl until the muscles have brought some strain to bear, so that when released the dactyl

will close more violently. In fact the effect is something like the snapping of the hammer of a gun lock.

The sucker-like structures, like the large size of the plunger, are characteristic of the species that make the loudest sounds. The sucker-like organs are not found in *Synalpheus*, though the plunger and socket, are present. Most other genera of the family lack these organs and make no such sounds.

All the seven Bermuda species can be distinguished by the form and sculpture of the large chela. Other useful characters are found in the form and size of the rostrum; the presence or absence of ocular spines; the size and form of the antennal spines; the proportions of the carpal joints of the second pair of legs; the form of the telson, etc. All the species have a fringe of long plumose hairs, and some slender plain ones, on the telson and uropods, usually with small spinules at their bases. See pl. 27, fig. 1s. Some have conspicuous and characteristic colors in life.

This genus is very abundant in all tropical and subtropical seas, especially on coral reefs. About 100 species are known. Some of them are widely distributed, apparently occurring both in the Atlantic and Pacific Oceans in some instances.

They especially abound in the cavities in coral reefs and in holes in dead corals. Others are found under stones, or sometimes burrowing holes in mud or sand. Several species inhabit the exhalant orifices and internal cavities of living sponges; a few inhabit the gill cavities of mollusks. They are usually remarkably pugnacious. When confined together they often destroy each other by a single stroke of the big claw.

The species seem to vary greatly in respect to the complexity of their development and the condition in which the young hatch from the eggs. Most have small eggs and complete metamorphoses, hatching as zoëas, or in the mysis-stage; others come from the large eggs in nearly the adult form.

According to Brooks and Herrick, who have made detailed studies of several species, the same species (e.g. *A. heterochelis*) may vary in this way in different localities,* but some of the forms

* Memoirs U. S. Nat. Acad. Sci., vol. v, pp. 361-463, 1892. Other species studied by them were "*A. minus*"=*A. packardii*; *Synalpheus saulcyi* var. *brevicarpus*; and *S. longicarpus*. Their identifications of some of the species were very unreliable.

referred to that species by them are now known to be distinct species. Other species were also confused by them.

Analytical Table of Bermuda species of Alpheus.

- A.—Large chela twisted or else notched on both upper and under margins.
- B.—Dactyl of large chela moving very obliquely; palm twisted, deeply grooved; with a distal lateral spine. Antennal scale longer than peduncle of antennule; basal antennular spine extends to second segment. Orbital lobes with a small spine; rostrum small; dactyls of third to fifth feet biunguiculate. *candei*, Subgenus *Dicnesia*.
- BB.—Chela notched above and below, not twisted. Dactyl moving vertically or nearly so. Orbital lobe rounded or obtuse with no spine. Basal antennal spine minute or lacking.
- C.—Legs of third and fourth pairs are unusually stout and wide, with a distal spine on the merus and carpal joints and a sharp spine on the ischium; tip of dactyl of large chela purple or blue. *bahamensis*.
- CC.—Legs of third and fourth pairs not unusually stout; tip of dactyl of large chela white or pale yellow.
- d.—Rostrum narrow lanceolate, thin and concave above, in the middle, bordered by deep abrupt sulci. Large chela rough haired and without an inner, supermarginal, longitudinal sulcus; smaller chela of male plain, very hairy; dactyl not crested laterally. *armillatus*=*lancirostris*.
- dd.—Rostrum small, regularly tapered, spiniform, not concave above. Large chela with an inner supermarginal sulcus; smaller chela of the male swollen and wider distally, and with curved, lateral, longitudinal, hairy crest and groove on each side of dactyl. *heterochælis*.
- AA.—Larger chela without a notch or with one only on the upper margin.
- C.—Chela with a narrow notch and tooth on the upper distal margin, with a groove running back from the notch on each side. Rostrum small.
- e.—Orbital lobe with a small obtuse tooth in front; rostrum slender, carinate; basal antennal spine strong. Dactyl of large chela strong, more than one fourth the length of palm. *packardii*.
- ee.—Orbital lobe evenly convex with no tooth; rostrum small, triquetral; basal antennal spine small and slender. Dactyl of large chela small, feeble, about one fourth the length of palm, which is elongated and much tapered, about three times as long as high. Legs of second pair very long and slender. Antennæ much longer than body; third maxilliped with third article foliate on one side. *bcarii*, n. sp.
- CC.—Larger chela without a notch on either margin.
- D.—Palm of larger chela without a longitudinal groove on either side distally.
- f.—Rostrum spiniform, well developed; orbital spine small or absent; basal antennal spine small or lacking; supero-lateral area of larger

chela defined proximally by an impressed oblique line; a small black spine on the distal angle of the penultimate joint of the uropods.

formosus.

ff.—Rostrum and orbital spines more or less nearly equal; eyes concealed; basal spines of the antennæ and antennules usually well developed, often elongated. Palm of the larger chela swollen, nearly smooth. Legs without epipods; third to fifth legs biunguiculate. Genus *Synalpheus*.

D, D.—Chela with a longitudinal groove on one or both sides.

g.—Chela with a longitudinal groove on both sides; orbital lobe rounded, with no marginal tooth; a short basal antennal spine.

A. floridanus Kingsley.*

Miss M. J. Rathbun (op. cit., 1904, p. 170) has called attention to the fact that Weber, in 1795, in an obscure tract, used the name *Crangon* for this genus. She proposed to adopt it in that sense, using *Crago* Fabr., 1798, for the genus usually called *Crangon*. The name *Alpheus*, when first used by Weber, included the crabs now called *Cancer* (sens. restr.). A few writers have followed her determinations using *Crangon* for the present genus *Alpheus* but these changes do not appear to me either necessary or wise. Weber's genera were not characterized, and the names were given as examples of genera that were *about to be published* by Fabricius, and the species cited could hardly be called types. He did not claim them as his own, nor did Fabricius in his later work recognize all of them, nor refer to Weber's paper. The use of *Crangonidæ* as the name of the family is not advisable, for it is preoccupied and has long been in general use for a different family. Therefore I propose to substitute Synalpheidæ for the family name, owing to the diversity of usage as to *Alpheus*. If Weber's names are to be considered valid, *Alpheus* was preoccupied by him, and becomes a synonym of *Cancer*.

Coutière (1899) divided this genus into five large groups (op. cit., pp. 351, 352), viz.: 1, *Megacheles* group; 2, *Macrochirus*; 3, *Crinitus*; 4, *Brevirostris*; 5, *Edwardsii* group. These names were taken from that of a typical species of each group, but were not intended as of generic nor of subgeneric value.

Most of these groups have already had old generic names given to one or more of the species. Such generic names could become valid if the genus should be subdivided into several genera, as may be done hereafter.

* Not recorded from Bermuda.

Craunگون Bosc, an x, was used for a species like *A. avarus* (Hist. Crust., ii, p. 96, pl. XIII, fig. 2).

Cryptophtalmus Rafinesque, 1814, type, *C. ruber* (Precis. dec. Somiol.). *C. ruber* belongs to the *brevirostris* group.

Dienesia Woodward. (Ann. and Mag. Nat. Hist., 1835, p. 552.) Type, *D. megacheles* (= *rubra* W. not of Olivi). This belongs to the first group of Coutière, which also includes *A. candei*; *A. dentipes*; *A. clamator*. *Racilius* Bate is equivalent.

Alpheus Fabr., 1798, had for its type, *A. malabaricus*. This species belongs to Coutière's fifth group, which also includes *A. armillatus*; *A. heterochelis*; *A. bahamensis*; *A. packardii*.

Alphcooides Paulson, 1875 (Res. Crust. Mer Rouge, pp. 101-105), was proposed for species like *A. lævis*; *A. insignis*. *A. lævis* may be taken as the type. It belongs to the *macrocheirus* group.

The first group, named *Dienesia* by Woodward in 1835, might well be kept as a generic, or at least subgeneric group, on account of its twisted large cheliped and biunguiculate ambulatory legs, with some other less obvious characters.

***Alpheus* (*Dienesia*) *candei* (Guerin) or *Crangon candei*. Twisted-claw Snapping Shrimp.**

Alpheus candei Guerin, in La Sagra's Hist. Cuba, part 2, vii, Crust., p. xix, pl. ii, fig. 9, 9a, 1857. Kingsley, Carcinol. Notes, V. Bull. Essex Inst., xiv, p. 124 (20), 1883; Amer. Nat., p. 717, fig. 36, 1899. Rankin, Ann. N. Y. Acad. Sci., xii, p. 541, 1900. Coutière, Proc. U. S. Nat. Mus., vol. xxxvii, p. 486, fig. 1, 1910.

Alpheus transverso-dactylus (*pars*) Kingsley, Bull. U. S. Geol. Survey, iv, 196, 1878.

Alpheus dentipes Rathbun, M. J., Brachyura and Macrura of Porto Rico, p. 105, 1901.

TEXT FIGURE 5b. PLATE XIX, FIGURES 3a—d (chelæ). PLATE XX, FIGURE I (photo). PLATE XXI, FIGURES 6, 6a (chelæ). PLATE XXIV, FIGURES 2, 3, 4 (chelæ). PLATE XXV, FIGURES 7, 8, after Guerin. PLATE XXIX, FIGURES 1a—t (details).

Color of body, in life, is pale green with indefinite whitish patches, and finely speckled with orange-red. On the gastric region of the carapace there is a dark green patch. Telson and uropods more or less orange. Large chela whitish at base, followed by a band of orange-brown on inner surface, followed by

a broad band of whitish, which is covered with small dark green spots. On the outer side the color is often pale or nearly white; the dorsal edge and the spines at base of dactyl orange; thumb dark green or brown; dactyl orange-brown, with a white tip. Smaller chela similar in color, but the middle orange band is wider and the white bands narrower and often more or less interrupted; sometimes lacking.

Legs pale, translucent, specked with orange; the fourth pair more orange. Antennæ pale yellowish green. Eyes brown. Sometimes the chelæ are greenish with orange spots; sometimes they are reddish brown, with dark red specks and a narrow white middle band. The edges of the carapace are sometimes orange.

Specimens preserved for a short time in formol are rather bright orange; large chela is crossed, on the outer side, by three transverse patches of whitish and is specked and spotted with white.

Found by us not uncommon at Bermuda (1898, 1901) in cavities of dead corals and reef rocks, etc. Cuba (Guerin); Key West (Kingsley). Porto Rico (Rathbun). Tortugas (Coutière).

This species is very closely allied to *A. clamator* Lock.= *A. transverso-dactylus* (Kings.) of California,* with which indeed Prof. Kingsley and others have considered it identical. In the Yale Museum are two lots of specimens from California, which are the types or cotypes of Kingsley (see our pl. 24, figs. 4, 5, 6 and pl. 29, figs. 2a, 2b, 1''). Specimens from Bermuda, labelled as the same, by him are also before me.

A careful comparison of these and numerous other specimens, received later, shows some differences that seem to be constant and indicate that the two forms are distinguishable.

The larger chela of the California species is longer and relatively thicker distally; the notches and grooves of the palm are deeper and more complicated, though mostly of the same pattern, but it has a deep longitudinal subdorsal groove running back from the distal transverse furrow to about the middle of the palm. This is entirely lacking in all the numerous Bermuda specimens examined or else only faintly indicated by a slight wave-like depression. The dactyl of the California form is more obliquely articulated and

* According to S. J. Holmes (op. cit., p. 182) this species, described by Lockington, in 1877, as *A. clamator*, is identical with *A. transverso-dactylus* Kingsley, 1878. Schmitt, op. cit., 1921, p. 74, fig. 50, does not separate it from *A. dentipes*.

moves more transversely; it is also thicker, especially at the end, and its lateral surface is more curved or twisted (pl. 24, figs. 5, 6), corresponding to somewhat different forms of the lobes on the fixed finger.

The smaller chela is also stouter and more complex than in the Bermuda species, for it has more of the notches and grooves seen in the larger chela, only they are less developed; even the characteristic subdorsal groove of the palm is present, in a reduced form; its dactyl is slightly oblique; the inner surface is hairy, the outer nearly smooth. Both species have a long, acute basicerite. The frontal spines and antennal scales and spines show no very tangible differences. The telson and uropods are nearly the same in the two forms. In both species the propodus of the ambulatory legs has six pairs of spines on the under side; the dactyls are biunguiculate in both.

Alpheus bahamensis (Rankin). *Purple-clawed Snapping Shrimp*.

Alpheus hippothoë var. *bahamensis* Rankin, *Annals N. York Acad. Sciences*, vol. xi, p. 247, pl. xxx, fig. 5, 1898; op. cit., vol. xii, p. 539, 1900 (Bermuda).

PLATE XX, FIGURES 6, 6a, (photos. cotype.) PLATE XXVIII, FIGURES 1, a-1, 2, 3-3l (details). By A. H. V.

The following description and the figures are made chiefly from a cotype of this species sent to me by Dr. Rankin. It was taken at St. David's Island in 1897. Our other Bermuda specimens agree perfectly with it.

Rostrum small, not concave above, sloping anteriorly, laterally compressed, very thin, the front part triangular in a side view, projecting but little beyond the orbital lobes; between rostrum and eyes is a shallow fossa, about two-thirds as wide as the eyes, and terminating in a regularly incurved shallow emargination of the front edge, between rostrum and orbital lobes and fading out gradually posteriorly. Eyes swollen, the orbital lobe is prominent and faintly bilobed in front, without a denticle; edge strongly emarginate below the eyes.

Antennular scale small and narrow, its spine scarcely reaching the second segment; second segment hairy, about twice as long as third segment. Basal segment of antennæ not distinctly denticulated on its outer margin; its spine minute or rudimentary.

Antennal scale and its spine about equal in length; the lamellar portion is relatively narrow, regularly tapered and acute.

Spine of antennal scale reaches the end of the antennal peduncle and considerably exceeds the peduncle of the antennules; its outer margin is strongly incurved; its tip is straight and acute. The large chela resembles that of *A. heterochelis* in general form and sculpture, but there are constant differences in details.

The dactyl is quite different, being much more obtuse, thicker, less hooked below and more evenly arched dorsally, besides being purple instead of white; it is also less hairy and smoother; the plunger of the inner surface is thicker and differently shaped. (See figs.) The tip of the immovable finger is also smaller and more acute, curved up at tip.

The palm is notched similarly, above and below, but the dorsal notch is more abrupt and narrower in this species, while the ventral one is less so; the subdorsal groove of the outer surface, running back from the notch, is somewhat hour-glass shaped, but does not send a branch obliquely backward and downward as in *heterochelis*. The latter also has a strong supermarginal sulcus on the inner surface, parallel with the lower margin and running back to the proximal articulation. It is lacking in this species. Breadth of the palm is about half the total length, without the dactyl.

The smaller chela is slender, rather small and nearly simple, without a notch on either margin; the dactyl is slender, slightly curved, and flattened above, tinged with purple at the tip.

The legs of the second pair are slender and long; the carpus has the first and second segments about equal, the second rather longer; third and fourth short and about equal, the two together about equal to the first; fifth about one-fourth longer than the fourth, but rather shorter than the chela.

The third and fourth pairs of legs are usually large, stout, and compressed, especially the fourth pair, which are more than twice as thick as the second or the fifth pair; carpus, merus and ischium have a distal spine, longest on the carpus: propodus hairy and strongly spinose beneath, about six spines in the row; dactyl long, slender, curved, white, acute.

The telson is somewhat tapered with the sides nearly straight; posterior end subtruncate, with two minute spinules at each angle; a distinct sulcus runs along the median line; the four small dorsal spinules are rather larger than usual in the genus.

Our Bermuda specimens, preserved in formol, after two months, had the body, on the back and sides, and the inner surface of the large chela grayish green, thickly covered with roundish spots of yellowish white, placed so close together as to produce an areolated or reticulated appearance, becoming less evident on the lower parts of the sides. Outer surface of larger chela spotted in the same way, but the ground-color is light reddish orange, becoming redder distally; dactyl bluish or amethyst purple.

This rather rare and conspicuous species was first recorded from Bermuda by Dr. Rankin. Our specimens were taken on a serpentine atoll near Hungry Bay, March, 1901, by A. H. Verrill. In the Yale Museum there are specimens from the Bahamas and Florida which agree in every respect with those from Bermuda. Bahamas (Rankin, type locality).

The larger chela is very much like that of *armillatus* in form and sculpture, but the dactyl articulates more obliquely and is much less compressed and not so broad in a side view; the tip, as seen from above, being thick, blunt, and scarcely narrowed; in a profile view the dactyl is quite different from that of the latter, for the tip is bluntly rounded and the dorsal edge back of it is not straight, but slightly convex; the plunger is also very different, being about as broad, but not nearly so prominent, and its distal edge rises at nearly a right angle to the cutting surface, while in *armillatus* it slopes back at a very obtuse angle. The notch back of it is narrow, with nearly parallel sides, while in *armillatus* it is wider, deeper, and more V-shaped, but with the outer side concave, owing to the backward curvature of the plunger. In the present species the plunger is nearly as large as the curved part of the dactyl in front of it; in *armillatus* it is only about half as large, owing to the much greater depth of the curved tip of the latter.

The hand is less swollen and rather more oblong, the under margin being straighter proximally and not gradually sloping; the tip of the claw is much smaller, narrower, more acute, and strongly incurved on the inside; the notch on the lower margin of the palm is not so large nor so deep, and the margin beyond it is not so convex; the notch in the upper margin is very similar in the two species, but the grooves running from the two notches on the inner surface of the hand are different, though similar in arrangement; on the outer side of the palm the groove that runs back from the

dorsal notch is deeper and much more definite in this species, owing partly to the greater elevation of the ridge below it.

The shape of the outer occludent margin is also different, for in this species the large angular lobe is much nearer the tip and its distal edge slopes much more, so as to make a decided angle with the small tip; the tubercle at the articulation of the dactyl is also more prominent, with a deeper notch each side of it. In both species the hand is hairy, especially the distal part of the hand, but the hairs are more abundant in this species. As preserved, the present species has a conspicuous violet or amethyst-colored tip to the dactyl, the color occupying the part beyond the plunger and continuing back on the dorsal margin to the articulation, the rest of the dactyl being white; but in *armillatus* the tip is ivory-white, while both sides are orange-red, spotted with yellowish-white.

Alpheus armillatus Edw., or ***Crangon armillatus***. *Banded Snapping Shrimp*.

Alpheus armillatus H. Milne-Edwards, op. cit., vol. ii, p. 354, 1837. Coutière, op. cit., 1899, p. 129, fig. 117; op. cit., 1910, p. 485.

Alpheus lancirostris Rankin, Crust. Bermuda, Ann. N. Y. Acad. Sci., xii, p. 541, pl. xvii, fig. 5, 1900.

Crangon armillatus Hay and Shore, op. cit., p. 386, pl. xxvii, fig. 1, text-cut 9, 1918.

TEXT FIGURES 5a, 6b. PLATE XX, FIGURE 4b (photo). PLATE XXI, FIGURES 4, 4a (photo). PLATE XXVI, FIGURES 1—1d (details), 2 var. (?). PLATE XXIII, FIGURE 4 (photo). PLATE XXVII, FIGURES 1—1s (details). By A. H. V.

This species can be most readily distinguished from the others that are closely allied by the form of the rostrum and front, and when recently caught, by the transverse bands of white with which its body is conspicuously marked.

The rostrum, viewed from above, is narrow lanceolate in form, with an acute tip, projecting beyond the ocular lobes; back of the tip it expands slightly, and then becomes very narrow; but its posterior dorsal portion becomes triangular and wide. In a profile view the middle narrow portion is concave above, and the tip is usually slightly bent downward. On each side there is a deep and wide sulcus, ending rather abruptly posteriorly, while it produces a distinct emargination of the front margin. The eyes are convex and the orbital lobe is prominent in front, with a slight

obtuse lobe, but with no spine nor denticle. Thus the front edge is sinuous. There is also a strong emargination of the edge below the eyes.

The large Colon specimen photographed (pl. 23, fig. 4) was 35 mm long; length of chela, 20; its breadth, 9; length of palm, 12.5; of dactyl, 7.5 (No. 484). Another was 38 mm long; carapace 13; chela 20; its breadth, 9; thickness, 5; length of dactyl, 8 mm.

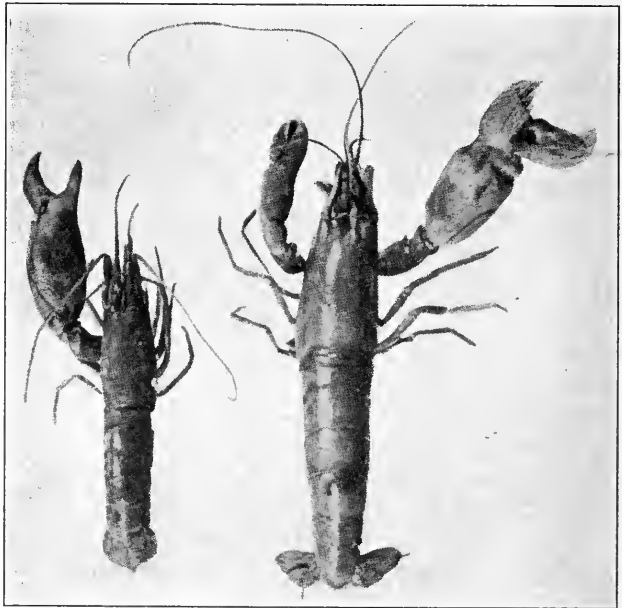


FIGURE 6. a, *Synalpheus goodei*; b, *Alpheus armillatus*. Enlarged about $1\frac{1}{2}$, from alcoholic specimens.

Coutière (op. cit., 1910, p. 485) states that his identification of this species is based on the types of H. M.-Edwards still preserved in the Paris Museum. The original description was too brief and imperfect for the identification of the species. The name alludes to the rings of color on the legs and antennæ.

Both of the larger chelæ are notably hairy. The hairs arise from pits. The largest chela is more elongated than in the preceding species; the length of the palm being about twice its breadth; total length without the dactyl is about two and a half

times the breadth; ventral notch is abrupt and large; dactyl is strongly curved, evenly convex and hairy dorsally. (See pl. 20, fig. 4b.)

The second legs are long; they reach beyond the rostrum by the parts beyond the middle of the merus. Legs of the third and fourth pairs are not large and compressed and have about seven pairs of spines on the under side of the propodus, larger and fewer than those of *heterochalis*; legs of fifth pair have a large brush of fine hairs; the dactyl is slender, incurved, and excavate on the inside. The spine on the ischium of the third and fourth legs is lacking or minute.

The telson is more narrowed distally than in *A. heterochalis*, and the apical spines are longer, especially the outer ones, which are about half as long as the inner. The uropods have two spiniform denticles and a sharp articulated spine on the outer angle of the second segment. The dorsal margin, especially of the inner lamella, has a submarginal series of minute, acute spinules, and a dense marginal row of long plumose hairs intermingled with long slender setiform hairs. See pl. 27, fig. 1s.

Body with a dark gray, or brown ground-color, darker on the abdomen, crossed by about nine conspicuous, more or less lunate or elliptical spots or semibands of translucent white, about equal in width to the intervening dark bands. Three white bands are on the carapace, the third at its posterior margin; six are on the abdomen, the first blending with the last of those on the carapace; those on the abdomen are usually whiter and more clearly defined than the others. The one on the gastric area of the carapace is usually bilobed; the one on the middle is often W-shaped; the third, narrow elliptical. On the abdomen the ground-color is often dark green or almost blackish green, and the light spots may be bordered by a line of orange. A broad band usually crosses the uropods and telson, which are, in some individuals, edged with an orange line. Chelæ with a pale ground-color, thickly specked with dark gray; two or three whitish bands cross the upper surface; the tips are pale salmon or whitish. Antennal peduncle grayish; flagella and ambulatory legs orange-yellow, annulated with white.

At Bermuda this is a common species, especially on the reefs, where it lives in holes in dead corals and limestone rocks. It was the largest species found by us. Some of our museum specimens were labelled as *heterochalis* by Professor Kingsley.

Florida (Coutière); Beaufort, N. C. (Hay and Shore); Porto Rico (Rathbun); Brazil (Coutière); Colon (Yale Mus., No. 484).

A peculiar specimen, perhaps a variety or a distinct species, comes from Colon. (No. 735-b.) See plate 48, figs. 2-2n. In this the rostrum is preceded by a low, wide, flat tooth, obtuse at the tip. It makes a distinct notch in front of it, at the base of the rostrum. In a profile view its upper margin overhangs so that there is a cavity all around it. The rostrum is slightly lanceolate and has a deep fossa on each side, much as in *armillatus*. The eye lobes are prominent with a slight elevation in front. Edge of front, between the eyes, is nearly straight, without the emarginations seen in typical *armillatus*.

The basicerite is a minute acute spine; scaphocerite is large; its spine strong, a little longer than the carpocerite and equal to or exceeding the antennular stalk. Stylocerite is small, not very acute, and does not reach the end of the first segment. It is shorter than the rostrum.

The third maxilliped (pl. 48, figs. 2, 2'') is covered with unusually long hairs distally; the exopod appeared to be divided distally into two slender annulated flagella. Legs of the second pair are long, slender; first and second articles of the carpus are long. Propodus of third legs have numerous spines beneath (fig. 2b); its dactyl is elongated and little curved; legs of fifth pair (fig. 2c) are more slender, brush of hairs on the propodus is not very long; dactyl is long and slender. Large cheliped is lacking.

***Alpheus heterochaelis* Say, or *Crangon heterochaelis*. *Big-clawed Snapping Shrimp*.**

Alpheus heterochaelis Say, Journal Acad. Nat. Sci. Philad., vol. 1, p. 243, 1818. M.-Edwards, Hist. Nat. des Crust., ii, p. 356, 1837. Gibbes, loc. cit., p. 196. Kingsley (*pars*), Synopsis N. Amer. sp. *Alpheus*, Bull. U. S. Geol. and Geog. Survey, iv, p. 194, 1878 (description); List Caridea, Bull. Essex Inst., x, p. 58, 1878; Proc. Acad. Nat. Sci. Philad., for 1880, p. 417 (*pars*); Carcinological Notes, No. v, Bull. Essex Inst., xiv, p. 120 (16), 1883. Brooks and Herrick (*pars*), Johns Hopkins Univ. Circ., vol. xi, pp. 69, 70, 1892 (life history); Mem. Nat. Acad. Sci., v, pp. 361-463; pl. ii (colored), pls. xvi-xx, 1892. (Embryology and life history.) Rathbun, M. J., Proc. Wash. Acad. Sci., ii, p. 152, 1900; Brachy. and Macr. of Porto Rico, p. 107, 1901 (*pars*). Coutière, op. cit., 1910, p. 485.

Crangon heterochaelis Hay and Shore, op. cit., p. 386, pl. 26, fig. 6, 1918.

Alpheus lutarius Saussure, op. cit., p. 45, pl. iii, figs. 24-24i, 1858.

Alpheus edwardsii (pars) Rankin,* Crustacea Bermuda Is., Ann. N. Y. Acad. Sci., xii, p. 539 (not pl. xvii, fig. 3, copied from De Mann).

PLATE XXII, FIGURES 1, 2, 4, a-c (photos). PLATE XXX, FIGURES 1-1a, 2a-2e; IT, No. 1760 (details, No. 1725). PLATE XXIV, FIGURES 7, 7a (chela) PLATE XXXIII, FIGURES 1, 2, (large chela.) By A. H. V.

The following description is based on specimens from Fort Macon, N. C., and Florida, not far from Say's original locality. They agree so well with the original description that there can be little or no doubt of their identity. Most writers have confounded two or more species, especially this and *armillatus*, under this name, and the descriptions are rarely exact enough to determine which species they had in view. Few good figures are extant.

It is one of the larger and more robust species. The large chela is remarkably large and thick, with strong marginal notches and lateral grooves, much as in the preceding species, but is wider distally and differs in the positions of the grooves and in the form of the dactyl and fixed finger (see pl. XXII). Its form is nearer that of *A. bahamensis*, but the fingers of the latter are different (pl. XX, 6a).

Although Say's description is not very precise, it is sufficient to distinguish his species from the two preceding and all our other species. He states that the chela ("hand") is tipped with white, which would exclude *A. bahamensis*, nor does he mention the enlargement of the third and fourth pairs of legs, conspicuous in the latter, though he described their spinules. His statement that the rostrum is simple, spiniform, and acute, and that the ocular lobe is "rounded at tip," excludes *armillatus*, as do the plain colors.

Say's specimens were from South Carolina and one from Amelia I., Florida. The latter was found under a mass of ascidians and was observed while living.

The smaller chela of the male has a characteristic form and structure. It is broad, elongated. The palm is about equal to the arched dactyl. The proximal dorsal area of the palm is bounded by an impressed line; the upper margin is notched distally, and from the notch a groove runs back on each side, that

* Specimens referred to *edwardsii* by Dr. Rankin, and which were sent to us by him, included the young of two species, one of which was *A. candei*, the other may be *heterochalis*.

on the inner side is deeper and joins the posterior impressed line; the distal articular margin is tridentate; the upper median tooth is small, obtuse, the lateral ones are more acute; these teeth and the tips of the fingers are often brownish black; dactyl is broad, somewhat flattened from above, arched, with an upper area bounded laterally by a thin ridge above a deep groove, on each side, which meet in an obtuse point at about the distal third, where the tip begins to bend down in a regular curve; the edge of the groove bears a dense fringe of hairs on each side. It has been described as "boat-bill shaped." The edge of the fixed finger is also fringed with similar hairs; this finger is bent upward a little near its tip; both tips are acute; on the inside, the fixed finger is excavated, while the dactyl has a median carina.

The rostrum is spiniform, small, thin, nearly straight on the dorsal edge, with no concavity, and usually slopes to the acute tip, which projects but little beyond the orbital edge. Each side of the rostrum there is a narrow and shallow sulcus, ending gradually posteriorly, not abruptly, as in *armillatus*. The ocular lobe is prominent, obtusely rounded in front, with no tooth or denticle, and there is only a faint emargination of the frontal margin each side of it.

The second segment of the antennules is about twice as long as the third; the basal scale is short and rather wide, with a minute spine that does not reach the end of the first segment. Description above is of No. 1830, from Fort Macon, N. C.

This species can easily be distinguished from *A. armillatus* by the rostrum and front, when the chelæ are lacking. In this the rostrum is smaller and simply spiniform, having no lanciform expansion distally, nor is it so broad and triangular at its base; its upper edge is not concave in a side view, as it is in *armillatus*, but is nearly straight, sloping distally. The fossæ, between the rostrum and the eyes, are narrower, and do not end abruptly, as in *armillatus*, and are therefore much less conspicuous.

The orbital lobe or hood is rounded anteriorly without the slight lobe seen in the latter. The front edge of the carapace is therefore less sinuous or indented and lacks the rather deep emargination each side of the carina.

The antennular scale or stylocerite is short, rather broad and acuminate in both, but most so in *heterochalis*; the acute terminal spine of the latter reaches the base of the second segment or beyond

it; in *armillatus* it usually barely reaches it. The second antennular segment is about equal to the third in both species, but is stouter and more hairy in *armillatus*. Seen from a nearly front view, the front edge of the carapace of the latter is 5-lobed or sinuous, due to emarginations above and below the ocular lobes and on either side of the rostrum. In *heterochelis* this edge is nearly evenly curved.

In *armillatus* the second joint of the antennæ has three small distinct denticles on the outer edge, the lowest bearing a minute spine; in *heterochelis* the denticles are scarcely distinct, except the lower, which usually is a very minute spine, scarcely worthy of the name, not visible from above.

The large chela of *armillatus* differs in its longer form and hairyness, and the grooves and furrows of the dactyl and form of the plunger; there is no supermarginal groove on the inner side of the palm, while in *heterochelis* it is conspicuous. The carina and lateral grooves of the dactyl of the smaller chela of the male are also characteristic of the latter. No. 1829 I. River.

Legs of third pair are little compressed, and have about eight or nine pairs of small spines beneath, besides the distal ones, all accompanied by many short hairs and a few long ones, especially distally; ischial spine inconspicuous or lacking. Fifth legs are smaller, nearly terate, and have a brush of many rows of short hairs ending about the middle; dactyl flatish, curved, acute.

This species is not common at Bermuda. At least, very few specimens referable to it are in the collections that I have studied from there. In the Yale Museum there are specimens from Fort Macon, N. C. (No. 1830); Beaufort, N. C.; Indian River, Fla. (No. 1760, figured); Key West; Sarasota Bay, West Fla. (No. 1725 figured); Colon; etc.

It has been recorded from North Carolina to Rio Janiero (Kingsley); Bermudas (G. Brown Goode, coll.); Mamanguape to Maceio, Brazil; Porto Rico, off Vieques Island, 16 fathoms (Rathbun). The specimens from Panama, in the Yale Museum, referred to this species by Kingsley, prove to be a distinct species. (See our plate xxxiii, figures 1, 2.)

The specimens from Beaufort, N. C., as figured by Brooks and Herrick, seem to be unquestionably of this species. Their beautiful colored figure (pl. II) is an excellent illustration of the male of this species when fully developed and highly pigmented.

The development of this Beaufort species is very fully described and illustrated (pp. 365, pl. 19, 20, etc.) by them.

Its large chela is marked with brown, green, and blue; tip of dactyl is yellow; uropods green, tipped with red and blue; body green with whitish longitudinal marks on the sides and behind the eyes; smaller legs banded with red.

The form from the Bahamas, pp. 377, 378, that they referred to the same species, though it has large eggs which hatch advanced larvæ and has also very different colors, is probably a distinct species, possibly *armillatus* or *bahamensis*. Probably the Key West species, of which Prof. Packard observed the larvæ, was also a distinct species.

Alpheus packardii (Kingsley) or ***Crangon packardii***. *Green Snapping Shrimp*.

Alpheus packardii Kingsley, Proc. Acad. Nat. Sci. Philad., xxxi, p. 417, for 1879, 1880 (Key West); Bull. Essex Inst. Salem, xiv, p. 118 (14) pl. ii, fig. 2, 1883.

Alpheus bermudensis Bate, Voyage Challenger, Rept. Zool., xxiv, p. 547, pl. xcvi, fig. 3, 1888.

Alpheus minus and *minor* Brooks and Herrick (*pars*), Mem. Nat. Acad. Sci., v, 372, pl. 1 (colored), pl. xvi, xvii (larvæ), 1891 (not of Say).

Alpheus packardii Rathbun, M. J., Brachyura and Macrura of Porto Rico, p. 107, 1901 (descr.).

Crangon packardii Hay and Shore, op. cit., p. 385, pl. 26, fig. 4, 1918.

PLATE XX, FIGURES 2, 5 (photos). PLATE XXI, FIGURE 5 (chela). PLATE XXII, FIGURE 7 (chela). PLATE XXIII, FIGURES 6c-d (photo of chelæ). PLATE XXV, FIGURES 4, a, b (general). PLATE XXXI, FIGURES 1, b-1, 2, b-u (details); 3, u, t. By A. H. V.

This is a rather large, stout species, easily recognized by its larger chela, which is elongated, with a very distinct oblique dorsal notch near the distal end of the palm and none on the under side, which is, however, somewhat constricted near the distal end; a groove runs back from the notch on each side. The dactyl is long and broad, bluntly rounded at the tip; the fixed claw is broad with a large hairy lobe on the inner edge. The smaller chela is nearly plain and very hairy. The rostrum is small, short, spiniform; ocular lobes without spines. The telson is rather long and narrow, little tapered, rounded at the tip.

In life this species is usually dull green, often clouded or mottled

with dark green or brown; a paler spot behind each eye; large chela dark green, usually banded with yellowish brown or yellow on the inner surface; smaller chela and other legs paler, often banded with dull gray or reddish. After two months in formol, the body is pale flesh-color, with a transverse orange line in front of each dorsal abdominal articulation; a patch of orange-red behind the eyes. Large chela whitish, the inner surface crossed by four obliquely transverse bands of orange red.

A specimen taken Dec. 19, 1915, in Hamilton Harbor, in 4 fathoms, among sponges, etc., had the body banded with red and pale yellowish; large chela had two pale bands, pollex blackish, finger red.

This well marked species is not uncommon at Bermuda. It lives in holes in rotten limestone and dead corals. Specimens taken at Hungry Bay, March, 1901, by A. H. Verrill, carried numerous small eggs—about 0.5 mm. in diameter.

Key West (Kingsley); Fort Macon, N. C. (Yale Mus.); Beaufort, N. C. (Herrick); St. Thomas and Bermudas (Bate); Porto Rico, 6 to 16 fathoms (Rathbun).

Brooks and Herrick, in their extensive work on the transformations of *Macrura*, have given an excellent colored figure, from life, of this species (pl. i) but they unfortunately identified it as *S. minus*.

In their figure the body is mostly grayish green, with a median and lateral stripe of whitish; the large chela is irregularly banded with green and dull yellow, tip of dactyl reddish; small chela pinkish; other legs faintly banded with pale red.

Their specimen was from Beaufort, N. C. Apparently the larvæ figured on their plates xvi and xvii are of this species. The eggs were described by them as small and the larvæ hatched in a zoëa-like form.

***Alpheus beanii* V. or *Crangon beanii*, new sp. *Bean's Snapping Shrimp*.**

TEXT FIGURE 7. PLATE XXII, FIGURE 1. PLATE XXXII, FIGURES 1, a-u.

A small species allied to *A. packardii*. Carapace smooth and polished. Rostrum short, small, narrow spiniform, tapering regularly from the base to the tip, projecting beyond the eyes, and reaching about to end of the first antennular segment, rather triquetral distally; the upper edge is slightly concave and sloped distally.

Sulcus each side of the rostrum is rather narrow and deep anteriorly, making an emargination of the edge. Eyes large and very convex, rather close to the rostrum. Orbital lobes over the eyes rounded in front.

Antennules (pl. 32, fig. 1a) with the basal segment short, stout; second segment not twice as long as third; basal spine short and broad, bilobed, with a minute spine below; upper one does not reach beyond the end of first segment; inner flagellum thick for twelve or more basal joints; distal lash slender, with about eight segments.

Basal segments of antennæ short, with a small, short, very slender spine on the second. Antennal scale (pl. 32, fig. 1, s) is about as long as the peduncle, lanceolate, its spine longer than the scale, very acute, its plumose hairs long and abundant; flagellum very long and slender, exceeding the entire body.

Large chela hairy, elongated, not much compressed, tapering distally, with a narrow notch and sharp tooth on the upper margin distally, from which a submarginal groove runs back on each side, that on the outer side larger and longer, reaching the proximal fourth; dorso-proximal area bounded by an impressed line; dactyl compressed, evenly arched, relatively short, articulated somewhat obliquely, pale orange; carpus subhemispherical, as long as broad, with two slight distal teeth at the angles (text-cut 7); merus with small triangular articular teeth. Smaller chela (pl. 32, fig. 1, l') is long, slender, very simple, with nearly straight margins without notches or spines except a small dorsal tooth at the articu-

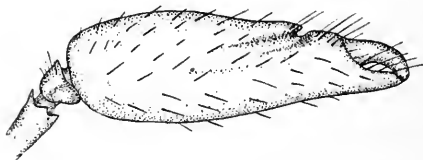


FIGURE 7. *Alpheus* (or *Crangon*) *beanii*, sp. nov. Larger chela enlarged.
By A. H. Verrill.

lation with the dactyl; very hairy both on the palm and fingers; the hairs form a row of tufts above and below, and a larger tuft at the tip of the fixed finger directed forward, and also a row in a groove close to the cutting edge, in small tufts. The dactyl is long, slender, evenly rounded, nearly straight to the distal third where

it arches regularly to the slender tip. The carpus is obconic, longer than broad, with distal tufts of long hairs. The merus is about as long as the chela, and distally is nearly as thick; it has tufts of hairs along each side and a larger tuft at the distal end.

Legs of the second pair (pl. 32, fig. 1, 1'') are unusually long and slender. The chela is a little thicker than the carpus, its palm is a little swollen and subovate, slightly constricted below the articulation of the dactyl; both fingers taper regularly and are about equally arched, and equal in length to the rest of the palm; each finger has a tuft of hairs at the tip and a smaller tuft a little farther back. The carpus is very long; the third and fourth articles are the shortest and about equal in length; the second is the longest and about equal to the sum of the fourth and fifth. The fifth is a little longer than the fourth and about as long as the chela; the merus is also very long and slender, about equal to the sum of the first and second carpal articles.

The third and fourth legs are stouter (fig. 1, 1'''); the dactyl is elongated, a little curved, acute, covered with short recurved hook-like hairs. The propodus is very spinose and hairy; it has a row of about five or six larger acute serrulate spines on the inner margin, and a row of nine or ten smaller ones on the side; the distal spine of each row is longer than the rest and stands at the base of the dactyl. The outer margin has a row of about six tufts of hairs on each side, and a distal porrect cluster of four or five larger hairs. The carpus and merus also have clusters of hairs along their margins; the carpus is about as long as the sum of the propodus and dactyl. Legs of the fifth pair are more slender.

The third maxilliped (fig. 1, 1''') is robust and very hairy; transverse rows of hairs on the distal article are very numerous and the hairs very long, with spinules between them, tip bears a group of smooth slender hairs, some very long; the exognath has a distal and lateral group of long slender plumose hairs. Third article wide, with the outer side flattened, ending distally in a flat lobe; flat part distally is as wide as the thick part.

The uropods (fig. 1, *u*) are wide and well rounded distally; the outer lamina is longer and has a slender acute movable spine at its outer angle, which is also spiniform; its outer and distal margins are fringed with long hairs alternating on the distal edge with small regular spinules. The inner lamella is fringed in the

same way, on the inner and distal margins with long hairs, but the spinules between are larger at the outer part of the edge and decrease to near the middle of the inner edge where they disappear. The basal spines are short. Some hairs on the surface of the inner lamella.

The telson (fig. 1, *t*) is rather long, width to length about 1 : 4, widest near the base, tapering evenly to the end, with slightly convex margins; distal margin, between the lateral spines, evenly rounded, and bearing about 16 long plumose hairs or setæ, with the same number of small acute spinules and a number of long smooth hairs. Postero-lateral spines unequal, slender, acute, the inner one about twice as long as the outer one. Anal tubercles conspicuous. The three specimens obtained were all females carrying eggs nearly ready to hatch.

This species is so nearly allied to *A. packardii* that it might at first be thought a dwarf deep-water form of that species. It cannot be the young, as the specimens taken all have large clusters of eggs. But there are some very characteristic differences, besides the color.

The antennæ are much longer, exceeding the body. The eyes are much larger and more prominent; the ocular hood has no frontal obtuse lobe, like that of *packardii*, but is evenly rounded; the large chela is more tapered, the marginal notch is narrower; the groove on the outer surface runs farther back and there is no distal constriction of the lower margin; the dactyl is relatively smaller and shorter and articulates more obliquely. The smaller chela also differs in form and armature of hairs. The second legs are longer. The dactyls of third legs are different, etc. The rostrum and antennal scales are similar in the two species. Taken on the Challenger Bank, in 24 fathoms, on a nullipore bottom, by the Field Natural History Museum party, in Oct., 1905 (No. 901).

It is named in honor of the director of the party, the late Dr. Tarlton H. Bean, the eminent ichthyologist.

***Alpheus formosus* Gibbes or *Crangon formosus*. *Striped Snapping Shrimp*.**

Alpheus formosus Gibbes, Proc. Amer. Asso. Adv. Sci., iii, p. 196 (32), 1851.

Alpheus poeyi Guerin, in La Sagra's Hist. Cuba, second part, Zool., vol. vii, Crust., p. xix, vol. viii, pl. ii, fig. 10, 10a, 1857.

Alpheus formosus Rathbun, M. J., Proc. Wash. Acad. Science, vol. ii, p. 152, 1900; *Brachyura* and *Macrura* of Porto Rico, p. 106, 1901.

Alpheus websteri Kingsley, op. cit., 1879, p. 416; *Carcin. Notes*, No. v, op. cit., p. 111 (7), pl. ii, fig. 5, 1883. Rankin, op. cit., vol. xi, p. 249, vol. xii, p. 543, 1900 (Bermuda).

Crangon formosus Hay and Shore, op. cit., p. 384, pl. 26, fig. 5, 1918.

TEXT FIGURES 5d, 6a. PLATE XIX, FIGURES 1, 2. PLATE XX, FIGURE 3. PLATE XXIII, FIGURES 5, a, b. PLATE XXIX, FIGURES 4, a-u. PLATE XXV, FIGURES 6-6a (type of *A. poeyi*).

In life the color is conspicuous and characteristic. The body is yellowish or greenish brown, with a conspicuous dorsal stripe of pale yellowish or white, extending to the telson, and a more or less interrupted stripe of the same color on each side; margins of abdomen bright blue. The ground-color, between the stripes, is finely speckled with orange. Uropods white at base, tipped with orange or yellow. Large chela, on the inner side, yellowish brown, or nearly like the carapace; tip and dactyl bright orange, with a whitish spot at the base of the thumb. Ambulatory legs and flagella of the antennules and antennæ, bright blue.

The large chela (pl. 19, fig. 2; pl. 23, fig. 5a) is notable for the absence of notches and longitudinal grooves, present in all other Bermuda species of true *Alpheus* (or *Crangon*), being in this respect like the chela in *Synalpheus*. It is long-ovate, swollen proximally, fixed finger is short, acute, incurved at the tip, shorter than the dactylus, which is stout, arched gradually, blunt at end. The smaller chela (pl. 23, fig. 5b) is long and slender, smooth, simple. The merus is triquetral, with an acute tooth on the distal superior and outer angles; carpus short, convex above, with a distal tooth; palm of chela about equal in length to the dactyl; its distal articular margin has a spiniform tooth at each angle, the outer one longer and sharper; the superior proximal area is bounded by an impressed faint line, extending back on the dorsal and inner surfaces, and enclosing an ovate area. Fixed finger nearly straight, slender, a little turned up close to the tip; dactyl nearly straight to about the middle, then gently arched to the tip.

Fingers are nearly equal in size; shutting closely, compressed laterally, both hooked at the acute tips, which overlap when closed; both sides slightly hairy; the hairs of the dactyl arise from a nearly straight groove below a sharp ridge on both sides. The

inner surfaces of the fingers have a slender groove and carina. The median carina of the fixed finger becomes more prominent, with a raised sharp edge, on the distal third.

The rostrum is a stout, tapering, flattened, triquetral spine. The ocular lobe has a small slender spine. The basal antennal spine is rudimentary or small.

On the outer distal margin of the outer branch of the uropods there is a small black spine, which usually retains its color a long time in preserved specimens. It is less conspicuous than the similar spine of *A. nigrospinatus* Ran., of the Bahamas. Several other species have the same spine black or dark.

We found this large species common at Bermuda, especially in holes and crevices in rotten limestone and dead corals on the reefs. It was also contained in the early collections of J. M. Jones and Dr. G. Brown Goode. Key West (Gibbes); Cuba (Guerin); Natal to Maceio and Pernambuco, Brazil; and Porto Rico, 4 to 6 fathoms (Rathbun).

Gibbes (op. cit.) gave only a brief description of this species, but as he mentioned particularly the strong rostrum, stout at base, the orbital spine, and the simple large chela without grooves or notches, there can be no doubt about the identification of his species.

The *Alpheus websteri* Kingsley was described in nearly the same terms, but Prof. Kingsley mentioned, in addition, the oblique impressed line that bounds the supero-proximal area of the large chela and the black uropodal spine. The oblique impressed line, which is present in all other species, is not always distinct in alcoholic specimens, unless allowed to partially dry, and the black spine often fades out in alcohol. It is smaller and much less conspicuous than in *A. nigro-spinatus* Rankin, of the West Indies. Prof. Kingsley had erroneously placed *A. formosus* as a synonym of *A. minus*, and was, therefore, naturally led to describe the real *formosus* as a new species. They are perfectly identical.

Alpheus poeyi Guerin seems to be allied to or identical with this. Some of his figures are reproduced on our plate XXV, figs. 6-6a. The chela, as figured, is longer and differently shaped.

Synalpheus Bate. *Smaller Snapping Shrimps.*

Synalpheus Bate, Voyage of Challenger, Rep. Zool., vol. xxiv, p. 572, 1888.*
Coutière, Ann. Sci. Nat., ser. 8, Zool., vol. ix, pp. 154, 334.

1899; Proc. U. S. Nat. Mus., vol. xxxvi, pp. 1-93, 1909. M. J. Rathbun, *Macrura* Porto Rico, p. 109, 1901. Stebbing, *South African Crustacea*, part viii, *Annals S. African Mus.*, vol. 15, p. 85, 1915. DeMan, *Siboga Exped.*, vol. 39a, p. 185, 1911.

This genus was separated from *Alpheus* on account of important structural differences. The most important character is the absence of epipodites on the thoracic legs, which are present in *Alpheus*. The large chela is always simple, without notches or grooves, and is usually more swollen or more nearly ellipsoidal than in the latter, and the dactyl is usually more simple and relatively smaller; it has the plunger-like lobe within, but lacks the disk at the articulation.

The front is usually tridentate; the three teeth may be subequal or unequal; the rostrum is usually small and simple, triangular, but often styliform; sometimes almost or quite lacking. The eyes are covered by a lobe or hood, usually bearing a triangular or pointed tooth, rarely rounded. The basal segment of the antennules is the longest; the basal spine is usually elongated; the external flagellum usually has a short secondary branch. Basicerite is spiniform, acute; often with a smaller spine at its base.

The legs of the second pair have the carpus 5-jointed (rarely 4-jointed in young); the second, third, and fourth segments are short and often about equal, sometimes moniliform. The dactyls of the ambulatory legs are usually biunguiculate, sometimes triunguiculate. The males lack the two extra retinules on the second pleopods, present in *Alpheus*.

The species have habits more or less similar to those of *Alpheus*. Many are found in holes in rotten limestone and dead corals, others under stones, oysters, etc., but many species are only found living as commensals in the oscular cavities of various large sponges, where they are often gregarious, forming large colonies.

Specimens of *S. harfordi* (Kingsley), now in the Yale Museum, were labelled as taken by Mr. Harford from under the mantle of the abalone shell (*Haliotis rufescens*) at Catalina Island, California.

Some species live clinging in the interstices of branched corals. Several oriental species cling to crinoids (comatulids) in deep water, and have their claws so modified as to adapt them to this

*The holotype of this genus was *S. falcatus*=*S. comatularum* Haswell, according to Coutière. See below.

habit. The structure and form of the dactyl hooks are important because directly related to their habits.

Their colors are various according to their habits. The sexes are often very different in color, but both may be variable. Some, if not all, are able to change their colors by means of the chromatophores.

All are capable of making an explosive sound with the large chela, like the species of *Alpheus*, when disturbed, but they lack the sucker-like disks on the dactyl and anterior end of the palm.

Some of the species are remarkable for the large size of their eggs, which are sometimes considerably over 1 mm. in diameter and much fewer than in ordinary species of *Alpheus*. The young of such species, accordingly, are hatched in an advanced stage of development (mysis-stage). Others have numerous small eggs and hatch in a zoëa-stage.

Brooks and Herrick (op. cit., 1892) claimed that the same species inhabiting different localities may produce larvæ differing very widely in form and structure, as well as widely different sizes of eggs. But the form studied by them, that produced small eggs from which hatched zoëa-like larvæ, proved to be a true *Alpheus* (*A. packardii*). See above under *A. packardii*.

Yet they demonstrated that closely allied species of this group have larvæ that differ widely in the state of development when hatched, as well as eggs differing greatly in relative sizes.

According to Coutière (op. cit., pp. 2, 3, 1909) the *Alpheus saulcyi* var. *brevicarpus* of Brooks and Herrick is a distinct species, while under *A. saulcyi* var. *longicarpus* at least two other species, viz.: *S. longicarpus* and *S. pectiniger* C. were included, as determined by the types. The last two and the former belong to different sections of the genus.

Typical *S. longicarpus* has small eggs and zoëa-like larvæ, while *S. pectiniger* and *S. brevicarpus* have very large eggs and mysis-like larvæ.

The species to which Coutière restricts the name, *S. minus*, has small eggs, their diameter being less than 1 mm., which give rise to zoëa-like larvæ, as do many other species. It is very unlike the *A. minus* of Brooks and Herrick.

M. Coutière, op. cit., 1909, described twenty-five American species of this genus, besides about twenty-one named varieties and subspecies, and more recently he has added another species.

He divided the genus into six groups of species. Of these two, viz., the *Comatularum*-group and the *Biunguiculatus*-group have not been found at the Bermudas, nor in the West Indies; according to him they are entirely oriental.

De Man, op. cit., 1911, recognized 62 species of the genus and 15 named varieties from the Indo-Pacific seas. At least seven species occur at the Bermudas.

In many cases the described differences are slight and may be due partly to individual or local variations, or to hybridism. The Rev. Thomas R. R. Stebbing, in a somewhat jocular way, says that "in the discrimination of these species minute measurement plays an almost alarming part, because, as the eyes are completely covered by the carapace, the vision of these creatures must be dim, and without compasses the members of different species will never know one another apart. Perhaps, indeed, the numerous varieties may be the result of inconsiderate intermarriages."

It is at any rate a group in which variations and perhaps "mutations" are abundant and in which natural selection has served to adapt the various species to varied and often unusual conditions of existence. Most of them seem to be admirably protected by their habits, colors, etc., so that they are often very numerous in individuals, as well as in species and varieties.

Analytical Table of the Bermuda species and of some additional related North American and West Indian species of Synalpheus.

- A.—Rostrum slender, spiniform, with no vertical prolongation. Ocular spines longer than wide. Hooks of dactyl of third to fifth feet dissimilar, unequal in width and form, lower one the wider and stronger, strongly divergent at a wide angle to axis of dactyl; usually a small spur or prominence proximal to lower hook. Merus often spinose.
Ncomeris-group.
- b.—Ventral spur of dactyl of third to fifth feet prominent, spur-like; inner hook abruptly divergent, bicurved. *S. hemphilli*.
- c.—Antennal spine equal to carpocerite. var. *hemphilli*.
- cc.—Antennal spine longer than carpocerite. var. *longicornis*.
- bb.—Ventral spur of dactyls low, obtuse or obscure; legs slender; merus of third pair of legs four times as long as wide; antennal scale or scaphocerite equal to or exceeding the stalk. *S. fritzmulleri*.
- AA.—Hooks of dactyls of third to fifth feet nearly or quite equal in width at base; merus generally without spines.
- B.—Dactyls long and slender; the hooks directed in same line with the dactyl, little curved, the upper one the longer. Scale of scaphocerite

always present. Lower lateral spine of basicerite (basal antennal spine) slender. Stylocerite, or antennular spine, longer than first segment of antennular stalk. Telson not abruptly narrowed distally; outer lobe of uropods not serrate on margin distally. Smaller chela of first pair of legs without a dense dorsal brush of porrect hairs; its carpus short.

- C.*—Frontal spines more or less spiniform, usually longer than wide; rostrum more slender than orbital spines and usually distinctly longer, furnished with a descending vertical process that embraces the ocellary beak. *Paulsoni-group.*
- d.*—Carpocerite long, at least about $3\frac{1}{2}$ times as long as wide and exceeding the spine of the scaphocerite; first segment of the carpus of the second pair of legs longer than the remaining four combined.
- e.*—Basicerite without an upper lateral spine; telson with acute posterior angles, its inner terminal spines about three times longer than the outer ones. Rostrum is rather longer than orbital spines, slender, acute, styliform, and equals first antennular segment. *S. townsendi.*
- ee.*—Basicerite with an upper lateral spine. Orbital spines and rostrum not long; rostrum not longer than orbital spines, acuminate at tip. Inner spine of distal telson angles not more than twice as long as the outer one. *S. bradleyi.**
- dd.*—Carpocerite shorter, about one-third as wide as long; basicerite with an upper secondary spine. Spine of scaphocerite equal to the carpocerite. Large chela stout, with a sharp distal dorsal spine directed somewhat downward. *S. apioceros.**
- CC.*—Front with three subequal triangular or subacute denticles; the rostrum similar in size and form to the ocular processes, but it may be a little narrower, or slightly longer or shorter, not styliform. It lacks the inferior vertical prolongation. Telson not rapidly tapered; distal end broad, convex, with numerous plumose hairs.
Brevicarpus-group.
- f.*—Rostrum triangular, similar in form and size to the ocular teeth. Carpocerite cylindrical, slender, at least 4 times as long as wide; antennal scale 5.5 to 6.4 times as long as wide; basicerite nearly unarmed above; carpus of legs of second pair 10 to 15 times longer than wide.
- g.*—Spine of scaphocerite scarcely exceeding the length of the scale. The three frontal processes are short, scarcely spiniform, about as long as width of base, about equilateral, often triangular. Eggs are large and produce *Mysis-like* larvæ. *S. brevicarpus.*
- gg.*—Lateral spine of scaphocerite is long and slender; frontal teeth as long as wide; rostrum has concave margins. Eggs are small; larvæ hatch as *Zoëa-like forms* *S. guerini.**
- ff.*—Carpocerite is shorter and swollen, 3.5 to 3.7 times longer than wide; antennal scale longer, from 7 to 8.5 times longer than wide; carpus

of legs of second pair less than 10 times longer than wide. The eggs are small and hatch *Zoëa-like* larvæ.

h.—Rostrum equals or slightly exceeds the ocular teeth in length. *S. minus*.

hh.—Rostrum is somewhat shorter and narrower than the ocular teeth.
S. digueti.*

BB.—Dactyls of the third to fifth pairs of legs small and short; their hooks very small, subequal in length, strongly curved in line with the margins of dactyl, not divergent. Scale of the scaphocerite usually much reduced, often rudimentary or lacking in one or both sexes; lateral spine of basicerite longer than the first antennular segment; stylocerite short, not exceeding basal antennular segment. Smaller chela has fingers toothed at apex and a dense brush of long porrect hairs on the dorsal side of the dactyl; its carpus is longer than wide. Telson usually rapidly narrowed to a narrow tip; terminal plumose hairs few, about 4 to 6. Outer lobe of uropods is often serrate distally. Several species have large eggs and *Mysis-like* larvæ. The species are numerous in the West Indies. *lavimanus*-group.

i.—Carpus of smaller cheliped is more than one-half the length of the chela in the adult (usually 0.54 to 0.8). Lateral spine of basicerite is smaller than that of the scaphocerite.

j.—Movable finger (dactyl) and pollex of smaller chela each with three strong flat teeth crossed in a vertical plane; no antennal scale; spine of the scaphocerite shorter than the antennular stalk. Dactyl of the large chela placed obliquely. Eggs are large. *S. pectiniger*.*

jj.—Fingers of the smaller chela each provided with only two teeth. Spine of the scaphocerite equal in length to the antennular stalk. Scale of scaphocerite small, present at least in the male. *S. longicarpus*.

ii.—Carpus of smaller cheliped is less than half as long as the chela (about 0.43 to 0.40). Merus of third pair of legs is not excavate; its carpus is shorter than the propodus. The brush of hairs on the dactyl of the smaller chela is large, containing 15 to 20 rows. Carpocerite is 5.2 to 6 times longer than wide. Antennal scale is present in both sexes. *S. goodei*

Those species marked with an asterisk (*) are extralimital, from the West Indies or Panama.

Special characters to aid in the identification of the known Bermuda species of Synalpheus.

1.—Rostrum notably longer than the ocular spines and spiniform or narrow in a dorsal view.

S. townsendii; *hemphilli*; *fritzmulleri elongatus*.

2.—Rostrum notably narrower than ocular spines in a dorsal view, but not much longer.

S. fritzmulleri; *goodei*; *longicarpus*.

- 3.—Rostrum and ocular spines triangular or dentiform and equal or subequal in size.
S. minus; *brevicarpus*.
- 4.—Telson much narrowed distally; the end very narrow, carrying only four to six plumose hairs between the lateral spines.
S. goodei; *longicarpus*.
- 5.—Uropods with the outer lamella serrated along the distal outer margin.
S. goodei; *longicarpus*.
- 6.—Smaller chela with a large tuft or crest of porrect hairs on the outer surface of the dactyl.
S. goodei; *longicarpus*; *pectiniger*.*
- 7.—Smaller chela with the tips of one or both fingers bidentate or tridentate.
S. longicarpus; *goodei*; *pectiniger*.*
- 8.—Ambulatory legs with stout tapered dactyls, ending in two unequal, divergent hooks, the inner one more incurved, and with a blunt spur or obtuse elevation proximal to inner hook.
S. hemphilli; *fritzmulleri*.
- 9.—Ambulatory legs have rather long gently curved dactyls and two nearly parallel unequal hooks curved with the outline of the dactyl; not divergent; no spur.
S. minus; *brevicarpus*; *townsendi*.
- 10.—Ambulatory legs with the dactyl short, incurved, and the two hooks not very unequal, small, incurved.
S. goodei; *longicarpus*.
- 11.—Antennal scale notably wide; usually wider than spine.
S. townsendi; *minus*; *brevicarpus*.
- 12.—Antennal scale narrow.
S. fritzmulleri; *hemphilli*; *goodei*; *longicarpus*.
- 13.—Antennal scale rudimentary or lacking.
S. longicarpus.
- 14.—Basicerite spine unusually short, but with an acute, secondary spine above its base.
S. hemphilli; *fritzmulleri carolinensis*.
- 15.—Basicerite spine without a secondary spine, or with only a short or rudimentary one.
S. brevicarpus; *longicarpus*; *townsendii*.
- 16.—Basicerite spine elongated, with a small acute secondary spine.
S. minus; *goodei*; *fritzmulleri*.

The above table is intended to be of use especially with specimens that have lost their large chelæ and more or less of the other appendages; additional species will doubtless be found at the

Bermudas, and if so they can easily be interpolated here. Comparative measurements have here been intentionally omitted for greater simplicity.

The appendages illustrated on the accompanying plates have been drawn with a camera-lucida; in such drawings there is pretty sure to be some distortion in the case of elongated objects, such as the legs, though corrected as well as possible. Moreover, the more convex parts are necessarily mounted under some pressure, so that hollow organs are flattened and may appear somewhat wider than they should. Thus minute measurements of the drawings will not always be found to agree with those made from fresh, unmounted objects. This applies to similar illustrations of other writers as well as to these. Thus minute measurements of proportions are often not easy to apply, nor to verify; especially such as breadth to length of the articles of legs, antennæ, etc. Ratios of length to length are more likely to be unaltered by pressure, but the hollow appendages often shrink in length in the process of mounting, especially the chitinous exterior, so that the muscles, etc. within become folded or distorted.

This genus, founded by Bate (op. cit., 1888, p. 574, pl. 103), had as its type and only species, *S. falcatus* Bate, which Coutière identified with *S. comatularum* of Haswell. It belongs to a special division of the genus, as now understood, viz. the *Comatularum* group of Coutière, of which no species are known in American waters. Some of the species live as commensals or parasites on crinoids.

Bate's type was a stout female with a long acute rostrum, twice as long as the sharp and elongated ocular spines. The rostrum reaches more than to the end of the second antennular article. The antennular stalk is shorter than the antennal stalk, which is elongated; its scale is well developed; basicerite has two subequal acute spines; stylocerite elongated. Mandibles have the cutting lobe reduced to a curved spine; second article of the palpus enlarged, ovate. Third maxilliped slender, the tip with few spines. Large chela with a strongly arched acute dactyl; smaller chela long with an incurved or crooked simple dactyl. Legs of second pair are described and figured as 7-jointed; articles 3-7 subequal; first elongated. Legs 3-5 slender, terete; secondary hook of dactyl obsolete; telson ovate, wide at tip, with an obtuse median lobe.

Synalpheus hemphilli Coutière. *Small Snapping Shrimp.*

Synalpheus hemphilli and var. *longicornis* Coutière, op. cit., p. 38, figs. b, 20, 21, 1909.

? *Synalpheus neptunus* M. J. Rathbun, Brach. and Macr. Brazil, p. 110, 1901 (not Dana's sp.).

PLATE XXXIII; FIGURES 3, 3a, large chela (slide ddd). PLATE XXXIX, FIGURES 2a, 2b. PLATE XL, FIGURES 1-1c, details. All var. *longicornis*.
By A. H. V.

The rostrum is very slender, styliiform, and about twice as long as the orbital spines, which are triangular, with wide bases (pl. 39, fig. 2; pl. 40, fig. 1). The ambulatory legs are quasi-triunguiculate, with the lower terminal claw stouter and much more bent than the upper one, diverging at nearly a right angle, its inner edge a sigmoid curve; proximal to the latter there is a small acute spur, so that the claws seem to be somewhat triunguiculate.

In the Bermuda variety (*longicornis* Coutière) (pl. 39, figs. 2a, 2b, after Coutière; pl. 40, figs. 1-1c) the antennal scale is longer, narrow, and reaches to the end of the antennular peduncle or exceeds it. The lateral basal spine is equal in length to the antennular spine and reaches the proximal third of the second joint. The superior basal spine is smaller, but acute. The meropodite of the third pair of legs bears a slender distal movable spine on under side, and a spiniform angle above.

Coutière records this species from West Florida, 21-28 fathoms, and as var. *longicornis*, from Bermuda (coll. Goode). It was also taken by my party in 1901. I have specimens from Fort Macon, N. C.

It is apparently the species recorded from Bermuda, by Miss Rathbun, under the name of *S. neptunus* (Dana). The latter is evidently distinct.* Miss Rathbun gives but few descriptive details, but she mentions the triunguiculate claw, which is not a character of any other Bermuda species known to me.

The following description is from a Bermuda specimen of the variety *longicornis*: The body is about 22 mm long; thorax, 9 mm; breadth, 5 mm. The eyes are separated by a space equal

* See the new description by M. Coutière, op. cit., p. 88, 1909, of *S. neptunus* from the Indo-Pacific. See also our plate XXV, figures 2a-e, copied from Dana. It belongs to the Biunguiculatus-group, which is not found in American waters.

to the diameter of the eye. Rostrum is acute, decidedly longer (nearly twice) and more slender than the orbital spines, about reaching the middle of the first antennular segment; ocular spines with very acute acuminate tips, their bases enlarged, conical. The antennular spine is stout and reaches to the proximal third of the second segment. The lateral basal antennal spine or basicerite is nearly equal to the antennular spine; the upper smaller one is small, acute, about even with the rostrum; the spine of the antennal scale reaches about to, or a little beyond, the antennal peduncle, which is a little longer than the antennular peduncle; the scale is rather wide and somewhat shorter than the acute spine.

Large chela (pl. 33, figs. 6, 6*a*) is elongated, not much swollen, broadest near the middle of the palm, slightly oblique, with distinct dorsal and lateral distal articular denticles. The dorsal one is most distinct; two shorter and blunter ones are on the inner edge; two and a larger lobe are on the outer edge. Palm with some slight, oblique rugæ on the side proximally. Dactyl compressed, the tip strongly curved and acute, amber-color. Middle of cutting edge a little convex; plunger cylindric, strongly bent backward; fixed finger a little shorter, a little divergent, incurved at the acute tip; socket for plunger with raised margins.

The legs of the second pair (figs. 1*c*, 1*c'*) are very slender; merus is 5 times longer than wide, longer than first four articles of the carpus; first carpal article is equal to sum of third, fourth and fifth; chela is equal to the fourth and fifth combined; fingers are longer than the palm, which is about twice as long as wide, with the borders only slightly convex; fingers are slender, acute, the fixed one slightly denticulated near tip; it bears five or six separate tufts of long hairs; one long tuft is near the middle of the cutting edge. The dactyl bears four or five similar tufts of shorter hairs, the largest tuft close to the tip.

The third and fourth legs (pl. 40, figs. 1*d*, 1*d'*) have the merus enlarged in the middle; length 3.5 times the width; dactyl biunguiculate, with a distinct spur higher up; propodus with 8 spines, including the distal one.

The third maxilliped (figs. 1*a*, 1*b*) has a stout third article and a smaller, tapered, distal one, about as long; the latter has five slender spines at the tip and about 12 transverse rows of hairs. Telson oblong, slightly convex in the middle of the margins, somewhat tapered distally, obtuse, not evidently bicarinate; four dorsal

and four terminal spines slender. External branch of uropods with two minute spines at the distal notch, and a movable one between them.

Some of the larger specimens taken in Castle Harbor, in dead corals, April 15th, 1901, carried clusters of olive-green or brown eggs. After two months preservation in formol and alcohol the color of the specimens described above was nearly uniform bright light red, but with darker red specks, larger on the chelæ.

Another Bermuda specimen (No. 3108) has, on the propodus of the third pair of legs, a row of ten sharp spines, each accompanied by a longer hair, in addition to the two distal spines; a similar spine is on the distal end of the carpus, while the outer angle of the carpus is prominent dentiform. The dactyl spur is prominent and conical. The outer sides of the propodus and carpus also have unequal smooth hairs.

The following description is from the Bermuda specimens of 1901 (aa), which seem to be nearer the typical form. The body of the female, carrying eggs, is rather stout, about 22 mm long. Front sharply trispinose; rostrum longer than the ocular spines, thin, compressed, very acute; the tip reaches about to the distal third of the basal antennular segment; seen in profile it is wider at the base beneath. Ocular spines nearly as long as the rostrum, acuminate, very sharp at the tip, swollen over the eyes and conical at the base. Basal spine of the antennule is slender, acute; it reaches about to the middle of the second segment; the basicerite has two acute, unequal, lateral spines; the lower and longer is about equal to the antennular spine; the antennal scale is long, rather narrow; its spine is a little longer than the scale, very acute at the tip, which reaches to or a little beyond the end of the antennal peduncle, and slightly beyond the antennular peduncle. Large chela smooth, entire, with no prominent spinule at the dorsal distal articulation; palm somewhat oblique; inner lateral articular margin of the fixed finger very oblique with two denticles and a large obtuse lobe on the inner side, and a small dorsal tubercle. Dactyl more than half the length of the palm, evenly curved, acute at the tip; inner edge plain, with no denticles; plunger of moderate size, directed strongly backward, slightly bilobed on one side.

Legs of the third pair have strong tapered dactyls, with the hooks divergent, lower one wider, shorter, and strongly incurved; the spur proximal to it is prominent and acute. Telson is

elongated, rather narrow, about twice as long as wide, tip obtuse, not very wide. Bermuda, 1901 (notes aa).

Synalpheus fritzmulleri Coutière.

Synalpheus fritzmulleri Coutière, op. cit., 1909, p. 35, fig. 18, and subspecies *elongatus*, p. 37, fig. 19.

PLATE XXII, FIGURE 6. PLATE XXXIX, FIGURES 1-1d (var. *carolinensis*) (No. 1831). FIGURES 3a-3c, var. *caribaea*, from Dominica Island. TEXT CUT No. 8, var. *caribaea*.

The rostrum is slender, compressed, acute, as seen from above, a little longer than the orbital spines, which are wide at base, acuminate and acute at tip, their margins being incurved.

The antennular peduncle is rather slender; proportions of the segments are about 1.5:1.1:1; its basal spine reaches about to the middle of the second segment.

The carpoperite is about three times as long as wide, and is longer than the antennular peduncle by about the length of the last segment of the latter. Its spine is nearly equally long, and the scale is a little shorter and narrow. The basicerite has a short, sharp lateral spine nearly as long as that of the antennules; above it a smaller secondary acute spine.

The large chela is oblong-ellipsoidal, only a little swollen in the middle, and has a very small obtuse tubercle on its distal dorsal margin. The width to the length of the palm is about as 1:1.90; to the total length as 1:3.3. The carpus is very short and wide, prolonged downward and inward. The merus is stout, width to length as 1:2.3; its inferior distal margin ends in a sharp angular point.

The smaller chela is similar in form; breadth to length about as 1:3.2; its fingers are pointed. The carpus is short cup-shaped; the merus, like that of the large chela, ends in a sharp distal point. The legs of the second pair are slender; first joint of the carpus is equal to the remaining four; chela is elongated, hardly thicker than fifth joint of the carpus.

The dactyl of the third pair of legs is elongated, tapered, and a little curved on the outer side, less so on the inner side; width to length from 1:3.14 to 1:3.55. The hooks are unequal, the outer one being thinner and a little longer, regularly curved, sharp; the inner is wider, strongly divergent and curved inward; a short

distance from its base there is a light obtuse protuberance, or rudimentary spur.

The telson is wide and tapers but little; distal width to length as 1 : 2; proximal width to length as 1 : 1.10; distal end is obtusely rounded, its angles are obtuse and bear two minute unequal spines.



FIGURE 8. *Synalpheus fritzmuelleri*, var. *caribaea*, new variety from Dominica Island. Frontal parts much enlarged.

In the subspecies *elongatus* the carpopocrite is more slender and its spine considerably exceeds it in length. The rostrum and orbital spines are longer and more acute, while the rostrum is decidedly longer than the orbital spines, nearly equalling the first antennular segment.

Coutière records this species from many places, ranging from both coasts of Florida to Porto Rico and St. Thomas, from low tide to 28 fathoms; and as subspecies *elongatus* from South Carolina, Florida, Venezuela, Jamaica, to Bahia and Desterro, Brazil. The Yale Museum has specimens from Fort Macon, N. C., specimen figured (No. 1831,* coll. Dr. Yarrow). Coutière mentions a single male from Lower California not distinguishable from Florida specimens. I have from Dominica Island a specimen differing somewhat from the type (var. *caribaea*, new, pl. 39, figs. 3a—3c).

* A closely related form, considered a new variety, which occurs off Fort Macon, N. C. (var. *carolinensis* Ver.)

The specimen from Fort Macon differs somewhat from the type-form though nearer that than to var. *elongatus* in most respects.

***Synalpheus fritzmuelleri* var. *carolinensis* Ver. new.**

PLATE XXII, FIGURE 6. PLATE XXXIX, FIGURES 1-1d.

The following description is from a North Carolina specimen. The frontal spines are very acute. The rostrum is a little longer than the ocular spines; seen from above it is compressed, narrow, spiniform, very acute, but seen in profile it is proximally broadened into a small vertical plate; its point reaches about to the middle of the first antennular article. Ocular spines are conical and swollen at base, with acuminate and sharp tips. The antennules are rather slender. The basal spine is slender, acute, and reaches to or beyond the middle of the second article.

The carpoperite is slender, cylindrical, and exceeds the antennular peduncle by more than the length of the last article. Its scaphocerite is narrow, its spine is rather slender, not as long as the carpoperite, about equal to antennular peduncle; the scale is shorter and very narrow.

The basicerite is short, two-spined; the lower spine is about as large as the rostrum, and extends not quite so far as the stylocerite, or about to end of first article; the upper spine is about one-third as long and about the same shape; the interval between them is U-shaped. The third maxilliped is long, rather slender; the tip has about nine slender unequal spines; exopod has a large brush of plumose hairs.

The large chela is long-ellipsoidal or slightly ovate, only a little swollen proximally and not projecting back of articulation, which is nearly central; slightly compressed in a dorsal view; distal dorsal margin has no prominent denticle, at most only a minute obscure tubercle; inner articular margin has two small tubercles; fixed finger short, subacute, apex channelled, shorter than dactyl; dactyl is strongly compressed in a dorsal view; strongly arched distally, tip acute; inner edges plane; plunger elongated.

Carpus is short, small, cup-shaped; merus rather short, triquetral, with the two distal angles dentiform. Smaller chela is much smaller, similar in form, relatively longer (pl. 39, fig. 1); width to length about 1 : 1.65; dactyl is about as long as width of

palm; length to that of palm about 1:1.7; fixed finger has two minute unequal teeth at the tip, and about five small clusters of hairs on the outer margin and on each side near the tip; fixed finger has four or five similar clusters on the lower edge, with two or three on each side; carpus and merus also have small groups of hairs; carpus is wider than long, about 1:1.3, nearly as wide as palm; merus about same thickness, largest in middle; length to that of carpus as 2.5 to 1; distal end has a spiniform tooth at outer angle and a prominent angle at inner one.

Legs of second pair are slender; chela small, with nearly parallel sides; palm about equal to dactyl, which is slender with a bidentate tip; it has a small tuft of divergent hairs at about the proximal third, and another at the tip; other finger is stouter with two tufts of hairs below and one near tip; first article of carpus is about equal to sum of 3, 4, 5, and about equal to chela; merus is about equal to sum of first four carpal articles.

Leg of third pair has on the propodus about six spines, besides two distal ones; dactyl is strong, tapered, inner hook shorter and stouter, divergent; proximal to it there is a slight obtuse elevation or hump. The carpus has a small distal movable spine on its inner angle and a prominent outer angle; merus is much stouter, width to length about 1:3, widest in middle, length about equal to propodus. Legs of fifth pair are much smaller and more slender.

Telson is somewhat elongated, tapered, distal end about one-third as wide as widest part; tip obtusely rounded, with about 14 plumose hairs, of which the outer lateral ones on each side are much smaller and shorter than others; between the plumose hairs are about as many very much more slender smooth hairs; the four dorsal spines are slender and acute; the two at the angles are very slender; inner one is about three times as long as the outer one.

Fort Macon (Dr. H. C. Yarrow coll.) No. 1831.

Synalpheus townsendi Coutière. *Small Snapping Shrimp.*

Synalpheus townsendi Coutière, Proc. U. S.-Nat. Mus., vol. xxxvi, p. 32, figs. 14-17, 1909. Hay and Shore, op. cit., 1918, p. 384, pl. 26, fig. 1; text-cut 7.

Alpheus minus? Say, op. cit., p. 245, 1818. S. I. Smith, Ann. Rep. U. S. Comm. Fish and Fisheries, for 1885 (p. 54), 1886 (*non* Coutière sp.).

PLATE XLVII, FIGURES 3—3d. (After Coutière.)

In this species the superior lateral basal spine of the antennæ is not developed. The rostrum is relatively long and slender, decidedly longer and narrower than the orbital spines, which are also elongated and acute, but with broad bases and incurved inner edges. The rostrum extends to or beyond the end of the first antennular segment.

The telson tapers regularly; its apex is convex, not very narrow and has a small denticle at each angle. The small chela lacks large dorsal tufts of hairs on the dactylus. The large chela has a small very acute dorsal spine at the distal margin; carpus very short. The two dactyl claws of the ambulatory legs are very unequal in length, not divergent, slightly curved, the outer one much the longer; the proportions about 3:1; the carpal joint has a distal spine above and below; the propodus is long and has about eight small spines below. The antennal scale is narrow, shorter than the carpoperite, while its spine is longer than the latter. Basal spine of antennules reaches to the proximal third of the second segment. Carpus of the second pair of legs has the first segment long, equal to the other four combined.

M. Coutière records this from Bermuda (col. G. Brown Goode). It was also taken there by our parties, several times, in 1898 and 1901.

It ranges from off Beaufort, North Carolina, in 13 to 16 fathoms, through the West Indies to Yucatan, and to Bahia, Brazil, and from low tide to 56 fathoms (Coutière). It is a very common species in dredgings. Also known from Hawaiian Is. and Lower California (var. *brevispinis*); and Gulf of California, var. *mexicanus* (t. Coutière).

It is quite probable that this species was Say's original *Alpheus minus*, for it agrees best with his description. Say stated that in his species the rostral spine was longer and more acute than the orbital spines, which were conical at base. This is the case in the present species, which is also a common species on our southern coasts (Cape Hatteras to Florida), where Say obtained his specimens. Doubtless Say subsequently referred all the related species of *Synalpheus* that he obtained to *S. minus*, as Kingsley and others have done, much more recently. Hence the two specimens mentioned by Coutière, now in the British Museum, and sent by Say,

are not necessarily even cotypes. They may have been collected long after the species was described, and then incorrectly labelled, as often happens in similar cases. However, as this matter must remain uncertain, it seems best to adopt the decision of Coutière.

Synalpheus minus (Say) Coutière. *Small Snapping Shrimp*.

Alpheus minus Say (?), Jour. Acad. Nat. Sci. Philad., i, p. 245, 1818.

H. M-Edw., Hist. Nat. Crust., ii, p. 356, 1837, (not of Brooks and Herrick, Mem. Nat. Acad. Sci., vol. v, not plate I), 1892. Kingsley* (*pars*) Synopsis Alpheus, p. 190, 1878; List of Caridea, p. 57, 1878 (*pars*); Proc. Acad. Nat. Sci. Philad., for 1879, p. 416; Carcinological Notes, No. v, p. 114, 1883 (*pars*), (*non* Bate, Voy. Challenger, xiv, p. 558, pl. C, fig. 2).

Alpheus minor (substitute for *minus*) Rankin, Ann. Lyc. N. Hist. N. Y., vol. xi, p. 250 (*pars*), Bahamas; op. cit., vol. xi, p. 540 (*pars*), Bermuda (*non* *A. minor* of earlier authors, *nec* Brooks and Herrick, op. cit., 1892).

Synalpheus minor Coutière, Ann. Sci. Nat., Ser. 8, vol. ix, 1899, text-figures 32, 98, 115, 165, 167, 181, 191, 200, 239, 247, 248, 249, 250, 326, 348, pl. v, fig. 4 (larvæ).

Synalpheus minus Coutière, Proc. U. S. Nat. Mus., vol. 36, p. 43, figs. 25, 26, 1909. Hay and Shore, op. cit., p. 382, pl. 26, fig. 2, and text-cut 5 (after Coutière).

Alpheus saulcyi Guerin, in La Sagra's Hist. Cuba, second part, Zool., vol. vii, Crust., p. xviii, pl. ii, fig. 8, 1857.

PLATE XXI, FIGURE 1 (No. 1827). PLATE XXIII, FIGURE 3 (No. 1827).

PLATE XXXIII, FIGURES 4, 4a, ♀; 5, 5a, ♂ (No. 1827). PLATE XXXIV, FIGURES 2—2n (No. 1827). PLATE XXXVI, FIGURES 1—1d, 2 (variety). PLATE XXXI, FIGURE 4 and PLATE XXV, FIGURE 3 (after Guerin as *A. saulcyi*). PLATE XLVII, FIGURES 1—1c, typical after Coutière; FIGURE 2, frontal parts of a Bermuda specimen, after Coutière, not typical. PLATE XLVIII, FIGURES 3—3c, after Coutière.

As restricted by Coutière† (1909), this species has the following characters;—It belongs to the "Brevicarpus group."

Say described his species as having the rostrum "spinform" and

* Kingsley, in his synonymy, erroneously included *A. formosus* Gibbes, with this species, as well as several distinct species of *Synalpheus*. See under *A. formosus*.

† Coutière found two dry specimens, sent by Say to the British Museum, and still preserved there (op. cit., 1909, p. 2), and on them based his restriction, though they may not have been cotypes. They do not agree very well with Say's description. He probably confused several species of this genus after publishing his description.

more acute than the ocular spines, which were "conic-acute"; larger chela inflated, "oblong-oval, not compressed"; carpus "very small." He described the color of the larger chela as "white, tip red, banded near the base of the fingers with white in the female and white tipped with green in the male."

The front of the carapace (see pl. 47, figs. 1, 2) in the restricted species has three teeth in the form of an equilateral triangle, the rostrum being usually a little wider at the base, compressed, and sometimes slightly longer than the orbital teeth; in side-views higher at base.

The antennular peduncle is 4.8 to 5 times longer than its width; its articles are as 2:1.5:1; its basal spine or stylocerite reaches to the distal third of the second article; its external flagellum branches at the tenth annulus.

The carpocerite (fig. 1*b*) is a little flattened; its length to its width is about as 3.7:1; it extends beyond the antennular peduncle by the length of the last article of the latter; the scale, or scaphocerite, is narrow, width to length about as 1:7, up to 1:8.5; its inner edge makes a very obtuse angle, not a regular curve; its lateral spine is a little longer than the antennular peduncle, and shorter than the carpocerite. The basal spine or basicerite reaches to the distal end of the first antennular article (or sometimes farther, as figured); above its base is a small secondary spine, rather longer than the width of its own base.

The large chela (fig. 1*a*) is regularly ovoid, proportions of fingers to total length is as 1:3.5; to height as 1:1.35; fingers to palm as 1:2.5. The anterior dorsal margin, or inner side, has a strong tooth, sharp at tip, often like a rather slender spinule. The dactyl, as figured, is broad, larger than the fixed finger, its cutting edge a little sinuous, dorsal edge curved distally, tip obtuse; fixed finger nearly straight, with inner edge a little sinuous.

The smaller chela (fig. 1*c*) in length is to the larger one about as 1:2.7; fingers to total length, 1:2.25; to height, 1:0.8; to length of palm, 1:1.25. It is therefore rather elongated, with long fingers, which are slender, acute at tips, and a little curved downward; the palm is narrow elliptical, about evenly curved above and below; its surface is plain; the dactyl does not bear a large tuft of hairs, but both fingers have several small tufts.

Legs of second pair are slender; width of the carpus to its length is about as 1:0.95; length of carpus to merus, 1:0.75.

Legs of third pair are stouter; carpus to merus, 1:2.2; to propodus, 1:1.6 or 1.7; width of merus to its length about 1:4, often less. The dactyl is elongated, a little curved; its hooks are almost parallel; the dorsal one is nearly twice as long as the other (figs. 1*d*, 1*e*).

The telson (fig. 1*f*) is stout, with a wide, convex distal margin; its length is 1.06 times its width at base and 1:84 times that of its distal margin; its lateral margins are a little sinuous; the postero-lateral angles have two pairs of small spinules; the posterior edge is fringed with about 20 plumose hairs (22 in my examples). Length of largest examples not over 25 mm. Eggs are small, about 0.6 mm, becoming 1 mm, and give rise to zoëas.

Coutière recognized two named varieties or "forms," viz. *bahiensis* (his fig. 26), from Brazil, and *antillensis* (fig. 27); from the West Indies. He also recorded a variety without name (our pl. 47, fig. 2), from the Bermudas, in which the basicerite has unusually strong spines. It has also a stouter small chela. Some of our Bermuda specimens agree well with the latter; others agree better with the variety *antillensis*.

The latter has the frontal teeth longer and narrower, especially the rostrum, which is only about half as wide as the orbital teeth, and a little longer; the latter are more acute than in the typical form. In these respects it agrees better with Say's original description than does the typical form of Coutière. This form also has a stouter antennular stalk which is only 4.2 to 4.3 longer than wide; the carpocerite is also longer, exceeding the antennular peduncle by the length of its third article, and its form is more ovoid, its width to its length being about as 1:3.2 or 1:3.15; the antennal scale is also a little wider and the smaller chela is more swollen. The large chela, basicerite spines, dactyls of third legs, joints of second legs, agree with those of the typical form described above.

The following large figured male and female specimens (No. 1827, plates 21, fig. 1: 23, 3; 33, figs. 4—5*a*; pl. 34, 2-2*n*), I have selected as typical specimens of the species as limited by Coutière.

The three frontal spines are somewhat elongated, acuminate, and triangular, tips very acute and carrying one or two small setæ (pl. 23, fig. 3; pl. 33, fig. 5). The rostrum is slightly longer than the ocular spines, with the under side compressed, as seen in profile, and a little deeper than the ocular spines, which are more

styliform distally and translucent at the tip. A slight dorsal carina extends back from rostrum. The rostrum connects below with ocular projections by a simple, thin, slightly incurved margin. There is a strong bulge over the eyes.

The basal antennular spine is rather long, slender, acute, reaching the middle of the second article, but not to middle of scaphocerite spine; it has a small acute secondary spine at its base. The articles of the antennules are stout and somewhat expanded at their distal ends; outer flagellum branches at tenth annulus. Carpocerite is somewhat fusiform, with the middle a little swollen, length 4.5 times the width (pl. 34, 2*b*); its spine is equally long, strong, acute; it reaches end of antennular peduncle; its scale is narrow, shorter than the spine.

Third maxilliped (fig. 2*n'''*) is long and not very stout; its third article is enlarged distally, 4.5 longer than wide, and about as long as the carpocerite; the penultimate article is longer than wide, one fourth the preceding; last article slender, tapered, six times longer than wide; tips oblique, with about six acute spines and a tuft of long plain hairs; about seven transverse rows of hairs partly feathered on one side; exopod as long as the adjacent article, with a terminal tuft of numerous long hairs.

Larger chela is smooth, oblong-elliptical, a little swollen proximally; thumb rather large, pointed, shorter than dactyl, deeply cut away on the inner side, where there is a deep canaliculate notch, above which the margin is very oblique, with three raised tubercles, the lower one largest; dorsal articular margin with three small denticles, the inner dorsal with an acute tip, the others obtuse; outer articular margin nearly transverse, with two rounded denticular tubercles, above a narrow notch at the angle; the cutting margin, beyond the notch, has a large, prominent rounded lobe. Dactyl is large, compressed, strongly arched externally; inner edge is not much incurved, but has two small lobes on the outer edge, and a distinct inner tooth distally (pl. 23, fig. 3). The form of this chela differs in the sexes; those of the male (pl. 33, figs. 5, 5*a*) are more swollen and the dactyl is longer than half the palm. Those of the female (figs. 4, 4*a*) are narrower, more oblong, and the dactyl is equal to or less than half the length of the palm.

The smaller chela (fig. 2*i'*) is narrow elliptical, with both margins of the palm slightly convex, fingers are acute, or minutely two-toothed; dactyl is evenly arched and bears two or three tufts

of hairs near the tip and a row along the cutting edge; fixed finger has corresponding tufts and also one on each side about the middle. Carpus is as broad as long, expanded distally, with a prominent angle above, length about half the palm of chela; little more than a third of merus. Merus is rather stout, breadth to length about 1:1.4; outer distal angle acute. Chela of second pair of legs (fig. 2l'') elongated; fingers acute, a little longer than the palm; dactyl with a small tuft of hairs on middle of outer margin, and two apical; pollex has three longer tufts and a small apical one. Carpus and merus slender; merus is as long as first four carpal articles.

Legs of third pair are not very stout; merus is long; width to length as 1:5; carpus about half as long; it has a prominent dentiform angle above, and a slender movable spine below; propodus is slender, width to length, 1:7; it has seven slender spines besides the two distal ones. Dactyl (fig. 2l''') is slender, sides nearly parallel, slightly curved, width to length about 1:4; hooks slender, nearly parallel, not divergent, outer one longer. Legs of fifth pair (fig. 2l') are smaller and more slender with the carpus relatively longer, dactyl similar but more curved and the hooks longer; propodus as long as merus; merus half as long as three terminal articles combined; propodus has a long series of brush-hairs.

The telson is broad, tapering but little; distal end is wide, a little convexly rounded, and bears numerous plumose hairs, and two small spines at each angle; dorsal surface has a wide sulcus and four small appressed spines, wide apart. This species is one of the largest of the genus. The specimens above described are the largest that I have seen.

It is rather common at the Bermudas, in holes in dead corals, etc., and among sponges. Its range, as recorded, is from Cape Hatteras to Bahia, Brazil, and probably farther south. Beaufort, N. C. (Kingsley, Hay and Shore). Off St. Thomas, 20 to 30 fathoms (Rathbun); Fort Macon and Beaufort, N. C.; West Florida, Dominica I. etc. (Yale Mus.) Florida, Antilles and Bahia, etc. (Coutière).

In life, specimens taken April 18th, in Castle Harbor, in dead corals, had the body translucent yellowish white with a green anterior patch (due probably to green ova showing through). Large chela translucent gray, with the fingers orange; a white

patch on the inner side of the palm. Some of this lot, April 18th, carried externally a cluster of bright green eggs, 14 to 15 in a cluster. They were identified as this species at the time, after a superficial examination, and are not now accessible for re-examination. They may have belonged to *S. brevicarpus*, judging from the small number of the eggs.

The synonymy and distribution of this species has been in much confusion. Several allied species were evidently confounded formerly by Kingsley and most others. Specimens now before me from Bermuda, Fort Macon, N. C., and from Florida, are evidently the *S. minus* as restricted by Coutière. Most of the specimens of *Alpheus* and *Synalpheus*, then in the Yale Museum, were loaned to Prof. Kingsley, before he published his articles, and still bear his labels. Otherwise it would not be possible, as in the cases of several forms of *Synalpheus* referred by him to *A. minus*, to determine what species and varieties he really studied, for his description is too general. The same specimens were also loaned to Brooks and Herrick, when they were preparing their work of 1892. They returned them without changing Prof. Kingsley's labels.

Among the specimens labelled by him as "*A. minus*," I find *S. minus*; *S. fritzmuelleri*; *S. hemphilli*; *S. goodei*; *S. brooksii*; *S. digueti*; *S. bradleyi*, new sp.; *S. brevicarpus*. He also referred *A. formosus* Gibbes to the same species.

Unfortunately Brooks and Herrick, in their valuable work (Mem. Nat. Acad. Sci., vol. v, pp. 1—372, 1892), erroneously gave the name *minus* (and *minor*)* to a totally different species, belonging to the genus *Alpheus*, viz., *A. packardii*. They gave a good colored figure of the latter, made from life (pl. I), under the name of *minus*, (*minus* on the plate, *minor* in the text).

They described remarkable variations in the eggs and newly-hatched young of their *A. minor* (*minus*) from different localities, but owing to the wrong identifications of the species, it is probable that they confused two or more species under that name. The larvæ figured as of *S. minus* may belong to *A. packardii*. Coutière has examined some of the types of Brooks and Herrick. (See above under the genus and *S. brevicarpus*, *S. pectiniger*, *S. longicarpus*.)

* This name was proposed as a corrected form of *minus*. It had already been used for a different species of *Alpheus*.

The specimens formerly labelled by Prof. Kingsley as *A. minus*, from the Pearl Islands, Bay of Panama (No. 742a, 742b, Yale Museum), are now before me. These specimens resemble *S. minus* in size and form. They belong to two species, both different from any of the Atlantic species.

The larger species (742a), which I have named *S. bradleyi*, has a rostrum longer and stouter than in *S. minus*, its tip reaching the end of the first antennular segment. The orbital spines are decidedly shorter and smaller, narrow and acute at tip, but with wide bases. It has a small superior spine on the basicerite, as in *minus*. The antennular spine reaches nearly or quite to the distal end of the second antennular article. (See plate xxxiii, figs. 1, 2.)

The smaller species (742b) has a very small and slender rostral spine, shorter than the orbital spines, which are also small, but acute-triangular. The larger chela is shorter and more swollen than in the last. This appears to be identical with *S. digueti* Cout., from the Gulf of California. Both these species will be more fully described elsewhere, with other extralimital species.

***Synalpheus minus*, var. *somersi* Ver. new var.**

PLATE XXXIII, FIGURES 4, 4a, chela of female; 5, 5a, of male, No. 62.

PLATE XXXIV, FIGURES 1-1u, ♀, No. 62. PLATE XXXVI, FIGURES 1-1e, 2, No. 62. All by A. H. V.

This form differs from the typical one especially in the much stouter carapocerite and the longer and wider antennal scale and spine. The antennular peduncle is also stout; breadth to length, 1:4.6; the articles are about as 2.6:1.9:1. The stylocerite (pl. 34, fig. 1a, as) reaches nearly to the middle of second article.

The carapocerite (figs., 1b, cc) is stout, swollen proximally, width to length about as 1:4.6; its spine (sl) is large, very acute, about as long as carapocerite (pl. 36, fig. 2); the scale (s) is wide with an evenly convex inner edge and obtuse tip; it is nearly as long as the spine and distinctly wider in middle (pl. 34, figs. 1b, s'). The basicerite is nearly half as long as the scaphocerite; its secondary spine is small, acute, longer than wide.

The third maxilliped (pl. 36, fig. 1e, n''') is long and stout, especially the third article, width to length 1:5; the fourth article is about one-seventh the third, and about as broad as long; distal

article is long, regularly tapered, subacute, proportions 1:6.5; it has about 13 transverse groups of plumose hairs; exopod is rather wide, not quite as long as third article; terminal bush of plumose hairs large; fourth article also bears both plumose and simple hairs.

The smaller chela (pl. 36, fig. 1) is long-ellipsoidal, the palm being a little swollen or convex above and below; fingers are shorter than palm, ratios about 1:1.2; height of palm to length about 1:1.73; pollex is slightly curved down, and feebly denticulate at tip; it bears three or four small clusters of hairs below, and a pair near the tip; dactyl has about four small clusters of hairs on outer edge and a large one close to tip. Carpus is large, about as wide as long; outer angle is prominent and has a minute spine; merus is stout, breadth to length about 1:2.5, swollen distally; outer distal angle spiniform.

Legs of second pair (pl. 36, fig. 1b) have the chela elongated, with the fingers slender, longer than the palm, about as 1.5:1; dactyl bears many long hairs; pollex has five or six clusters besides that near the tip; carpus is long; first article is about as long as the sum of the others and half the palm; fifth article is longer than palm; merus is stouter, somewhat enlarged along the middle, width to length about 1:6; about as long as the sum of chela and last four articles of the carpus.

Legs of third pair are long, especially the propodus (fig. 1d), which bears about five spines besides one or two at the distal end; dactyl is elongated, not much enlarged proximally; hooks are nearly parallel, slender, outer one about twice as long as inner; carpus has one distal spine, its length is one-half the propodus or merus, which are about equal in length. Legs of fifth pair (fig. 1c) are more slender, with the hooks of the dactyl more incurved; propodus bears eight clusters of stiff setæ and small spinules.

Uropods (pl. 34, fig. 1u) are broadly rounded; outer lamella has two nearly equal spines at the suture and a much longer articulated spine between them. The telson (fig. 1t) is wide; lateral borders somewhat sinuous; width of distal part to widest part about 1:1.7; length about twice distal width; distal angles acute, with two unequal spines, the inner one-third longer than outer; four dorsal spines large, far apart; tip broadly rounded, with about 22 plumose hairs.

No. 62. Bermuda, on the coral reefs.

Alpheus tridentulatus Dana, Crust. U. S. Expl. Exped., i, p. 552, 1852; pl. xxxv, figs. 4a—4c, 1855.

This is evidently closely allied to *S. minus* and may, perhaps, prove to be the same. It has three small, short, equal, triangular frontal teeth; the antennular spine reaches the middle of the second segment; the basal antennal spine is stout and its tip is about even with that of the antennular spine. The spine of the scaphocerite is narrow and acute. The larger chela has the palm about twice as long as the dactyl; the distal articular margin is nearly transverse and has several small denticles. The principal differences noticeable in the figures are in the form of the antennal spines and the shorter large chela, with a more transverse articular margin.

Dana did not describe nor figure the uropods and telson. It is impossible to determine with certainty its relation to the species now recognized. It was from Rio Janeiro, Brazil.

S. saulcyi Guerin, from Cuba, seems to be the true *S. minus* of Coutière. See Pl. XXV, fig. 3, and Pl. XXXI, fig. 4, copied from Guerin's figures. Some of our Bermuda specimens agree well with Guerin's figures in all essential respects, but his general figure is incorrect in certain parts. It does not even show articulations in the carpus of the second pair of legs.

Four small but perfect specimens (No. 1174) collected at Key West by Edw. Palmer, and now in the Yale Museum, were labelled as *minus* by Prof. Kingsley. Some are females, with large eggs. The rostrum is minute and acute; the ocular lobes have small acute spinules. The telson is very narrow, tapering rapidly distally. The large chela has a conical, acute, distal, dorsal spinule turned upward; small chela is short, attached low down. It appears to be the *S. brooksii* Coutière.

Synalpheus brevicarpus Coutière.

Alpheus praeox Herrick, Johns Hopkins Univ. Circ., vii, No. 63, pp. 34, 35, 37, 1888 (no description); op. cit., 1891, p. 381 (type cited).

Alpheus saulcyi, var. *brevicarpus* Brooks and Herrick, Mem. Nat. Acad. Sci., v, pp. 381, pl. iv, figs. 1-3 (colored), pl. xxiii, xxiv (details), 1891.

Alpheus minor (subs. for *minus*) pars, Rankin, Ann. Lyc. N. Hist. New York, vol. xi, p. 250. Name *minor* was preoccupied.

Synalpheus brevicarpus Coutière (restricted), op. cit., 1909, p. 51, figures 29, 30.

PLATE XXXIV, FIGURE 4 (No. 8). Variety, after B. & H. PLATE XXXVI, FIGURES 3—3*d* (typical). PLATE XXXVI, FIGURE 4. (? Variety, No. 8); after B. and H.

This species, as restricted by Coutière, is closely similar to *S. minus*, and yet, unlike the latter, it produces large eggs and advanced *mysis-like* larvæ. It is best recognized by the obsolete or small superior spine on the basicerite. Adult females are much swollen.

The rostrum and orbital spines are small, about as long as wide, triangular, about equal in size, and much like those of *S. minus*.

The antennular peduncle is rather stout and long, nearly equal to the carpocerite, its width to length is about as 1:5.5; proportions of its three segments are about 1.8:1.7:1. Its spine is long, reaching about to the middle of the second antennular segment, but not so long as in *S. minus*. The basicerite has a long, sharp lower spine, reaching about to end of the first antennular segment; it has no sharp upper or secondary spine, but only an angular prominence or denticle there, while *S. minus* has there a distinct small sharp spine.

The carpocerite is long, width to length as 1:4; it is more cylindrical, or less swollen, than in *S. minus*. It is a little longer than the antennular peduncle. Its spine is about equal to the latter and distinctly shorter than the carpocerite, yet a trifle longer than the scale, which is rather wide.

The large chela is oblong-elliptical, a little swollen in the middle, and has a distal dorsal tubercle ending in a small acute spine; its pollex is large and wide and the dactyl is wide and evenly arched dorsally; its length is about one-half of that of the palm. The width of the palm is about one-half its length. It is less swollen than in *S. minus*.

The smaller first chela is nearly like that of *S. minus*, but rather more slender. The carpus of the legs of the second pair is rather slender, width to length about as 1:12; its length compared to the merus is about as 1:0.85; its first article is longer than the rest of the carpus. It is not so slender as in *S. minus*. The chela is shorter than in the latter. The proportions of the ambulatory legs are about as in *S. minus*, but the merus is a little more slender, width to length about as 1:4.25, and the carpus is a little longer and rather more slender, while the dactyl is rather more curved

and stouter, and the claws are stronger. The third maxilliped (pl. 36, fig. 3c) has its last article notably shorter than in *S. minus*.

The telson is shaped much as in *S. minus*, but it is relatively smaller and rather more narrow; width of its distal end to length as 1 : 2.05 to 2.24.

Our largest example (1828) referable to this species is a female with large eggs, from the Bahamas. The body is very stout and thick, thorax swollen. Front tridentate, the rostrum and orbital spines close together at their bases; triangular and sub-equal.

Antennular spine strong, reaching to the distal third of the second segment. Basal antennal spine (basicerite) is not so long, more slender, reaching to the end of the first segment; a small dentiform lateral spine is situated above its base. Antennal scale or scaphocerite is as long as the peduncle, or carpcerite: its spine is about equal to the antennular peduncle.

Telson is rather broad, convex on the margins, little tapered, obtuse, with four small dorsal spines and a pair of small terminal ones nearly in the same lines, at each distal angle. It is accompanied by two males that are slender and not half as large.

These specimens were labelled as *minus* by Kingsley.

A similar female specimen from St. Thomas (No. 1832, C. F. Hartt, coll.) also has a very stout body. Front has three nearly equal, short, narrow, acute spines not much longer than broad, the rostrum only a little narrower than the others. The antennular spine reaches to about the middle of the second segment. Basicerite is not very long, slender and acute; secondary spine lacking or rudimentary. Antennal scale is narrow, shorter than its spine, which reaches about to the end of the antennal stalk. The large chela is lacking. The smaller one is simple and nearly smooth. Ambulatory legs are rather stout. Third maxillipeds are stout and very hairy. Telson is regularly tapered.

Brooks and Herrick, 1891, apparently had at least two species confounded under the name of "*var. brevicarpus*." On page 381 they gave a special diagnosis of this form and designated its type. They there gave a detailed description of it and its variations. Thus there need be no doubt as to the application of the name. The earlier provisional name, *præcox*, without a description, is there given as synonymous. In the comparative tables, pp. 385-7, and table of measurements (pp. 386; 387) they gave additional

characters of importance. At the same time they claimed that there are various intermediate forms between this and their *var. longicarpus*. Coutière stated that they had two or more species confused under the latter name, as he proved by types.

Their colored figures (pl. IV, figs. 1-3) of the male and female *brevicarpus* from a "green sponge" were regarded as the typical form. The female carried over 300 large eggs, and had a distended abdomen full of green eggs; the young hatched in an advanced larval stage (mysis-form). However, there is one character in which these figures disagree with the *brevicarpus* as restricted by Coutière, viz.—there is shown a small acute spine above the base of the basicerite, where in the restricted species there should be merely an angular lobe; still this spinule is represented as much smaller than it is in *S. minus*. However, in their figures of the details (see their pl. 33, fig. 8, and our pl. 36, fig. 3b) no spinule is shown in this place, though these figures are also based on specimens from the "green sponge" and are represented as typical of the variety. These also agree well with Coutière's figures.

Their specimen numbered 8, p. 386, pl. 23, figs. 5, 8c, 13 (our pl. 34, fig. 4) seems to be a distinct species. They referred it to *var. brevicarpus*, but as an intermediate form. It has a very short stylocerite (their pl. 22, fig. 18) not so long as the first article of the antennule. It is said in the table (p. 386) to have a rudimentary antennal scale, as in their pl. 22, fig. 13; but some of their figures show a wide scale.

The antennular peduncle is represented as long, and the carpo-cerite is four times as long as wide. The smaller chela is described as cylindrical, with simple pointed fingers and no tuft on the dactyl. I have seen no specimens agreeing with this form, nor does it agree with any described by Coutière.

This species is rare at Bermuda,—perhaps not yet positively identified as found there. Our specimens are from the West Indies.

Synalpheus longicarpus Coutière.

Alpheus saulcyi, *var. longicarpus* (*pars*) Herrick, Mem. Nat. Acad. Sci., v, 383-389, plates xxi, figs. 11, 13, 14, 17, 18; xxiv, figs. 2, 8, 1891.

? *Synalpheus levinianus*, *var. longicarpus* (*pars*) Coutière, Bull. Soc. Entom. France, 1898, No. 8, p. 189, fig. 20; op. cit., 1899, figs. 116, 123, 153, 241, 360, 394.

Synalpheus longicarpus Coutière, op. cit., 1900, p. 53, fig. 31. Hay and Shore, op. cit., p. 383, pl. 26, fig. 2; text-cut 6 (after Coutière), 1918.

PLATE XXV, FIGURES 1a—1h (after Coutière). PLATE XXXIV, FIGURES 3, 3c (? Variety). PLATE XXXVI, FIGURES 5, 5a.

Rostrum narrower and a little longer than the triangular, obtuse, orbital spines; space between the latter and the rostrum V-shaped, but not acute distally, broadest in female; rostrum scarcely reaches middle of first article of antennular peduncle. Articles of antennular peduncle have ratios of 2:1.5:1; its entire length to breadth is 5:1; anterior margin of basal article is less emarginate than usual; its short stylocerite reaches the distal third of the basal article. The carpocerite is slender and cylindrical, a little excurved; it exceeds the antennular peduncle by the length of the third article of the latter, and is five or five and one-half times as long as thick. Its scaphocerite in the male has only a rudimentary scale, sometimes none; in the female the scale is small and variable, rarely longer than the basal article of antennule, and never more than half as wide as the lateral spine, which is strong and acute; it exceeds the antennular peduncle by half the distal article.

The large chela is elongated, somewhat ovate, the margins somewhat convex; the posterior end is swelled and prolonged backward beyond the articulation, the very small and short carpus being inserted below the central axis of the palm. The anterior dorsal margin of the palm has a small acute spine; total length to height of chela about as 2.73:1; dactyls about one-fourth to one-fifth the total length; dactyl a little oblique at end.

The larger chela is from two and one-half to three times the length of the smaller one, which is elongated, its height to length being about as 1:3.75. The dactyl has two apical teeth, the lower stronger. The fixed finger has three teeth, the apical one longer. The dactyl is elongated, nearly straight on the edge, gently arched dorsally. It bears on its dorsal surface a dense tuft of erect hairs, covering most of its length; the fixed finger has hairs along the inner edge and two small apical tufts.

The legs of the second pair are slender; the chelæ are elongated and little swollen and have several tufts of hairs on both fingers, about ten in all. They are stronger in the male. The first article of the carpus is shorter than the sum of the other four. The chela in the male is longer than the four distal articles, but shorter in the female. The third legs are also stronger in the male; the

merus is three and one-half times longer than wide; the propodus has a row of eight spines; the dactyl is short and stout, curved distally, with the two hooks divergent and about equal, the inner a little wider and more incurved.

Sixth abdominal segment has a strong triangular lateral tooth on each posterior angle. The uropods are wide, well rounded, little longer than the telson. The outer one has about seven or eight denticles, with a movable spine between the first two. The uropods are smaller in the female.

The telson is shaped much as in *S. goodii*, but is relatively narrower and longer, greatest width to length about as 1:1.33; distal third narrow, tip very narrow, space between apical spines small, bearing four plumose hairs and some simple ones. The eggs are small and produce zoëas. Color translucent-whitish; fingers brown.

It usually inhabits cavernous sponges, especially the logger-head sponge, often in large colonies. Not obtained at Bermuda so far as positively known to me. The Bermuda specimens referred to it by Miss Rathbun are apparently different. It is likely to be found hereafter, for the same sponge occurs there. It may have been confused with *S. goodii* formerly.

Coutière records it from off Cape Fear, N. C., 15 fathoms; Gulf of Mexico, 24 to 26 fathoms (4000 to 5000, in one haul); Yucatan; Jamaica, in black sponge; Curacao. Very abundant at Beaufort, N. C., in large sponges cast upon the shore by the waves, and dredged on the off shore fishing banks (Hay and Shore). Our specimens are from the West Indies.

Brooks and Herrick, in their large work, p. 387, in the table, named especially as the *type* of their "*var. longicarpus*," No. 13 of their list. It is described there as having *no antennal scale*; the smaller chela is said to have "prongs and a tuft," i.e., the fingers have teeth at the tips and a large crest of hairs on the dactyl; length of male 9.5 mm; stylocerite or "*aural spine*" one half as long as first antennular segment; scaphocerite spine more than half as long as carpoperite. It was a male.

Their No. 9, also referred to *var. longicarpus* (see their pl. 23, fig. 14, antenna) shows a rudimentary antennal scale; its smaller chela (their pl. 24, fig. 2), our plate XXXIV, figs. 5, 5a, has the carpus long, a tuft on the dactyl, and three teeth at the tip. This may be *S. pectiniger* of Coutière.

The form defined as found in the "logger-head sponge," with no special number given, appears to be a different species, judging from the large chela, our plate 34, fig. 3 (their pl. 24, fig. 8), for this chela is remarkably elongated and swollen above proximally, so that the proximal end projects backward over the carpus, which is articulated lower down than usual. The fixed finger or "pollex" is extremely short, much shorter than the dactyl. It is, perhaps, as near that of *S. longicarpus* of Coutière as to any of the forms described by him, but does not agree well with it.

Synalpheus goodei* Coutière. *Goode's Snapping Shrimp.

Synalpheus goodei Coutière, op. cit., 1909, p. 58, fig. 33, a-u.

PLATE XXXVII, FIGURES 1, a-u, ♀, from slides a-a". PLATE XXXVIII, FIGURES 1, a-u ♂, from slides g-g", 1898, 2-0; ♀. PLATE XXXIX, FIGURES 4-4d (after Coutière). PLATE XL, FIGURES 2, a-l, slide bb. All are from Bermuda specimens. All are by A. H. V. except pl. 39, figs. 4-4d.

Rostrum acute, a little longer and narrower than the ocular lobes, which are triangular and acute or subacute, about as long as broad. (Pl. 38, fig. 1.) Antennules rather stout; articles of the peduncle have proportions about as 2.3:1.2:1 (pl. 37, fig. 1, a; pl. 38, fig. 1a); the inner flagellum has about five or six articles before it branches; longer branch is about half the length of the outer flagellum; basal spine (stylocerite) reaches about to end of first article, sometimes beyond it.

The carpoperite is cylindrical, long, slender, usually nearly or quite six times as long as thick (pl. 38, fig. 1, b); antennal scale or scaphocerite is small, narrow, much shorter than the carpoperite, but may reach the middle of the distal article of the antennule; its spine is strong and much longer, very acute; the basal spine (pl. 37 and 38, fig. 1, b) or basicerite is long, acute and reaches to about the distal third of the larger spine; it has a small secondary short spine or angular tooth at its base.

The palm of the large chela (pl. 39, fig. 4; pl. 38, fig. 1c') is oblong-ovate, a little swollen in the middle, and with a small acute dorsal spine at the distal end, above the base of the dactyl; it usually curves down a little. The length of the dactyl is about half that of the palm; height of palm about one and two-thirds the length. This chela is relatively a little shorter in the female than

in the male. The dactyl is nearly straight proximally, with sinuous edges, but is strongly arched distally to the acute tip; its plunger (fig. 1c') is compressed, oblique, not very long.

The smaller chela (pl. 37, 2c; pl. 38, fig. 1c"; pl. 40, fig. 2c) is but little wider than the carpus; its palm is oblong with borders only slightly convex; length is about one and three-fourths times its height; length to that of dactyl about 1.75:1 to 1.6:1. Both fingers have two small, acute, unequal teeth at the tip.

The fixed finger is a little bent down and the dactyl is arched its entire length, more so distally. The dactyl bears on each side a large, dense, longitudinal plume of long curved hairs, turned forward, and a row of small hairs on the cutting edge; also two small tufts at the tip. The fixed finger has a small tuft on each side at about the distal third, and a terminal longer tuft. The carpus is distally nearly as wide as the chela, but narrow proximally, about one and two-thirds or one and one-half longer than wide, and about one-half the total length of the chela. The merus is stout, about three times as long as wide, and about as wide in the middle as the distal part of the carpus; its length is about equal to the sum of the carpus and palm.

The legs of the second pair are slender (pl. 37, fig. 1, 1"; pl. 38, fig. 1, 1"; pl. 40, fig. 2d); the chela is but little wider than the carpus, and the palm is slightly convex above; fixed finger is nearly straight below; dactylus is gently arched, acute; both fingers are very hairy; dactyl has about three tufts of long hairs on each side, and fixed fingers about four larger tufts. Carpus is about two to two and one-fourth times longer than chela; first article is about equal to the sum of all the others; second, third, and fourth are short, nearly equal, a little wider than long, distal end of fifth with an angular tooth; fifth article is about as long as the palm of chela. Merus is about as long as the sum of the first four carpal articles.

Legs of the third pair (pl. 38, fig. 1, 1"', 1" x; pl. 40, fig. 2e) are rather stout; the dactyl is short, thick, incurved, with two small, unequal, apical claws, inner one about half as long as outer and a little more curved; the notch between them is rounded at bottom; proximal breadth is about one-half the length of the dactyl. Two or three spines of the propodus stand at its base. Propodus has a row of about eight spines besides the two or three apical ones; its length is about five times its width. The carpus

is wider; rather more than half the length of the propodus and dactyl, and rather less than half the length of the merus. Merus is fusiform, three and one-half to four times longer than wide, its length is nearly equal to the sum of the propodus and carpus.

The third maxilliped (pl. 38, fig. 1d n'''; n''', x) has about nine spines at its apex and about 13 transverse rows of unequal hairs and spines on the dactyl, the distal ones long.

The uropods (pl. 37, fig. 1, u.; pl. 38, fig. 1, u; pl. 40, fig. 2f) are large and broad, longer than the telson; the outer lamella is the larger, broadly obovate, with a faint distal sutural line and notch, at which stand three small spines, the middle one articulated; proximal to these a row of smaller denticles, about eight in the female, ten to twelve in the male, extends for nearly half the length of the outer margin, decreasing in size; both lamellæ are fringed with long hairs; the inner one has some hairs on the surface. Inner lamella is more nearly elliptical.

The telson (same figures, t) is longer than wide, greatest breadth about two-thirds the length; it is rather triangular, broadest with convex margins near the base; decreasing rapidly to the very narrow end, with somewhat incurved margins distally; narrow part about one-fourth the length; tip has two slender spines at each angle, occupying about two-thirds of its breadth; inner one is about one-third longer than outer one. Between the spines the median part is narrow, a little prominent, truncate, and bears four to six long plumose hairs, and some simple ones. The upper surface has a median groove and a slight carina each side of it.

The four dorsal spines in the male are larger and longer than the terminal ones, and are separated longitudinally by a distance not more than their length; in the female (pl. 37, fig. 1 t) they are smaller and not so near together; the posterior pair are much nearer together than the others.

General color is reddish or pink. Length about 16 to 20 mm. It inhabits the cavities of living sponges of several species, often in large colonies. We found it much the most common species of the genus at Bermuda.

In a lot of 37 specimens taken at Long Bird Island, Apr. 19, 1898, 18 had the large chela on the left side; 19 on the right. There is some variation in the chela in this lot. Some have it more swollen than usual; others have it more oblique, or more elongated.

The telson and uropods show but little variation. Some of those in this lot carried eggs.

This species is easily distinguished from *S. minus* and most of the other related species, except *longicarpus*, by the abruptly narrowed telson, with only five to six terminal plumose hairs, and by the broadly rounded uropods, sharply denticulated on the outer edges distally. The spine of the antennal scale is unusually long and the scale short and narrow. The rostrum and ocular spines are somewhat like those of *S. minus*, but the rostrum is more spiniform.

The only species with which it is likely to be confounded is *S. longicarpus* Coutière, which is closely related. The latter has a much more reduced or quite obsolescent antennal scale; a shorter carapocerate; more elongated large chela; the smaller chela longer and with a longer carpus; outer lamella of uropods has only seven or eight denticles; and the tip of the telson only four plumose hairs.

We took this small species many times in 1898, in the "Reach," in 2 to 3 fathoms; Castle Harbor; Long Bird Island; and in Harrington Sound; also in 1901, in several places, and in Dec., 1915 abundantly at Grassmere, in sponges. It was previously taken by Mr. G. Brown Goode, Mr. George Hawes, and by Dr. C. H. Merriam. (Yale Mus.)

Large numbers were taken from a dark brown, cake-shaped, keratose, fibrous sponge, found on the flats at low-tide on the north side of Long Bird Island. It is sometimes associated with *S. minus*.

M. Coutière recorded it from the Gulf of Mexico, 34 fathoms; Tampa Bay; and Colon; as well as from Bermuda. He also described a variety, "*occidentalis*," from Lower California. The latter has no antennal scale and has different uropods, and it may well prove to be a distinct species.

We found large colonies at Grassmere, near Hamilton, in shallow water, occupying cavities in a large cavernous sponge, dark smoky brown or blackish externally, sulphur yellow within, exterior crust firm. Often a hundred or more were found in one sponge, not mixed with any other species. Many females had green eggs, Dec. 25, 1915, usually not more than 15 to 20.

Most of these had the body pale pink or deep pink, others light red, the colors due to minute chromatophores on a pale translucent

ground-color; usually a brighter red median dorsal line; ovaries of female show through the integument as two greenish patches. Large chela was pink with light brown tips. Chelæ retain a reddish color a long time in formaline or weak alcohol. These specimens made a sharp snapping noise, loud for so small a species. Length of the body of the larger ones, 20 to 23 mm.

Nearly all were adults of about the same sizes. The following additional notes were taken from these specimens while they were fresh from the sea. The stylocerite usually does not quite reach the end of the first antennular article. The narrow antennal scale is about half as long as the carpocerite and about equal to the basicerite; its spine is longer and wider, about three-fourths as long as the carpocerite. Basicerite is long, strong, and acute; its secondary spine is short, but acute, longer than wide.

The legs of the fifth pair are much smaller than those of the third pair; the propodus has, on the distal half, a brush consisting of eight oblique compact clusters of short setæ; the dactyl is small and short; its hooks are small, short, evenly curved and but little divergent, the lower one being a little more incurved than that of the third pair of legs, as well as smaller.

The narrow tip of the telson usually had six long plumose hairs and four more slender smooth ones.

Probably this is the species referred to by Mr. G. B. Goode (op. cit., 1878) as follows:

"Some smaller species of the genus are found only in the cavities of a large aplysine sponge, abundant on the reefs. I have picked out seventy or eighty from a fragment of sponge not more than three inches in diameter. When the sponge is taken in the hand, the quick succession of clickings reminds one of the sound of the instruments in a large telegraph office"—

"When one of these animals is put in an earthen or glass vessel it makes a much louder noise, resembling a quick tap with the finger nail, or the back of a knife, upon the edge of the same vessel. This noise is produced by a convulsive snapping of the last joint of the large claw, by a movement resembling that of the spring beetles (*Elateridæ*), and the sounds are quite similar. Possibly these movements may have a protective object, enabling the little decapods to escape from the grasp of enemies, or to work out from under the stones and loose sand in which they must often become buried."

This species is perhaps the Bermuda form called *S. lævimanus*, var. *longicarpus*, by Miss Rathbun. At least, some of our specimens were so labelled by her. But it seems to be quite distinct from *S. lævimanus* of Europe. She stated that it had the rostrum and ocular spines slender and acute, and the antennular and antennal spines much as in *minus*.

Specimens of this species were also in the lots labelled and returned as *A. minus* by Kingsley, and it may be one of the "varieties" alluded to by him.

***Synalpheus neptunus* (Dana).**

Alpheus neptunus Dana, Crust. U. S. Expl. Exped., i, p. 553, 1852, pl. 35, fig. 5, 1855.

Synalpheus neptunus Coutière, Ann. Sci. Nat. (8), Zool., ix, p. 15, 1899. Not of M. J. Rathbun, op. cit., p. 110, 1901.

PLATE XXV, FIGURES 2, a—d. After Dana.

This oriental species somewhat resembles *S. minus* as shown by Dana's figures, here reproduced. Dana did not describe the telson. The frontal spines and the antennular and antennal spines are similar, though all these spines are unusually large and long. The ocular spines are longer and more acute. The most notable differences are the absence of the upper lateral spine of the basicerite and the form of the larger chela, which is relatively shorter and thicker, more oblong and more swollen medially beneath; its palm is scarcely twice the length of the dactyl, which is strongly curved.

Smaller chela of the first pair is peculiar. Its movable finger is flattened and expanded beyond the base, thus becoming spatuliform, and has a groove armed with a row of hairs close to the edge. The antennal scale is rudimentary and its spine reaches to about the proximal third of the last antennular segment. The ambulatory legs are biunguiculate, with very small hooks.

Sooloo Sea, 6½ and 9 fathoms, and Fiji Islands (Dana); Red Sea (Heller, Paulson). Miss Rathbun identified with it some specimens from Bermuda and Porto Rico, though she noted some important differences. I have myself seen no Bermuda specimens referable to Dana's species.

According to Coutière, *S. neptunus* Dana belongs to a different section (*biunguiculatus* group) of the genus, entirely oriental in

distribution. Coutière states that no species of the biunguiculatus-group occurs in American waters. They are Indo-Pacific species. The original figures of Dana are copied on my plate 25, figures 2, a—d.

The species from the Arafura Sea, identified by Bate as this species, seems to be very distinct. He states that the palm of the large chela is scarcely three times as long as the dactyl. It differs also, in several other respects; the large chela is longer and more ovate, being swollen proximally; its carpal edge is strongly dentate; its carpus is angular, very short and wide; the smaller chela is shorter and stouter; its carpus is longer; the antennular spine is short.

Jousseaumea Coutière.

Bulletin Mus. Hist. Nat., Paris, vol. ii, p. 381, 1896, Ann. d. Sci. Nat. Zool., vol. ix, 1899, pp. 70, 129, 141, 179, 181, 325, figs. 19-23, 134, 215, 216, 217.

The carapace, which is rather depressed, has a dorsal carina; rostrum triangular, flattened; orbital spines small; eyes concealed, or nearly so, by ocular hoods which blend with the rostrum or frontal lobe. Chelipeds very unequal, closely folded beneath the body when at rest; larger one usually with an angular and grooved propodus and cup-shaped or angular carpal segment. Larger chela in typical species has the cutting edges of the fingers serrulate, shutting together closely; palm usually angular and carinate, its inferior surface deeply grooved to fit on the merus when folded; merus angular, elongated. The following species has the palm smooth.

Carpus of second pair of legs 5-jointed; first article longest. Third and fourth legs have simple dactyls; fifth legs have 10 to 12 oblique rows of hairs, as a brush, on the propodus. Mandible has a 2-jointed palpus; its cutting process is much reduced.

Uropods not movable. Telson much narrowed distally; tip narrow, usually with only a single pair of plumose hairs between the four spines at the angles. No anal tubercles. Branchial formula as in *Alpheus*.

Jousseaumea ortmanni (Rankin) Coutière.

Athanas ortmanni Rankin, Ann. N. Y. Acad. Sci., xi, p. 251, pl. xxx, fig. 7, 1898. Verrill, Trans. Conn. Acad. Art. Sci., x, pt. 2, p. 579, 1900 (Bermuda).

Jousseaumca ortmanni Coutière, C. R. Acad. Sci., Paris, vol. cxxxi, p. 356, 1900.

Rostrum slender, acute, extending slightly beyond the second joint of the antennules. Eyes concealed by a hood; edge of hood with a minute acute spine; below the eyes the margin of the carapace is very oblique. Spine of antennules reaches the distal end of the second segment. Antennal scale is about as long as the peduncle of the antennules. Larger chela is smooth, entire, short, thick, swollen, length twice the breadth; fingers slender, hooked, and serrulate on the cutting edges. Carpus of second leg is 5-jointed; first segment is equal to the four distal ones. Telson narrow, compressed; margins smooth. Length about 16 mm.

Bermudas, coll. G. B. Goode, 1 specimen (M. J. Rathbun); New Providence, Bahamas (Rankin, type-locality). It was not taken by us nor by later collectors. Its habits are not known. It may live in sponges.

***Amphibetæus simus* (Guerin).**

Alpheus simus Guerin, op. cit., 1857, pl.

PLATE XXV, FIGURE 5 (after Guerin).

This species seems not to have been rediscovered since the time of Guerin. However, I have a similar specimen, apparently of the same species, taken among branching corals and sponges at Dominica Island in shallow water several years ago by A. H. Verrill. It appears to belong to the genus *Amphibetæus* of Coutière (op. cit., p. 325).

The frontal region is convex, produced far over the eyes, without a rostrum or distinct ocular lobes. The antennular stalk is elongated; the second segment being much longer than the first or third; stylocerite is short, foliate; carpocerite is about equal to the antennular stalk; scaphocerite is of about equal length, with a well formed scale; basicerite is short, dentiform. Guerin's type was from Cuba.

Family **HIPPOLYTIDÆ** Rate, 1888. *Shrimps*.

Eyes not covered by the carapace. Rostrum well developed, usually toothed. Chelæ of first pair of legs not unusually large, nor very unequal; second pair slender, with the carpus variously segmented, and the chelæ small.

Key to the Bermuda genera of Hippolytidae and the Ogyridae.

- A.—Rostrum not very short; carpus of second pair of legs with three articles.
- B.—No exopodite on first pair of legs.
- C.—Rostrum strong, flat, toothed on both edges; third, maxilliped acute, leg-like. *Hippolyte*.
- CC.—Rostrum long acute, rounded above, without teeth; multidentate below; a pair of dorsal spines behind the eyes. Antennules very large. Third maxilliped short, flat, obtuse, without an exopod; tip with marginal spines. *Tozeuma*.
- BB.—An exopodite on first pair of legs; rostrum cultriform; toothed at end; a median dorsal spine on carapace; third maxilliped leg-like; acute. *Latreutes*.
- AA.—Rostrum very short; carpus with more than three articles.
- D.—Carpus of second pair of legs 5-jointed; eye-stalks not very long, uropods not excurved. Third maxilliped not 5-jointed. *Thor*.
- DD.—Carpus of second pair of legs 3 to 4-jointed, with additional imperfect annulations. Eye-stalks long and slender. Uropods excurved; third maxilliped long, slender, 5-jointed. Pl. 47, fig. 6. *Ogyris*.

Hippolyte Leach, 1813. Type, *H. varians*.

Hippolyte Leach, Edinb. Encyclop., viii, p. 432, 1814; Trans. Linn. Soc. London, ix, p. 346, 1815. M.-Edwards and most later writers, in part.

Virbius Stimpson, Proc. Acad. Nat. Sci. Phila., xii, p. 35, 104, 1860 (not *Verbeus*, as spelled by Bate). Smith, these Trans., v, p. 63, 1879. Kingsley, N. Amer. Caridea, Bull. Essex Inst., x, p. 63, 1878; Science, 1899, p. 717.

Hippolyte (restr.) Bate, Voy. Chall., Zool., xxiv, p. 587. Holmes, Synopsis Calif. Stalk-eyed Crustacea, Occasional Papers Calif. Acad. Science, vii, 1900, p. 192.

Carapace is carinate. Rostrum is compressed; toothed above and below. Mandibles are destitute of a palpus. Antennulae are biflagellate; first joint is excavated above. Carpus of second pair of legs is 3-jointed; legs slender.

Antennal scale is well developed and has a spine on the outer margin. Legs of first pair are shorter and stouter than the others: its carpus is excavated distally to receive the proximal end of the chela. Legs of second pair slender, longer than preceding. Other legs are successively shorter; their dactyls are spinulose beneath. Third segment of the abdomen is prominent and somewhat gibbous dorsally; abdomen is not carinated nor spinulose.

Bate and others have legitimately restored the name *Hippolyte* to the group that includes the original type of Leach (*H. varians*). For the large group of arctic and northern species called *Hippolyte* by Stimpson, S. I. Smith (these Trans., v, p. 62) and many others, the name *Spirontocaris* was proposed by Bate in 1887.

Many species of *Spirontocaris* occur on the northern coasts of New England. Most of them are handsomely colored with various patterns of bright red, etc.

***Hippolyte acuminata* Dana.**

Hippolyte acuminata Dana, U. S. Expl. Exped., Crust., p. 562, 1852; Atlas, pl. xxxvi, figs. 1—1e, 1855. Stebbing, op. cit., p. 289, 1914.

Virbius acuminatus Stimpson, Proc. Acad. Nat. Sci., Phila., p. 36 (105), 1860. Kingsley, List N. Am. Caridea, Bull. Essex Inst., Salem, x, p. 63, 1878.

Hippolyte bidentatus Bate, Voy. Chall., Zool., vol. xxiv, p. 591, pl. cv, figs. 1, 2, 1887.

TEXT FIGURE 8, a-f. PLATE XLIII, FIGURES 1, a-l, after Dana. PLATE XLVII, FIGURES 5—5d (after Bate).

This species, as described by Dana, has a slender, acute rostrum with a small spine on both the upper and under margins, at about the distal third. (See our figures copied from Dana.) The first legs have chelæ that are short and only a little larger than the carpus. Chelæ of the second pair are smaller, cylindrical, scarcely larger than the third joint of the carpus and only slightly longer.

It lacks the hepatic spine. The fifth abdominal segment has two small dorsal spines. It can be easily distinguished by the slender rostrum, wider distally, and usually with only one spine, above and below; rarely two below, and by the odd gibbous form of the larger chela.

It was not obtained at Bermuda by our parties. Miss M. J. Rathbun has sent me the following note: "One specimen, a female bearing eggs, was taken in floating weed on the north shore of the Bermudas by the late Dr. Geo. Hawes, Jan. 12. (U. S. Nat. Mus.) It differs from the type in lacking the spine on the superior margin of the rostrum. Sometimes the rostrum in this species has two spines above." (M. J. R.)

It is found among floating Gulf Weed (*Sargassum*) in the central Atlantic Ocean and also along the course of the Gulf

Stream, from Florida to North Carolina. Bate recorded it under the name *bidentatus* as taken by the Challenger Exped., off Bermuda in *Sargassum*.

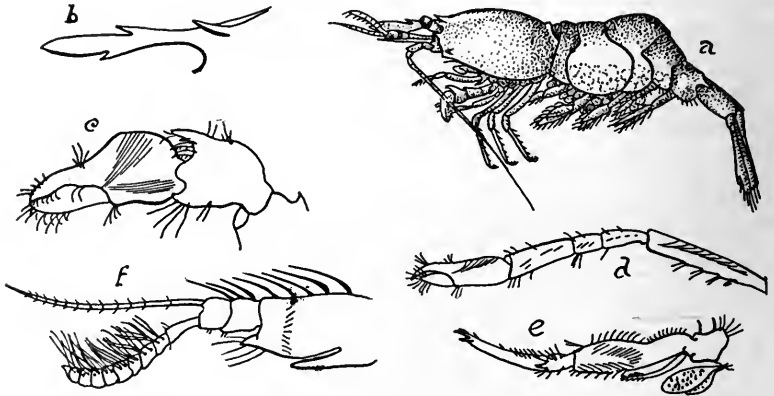


FIGURE 9. *Hippolyte acuminata*; a, female with eggs, enlarged two times; b, rostrum enlarged; c, larger chela; d, leg of second pair; e, first maxilla; f, antennule. After Bate, as *bidentata*.

Tozeuma Stimpson.

Tozeuma Stimpson, Proc. Acad. Nat. Science, Philad., vol. xii, p. 26, 1860. M. J. Rathbun, Brach. and Macr. Porto Rico, p. 114, 1901.

The body is much elongated, tapered both ways, compressed. The rostrum is continuous with the carapace, long and slender, acute, unarmed above, multidentate beneath, sometimes about as long as the body, its dorsal surface is thick and rounded, the margins bent down, forming a channel beneath, lamellate and wider near the base. Antennules are short and biflagellate, outer branch thickened. Antennæ have a very long and large scale.

Mandibles are strong, incurved, undivided, and lack a palpus, crown has numerous dark spinules in many rows. Third maxillipeds are short, and have neither an exognath nor a flagellum; tip flat, blunt, with short marginal spinules, alternate in size, last article longer than preceding one.

The legs are rather short and are without epipods. The first pair are shortest, incurved, stout, and chelate. Chelæ are thick, unequal, bent, tips dentate; the second pair are very slender with the carpus long and 3-jointed, the small chelæ are hairy, finger

bidentate; other legs have a row of spines on the propodus and dactyl and are biunguiculate.

Carapace has a pair of anterior dorsal spines at base of rostrum; last abdominal segment is much elongated and compressed. Telson is tapered, narrow, with four dorsal and four small terminal spines. Uropods have two distal spines at the suture.

Type-species is *T. lanceolatum* St., from Hong Kong. In that species the third, fourth, and fifth abdominal segments are carinated and have a dorsal spine.

Stimpson did not mention the presence of a pair of spines near the base of the rostrum, nor the peculiar structure of the third maxillipeds. He merely says they are short. Nor did he mention the bifid character of the ambulatory feet. Therefore our species may not be strictly congeneric with his type. The characters of the rostrum, antennulæ, jaws, etc. seem to be the same.

Tozeuma carolinense Kings. *Phantom Shrimp*.

Tozeuma carolinensis Kingsley, Proc. Acad. Nat. Sci. Philad., vol. xxx, for 1878, pp. 90, 328; op. cit., xxxi, for 1879, p. 413, pl. xiv, fig. 8 (rostrum), 1880; American Naturalist, xxxiii, p. 715, fig. 8 (rostrum only), 1899. Verrill, these Trans., xi, p. 19, 1901 (desc., Bermuda spec.). M. J. Rathbun, Brach. and Macr. Porto Rico, p. 114, 1901 (as *carolinense*). Hay and Shore, op. cit., p. 391, pl. 27, fig. 2 (photo.), 1918.

PLATE XXIX, FIGURES 3-3m. PLATE XLII, FIGURES 1, 1f. Details. By A. E. V.

This very slender and transparent shrimp can be recognized easily by its elongated form and very long and slender, tapered, dagger-shaped rostrum, longer than the carapace, thick and rounded and without denticles or spines above, but with many minute sharp serrulations beneath; about 16 or 17 in our examples, largest on the proximal part; with 2 to 5 rough hairs between them. The dorsal margin is nearly straight or a little curved upward distally.

The margins turn down so as to form a deep channel on the under side, open for more than half the length, and apparently adapted to enclose and protect the antennules. In our examples one margin is narrower than the other and without denticles. The tip is acute. A small acute spine, curved forward, is situated back

of the eyes on each side of the base of the rostrum; also one below the eye; another at the antero-lateral angle.

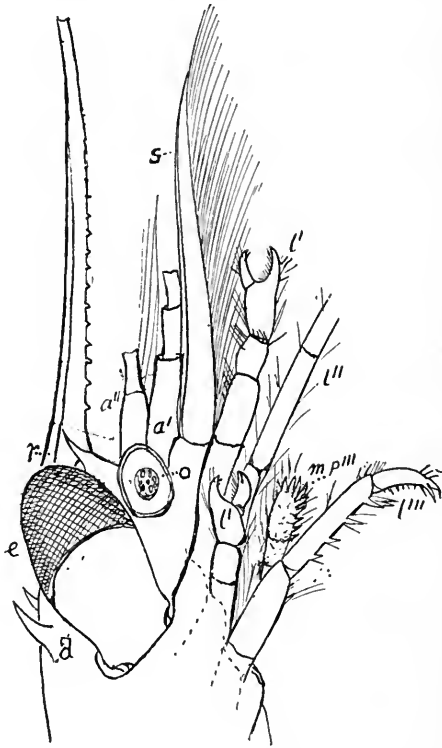


FIGURE 10. *Toxocuma carolinense*. Frontal parts enlarged. a', antennule; a'', antenna; s, scaphocerite scale; o, oöcyst; e, eye; r, rostrum, tip is broken off; d, dorsal spines; l', first legs; l'', second leg; l''', third leg; mp''', maxilliped; from a cotype. By A. H. V.

The body is compressed, most so in the male, especially at the posterior part of the abdomen; it is strongly angulated between the third and fourth abdominal segments; the sixth abdominal segment is elongated and strongly compressed with the margins incurved and nearly meeting beneath; it has a pair of small spines at the base of the telson and also at the inferior angles; the fifth segment has a small lateral epimeral spine on each side.

The eyes are large, cylindric, and their stalks are short. The antennular peduncle is long and stout, with many hairs, first

article much the longest, and with a short, sharp, incurved basal spine, and a thin, linear, acute acicle, in length about equal to the first joint. Its outer flagellum is stout, about half as thick as the peduncle and about eight times longer than wide, and about equal to the combined length of the last two articles of the stalk, and about equal to the antennal scale.

The stalk of the antenna is a little longer than the first article of the antennule; its scale is relatively very large and long, lanceolate and acute, with long marginal hairs; it is about three and a fourth times longer than the antennal stalk, and twice as long as the stalk of the antennule, or about half the length of the rostrum. The basicerite is short, broad, dentiform. The flagellum of the antenna is long and slender; it reaches to or beyond the base of the telson.

The third maxilliped is short and blunt; about as long as the first legs; its distal article is wide, flat or a little concave and obtusely terminated; its distal margin is bordered by a row of about twelve or thirteen spines, alternating in size; the broad surface has two larger oblique rows of stiff hairs, with a smaller cluster near the tip. The carpal article is short, rather longer than broad, and about half as long as the distal article. It has a cluster of hairs on each distal angle, one on the suture, and an oblique row on the surface distally. Part of the hairs are pinnate or plumate; part are slender and plain. The basal article is stout, curved, about three times longer than the distal one; it has a cluster of hairs on each distal angle; a long oblique row on the surface along the distal third, arising from a ridge along a groove; also a series of clusters of shorter hairs on the incurved edge, and an oblique row of stiff hairs near the base, and a few clusters on the convex margin distally.

Legs of the first pair are shorter and stouter than the others, strongly incurved and bent down, with a short carpus and smaller chela. The right and left legs are somewhat unequal as to the form of the chela and carpus, and slightly in length. The longer one (fig. 2, *c, l*), the left one in the example figured, has the merus longer, about equal to the chela, and the carpus about half as long, wider, obovate, hardly cup-shaped distally; the chela is strongly bent inward at the base of the digits; the palm is ovate, swollen, rather longer than the dactyl; the fixed finger is strongly bent down, with the tip acute; the dactyl is wider and rather longer,

with about three small teeth at the apex and a lobe on the inner margin.

The other leg, the right one as figured (fig. 2c, 2c'), has the merus shorter than the chela; the carpus is wider than long, constricted proximally, cup-shaped distally; the palm is broad ovate, swollen proximally, hardly as long as the dactyl; fixed finger is strongly incurved with an acute or slightly hidentate tip. The dactyl is larger and wider, with a large, obtuse, lateral lobe and with about five apical teeth. Both these chelæ have numerous hairs on both the inner and outer margins of the fingers and at the tips. The carpus has a cluster of hairs on the inner distal angle and a row near the distal suture.

Legs of the second pair are slender with a long slender merus and a longer 3-jointed carpus; the proximal carpal joint is the longest, about double the length of the second, which is the shortest; first and second together are about equal to the merus; chela is slender, elongated, longer than third article of the carpus; fingers nearly the same length as the palm, tips with numerous hairs curved forward. Ambulatory legs are rather slender; fifth is smallest and shortest, all have incurved bifid tips; the outer apical claw is longer; dactyls are most curved on the fifth pair of legs; claws are little divergent.

The dactyl on each leg has three or four minute spinules on the inner edge, each with a hair at its base. The propodus of all these legs is nearly twice the length of the carpus; each has a row of spines on the inner margin, each spine with a stiff hair; distally the rows are usually double; proximally single and spines smaller; on all two of these spines stand at the distal end, one on each side of the base of the dactyl; some of these spines have a rough or minutely serrulated inner edge, especially on the fifth leg. On the third and fourth legs there are five or six spines, besides the distal pair; on the fifth leg usually but four. The merus is about the combined length of the carpus and propodus.

The jaws are stout, with a smaller incurved body and flattish, horse-shoe shaped or roundish crown, covered with many close rows of dark-colored minute spinules, and short stiff hairs; spinules divergent at the sinus. One jaw has two blunt tubercles on the crown (pl. 42, fig. 1b), lacking from the other (fig. 1a). They have no branch nor palpus.

The telson is elongated, narrow, width to length about 1:4.7,

convex, and regularly tapered to the tip, which is very narrow, and bears four small spines, the outer ones the shorter; four dorsal spines small.

The uropods are long, rather narrow, about as long as the telson; elliptical, subacute, width to length about 1:4.20. The outer edge of the outer lamella has two small spines at the notch; outer basal spine obtuse, inner one small, dentiform.

The color in life, according to Hay and Shore, is usually green, sometimes gray or grayish red. Our Bermuda specimens were nearly colorless.

Length of the body and rostrum of the larger Beaufort specimen, a female, is 48 mm; length of rostrum, 12 mm; of carapace, 10 mm; of abdomen, 20 mm; of telson, 6 mm; antennal scale, 6 mm; antenna, 40 mm.

Fort Macon and Beaufort, N. C., to Florida, Texas, Porto Rico, and St. Thomas. Very common in the harbor of Beaufort, N. C., among *Zostera* (Hay and Shore). This species was dredged by the Yale party in May, 1901, in Castle Harbor, Bermuda, in 3 fathoms, weedy bottom. The above description and the figures are from cotypes, collected by Prof. A. S. Packard at Beaufort, N. C., and labelled by Prof. Kingsley.

***Latreutes fucorum* (Fabr.) Stebbing. Gulf-weed Shrimp.**

Palaeon fucorum Fabricius, Supl. Entom. Syst., p. 404, 1798.

Hippolyte ensiferus H. Milne-Edw., Hist. Nat. des Crust., ii, p. 374, 1837.

Krauss, Sudafr. Crust., p. 56, 1843. Goodsir, Ann. Mag. Nat. Hist., xv, p. 74, pl. 7, fig. 2, 1845. Dana, U. S. Expl. Exped., Crust., p. 562, 1852.

Latreutes ensiferus Stimpson, Proc. Acad. Nat. Sci., Phila., p. 27, 1860.

Smith and Harger, these Trans., iii, p. 26, 1874. Smith, these Trans., vol. iv, p. 266, 1879. Bate, Rep. Zool. Voy. Chall., xxiv, p. 583, pl. 104, figs. 1-1g, 1888. Verrill, these Trans., vol. x, p. 579, 1900. Rathbun, M. J., Brachyura and Macrura of Porto Rico, p. 114, 1901. Hay and Shore, op. cit., p. 390, pl. 26, fig. 13, 1918.

Latreutes fucorum Stebbing, op. cit., p. 290, 1914.

PLATE XVI, FIGURES 5-5b. PLATE XLII, FIGURES 2-2t. PLATE XLIV, FIGURES 1-1m; 2a-2n, 3.

This small oceanic shrimp has a smooth slender body, with a thin, elongated, smooth-edged rostrum, broadened in the middle, convex below, slightly concave above, obtuse or subtruncate at

the end; there are usually about five small acute spinules at the apex (varying from 1 to 9).

The rostrum is nearly as long as the carapace; breadth to length is about as 1:3.5. The upper edge curves upward somewhat, distally. There is a small median dorsal spine on the carapace back of the base of the rostrum and orbits, and a spine behind the eye. The anterior margin of the carapace has four to eight small denticles below the orbit, on each side. The stalk of the antennules is stout, crooked, excavate at base, bent outward distally (pl. 42, fig. 2). The second article has a strong spine on the outer margin near the distal end; the third article is short, not much longer than broad, distal border obscurely denticulate; outer flagellum is thickened; the basal acicle is long, lanceolate, and acute.

The stalk of the antenna is stout; third article is a little longer than the second (plate 42, figs. 2a, 2a''). The antennal scale is long, wide at base, tapering to an acute tip, it is about three and a half times longer than the third antennal segment, and nearly twice longer than the antennular stalk; the tip has no differentiated spine nor notch.

The third maxilliped (pl. 44, figs. 2n''; 3n''') is elongated and leg-like. Its distal article is long, proportion to that of the preceding article about 2:1; the inner edge is convex, tapered distally to a subacute tip, with a row of about eight or nine acute marginal spines on the distal third of the edge, one of which is apical; rows on the outer edge. On the surface there are about eight obliquely transverse rows of setæ. The penultimate article is short, longer than broad; its distal end has a transverse row of spines and longer hairs on both sides.

The legs of the first pair are incurved, rather short, and relatively stout, unequal; the merus and carpus are excavated beneath; in the larger chela the carpus is large, cup-shaped, broader than long; merus short, stout, with a dentiform lobe on the outer distal angle; the carpus and propodus articulate at the lower angle, so that the propodus can fold inward obliquely.

The larger chela is proximally thick, broad ovate, and tapers rapidly distally. The dactyl is wide, rather longer than the fixed finger, with a broad lateral lobe, and with about five denticles at the tip; it bears many hairs distally and along the margin; the fixed finger is bent slightly inward and strongly arched; tip is

subacute or slightly bidentate, outer convex surface, near tip, has a slight lobe bearing a group of hairs; numerous other hairs are at the tip and along the cutting edge. The carpus has a cluster of hairs on the outer distal angle, part of them plumose, others are long and plain. The merus also bears clusters of hairs on the inner margin and on the outer distal margin.

The smaller chela is more simple and not so much incurved; its fingers are narrower, more acute, and cross each other at the tips; its carpus is narrower, about as broad as long, not so cup-shaped. The palm of the chela is ovate, but not so swollen as in the other chela. Its fixed finger is similar, but more acute and scarcely bidentate at the tip. The dactyl is narrower with a smaller and narrower lobe on the cutting edge, and with only about three apical denticles; it has similar clusters of hairs.

Legs of the second pair are very slender; carpus has three unequal joints; middle one is longest, more than twice as long as the third, and nearly as long as the chela. Third is shortest, enlarged distally. The chelæ are somewhat unequal in size and form. The palm is longer than the fingers, which are incurved and have tufts of hairs at the tips, which have two or three small apical denticles; their margins do not meet except at the tips and have rows of hairs; inner edge of dactyl has a small lobe.

The three posterior pairs of legs are longer, slender, and subequal; propodus and dactyl have a row of spines on the inner edge; dactyl is biunguiculate, or terminates in two incurved claws or spines. The third and fourth legs are nearly alike; the terminal claws are moderately incurved and a little divergent; the inner one is only about half as long as the outer; a few hairs stand at their bases; about four or five minute appressed spinules are on the inner incurved edge of the dactyl. The propodus has a pair of spines at its distal inner angle, one on each side of the base of the dactyl, and also a few longer stiff hairs; along its inner margin there is a row of about seven or eight spines, some of the distal ones paired; proximal ones smaller; each spine is accompanied by a small stiff hair, a corresponding number of small clusters of hairs also occur on the outer margin, sometimes as many as eight.

The fifth leg is similar to the fourth, but somewhat smaller. Its dactyl is shorter and more incurved with about four appressed, minute denticles on its inner edge; the terminal claws are shorter

and more strongly incurved; inner one is not much shorter than the outer; the propodus has about six spines on the inner edge, besides the pair of distal ones, and a corresponding number of small clusters of hairs on the outer margin. The carpus has a spine on the outer distal angle, and about three clusters of hairs on the outer margin. The merus has about three clusters of hairs on the inner edge, besides the distal cluster.

The uropods are narrow ovate, in length about equal to the telson, nearly equal in length; outer the wider, with two sutural spines.

The telson is long and narrow, with the edges turned down; it tapers regularly to the narrow tip, which has a small, spiniform median process; each side of this there are two unequal spines; the inner one is longer than the median process; the outer one much shorter (pl. 42, figs. 2t, 2tx). The length to the breadth of the telson is about 1:3. It has four dorsal spines. Details of structure of various other appendages are illustrated by the figures (plates 42 and 44). In life it is often nearly colorless and transparent; sometimes marked with bluish or brownish patches. Length 15 to 20 mm.

This delicate species is common in floating masses of "gulf-weed" (*Sargassum*). It has been found as far north as Vineyard Sound, Mass. (S. I. Smith.) Very common in the Gulf Stream farther south.

Bermuda (coll. G. Brown Goode). Near the Azores (Milne-Edwards); African Coast (Krauss); Porto Rico (Rathbun); Beaufort, N. C. (Hay and Shore). It has been taken at Bermuda by nearly all collectors. It is nearly always associated with *Leander tenuicornis* and the small crab, *Planes minutus*.

Thor Kingsley.

Thor Kingsley, Proc. Acad. Nat. Science, Philad., Vol. xxx, p. 94 (6), 1878. M. J. Rathbun, Brach. and Macrura Porto Rico, p. 110, 1901.

The rostrum is short, acute, with the upper margin toothed, lower smooth. The carapace has an antennal spine. Antennules have a short thick stalk and are biflagellate; the outer flagellum is very thick, terminated by a short slender spine. Antennal scale is large and wide.

The mandibles are bilobed, but lack a palpus. The third maxil-

lipeds are elongated, leg-like, with an exopod; the last article is long and is spinose at tip and on one side distally; preceding article is much shorter.

Legs of first pair are short and incurved; chela is simple and not much enlarged; legs of second pair are long and slender, with small chelæ; carpus 5-jointed.

Ambulatory legs are biunguiculate, with the dactyl and propodus spinulose; those of fifth pair have a large comb of numerous spines on the distal part of the propodus and inner edge of the dactyl.

Uropods are large; outer lamella larger than the inner; outer edge has short hairs proximal to the sutural spines and notch. Telson is narrow, with the margins turned down and tapered to a very narrow tip, occupied by six spines; upper surface has three to five pairs of spines.

Thor floridanus Kingsley.

Thor floridanus Kingsley, Proc. Acad. Nat. Science, Philad., vol. xxx, 1878, p. 95 (7); Proc. Acad. Nat. Science Philad., xxxi, 1879, p. 421, pl. xiv, fig. 6, 1880; Amer. Naturalist, xxxiii, p. 718, fig. 20 (rostrum), 1899. Rathbun, M. J., Brachyura and Macrura of Porto Rico, p. 116, 1901. Verrill, these Trans., xi, p. 19, 1902 (Bermuda).

PLATE XXXV, FIGURES 2—2f, details. PLATE XLI, FIGURE 1, photograph.
PLATE XLVI, FIGURES 2—2c, details. PLATE XLVII, FIGURES 4, 4a.
By A. E. V.

This is a small, rather plump shrimp, with a short rostrum, shorter than the large black eyes; its upper margin is sloped to the tip and has three to five sharp denticles. The carpus of the legs of the second pair has five unequal segments.

It is easily recognized by its peculiar antennules, the outer flagellum being very thick, with a short, thin, terminal portion, while the stalk is short and thick. The basal article is longer than the other two combined; it has an acute outer basal spine as long as or longer than the article, and also a small distal spine on the inner margin. The second article is short, wider than long, with a small spine on each distal angle.

The third article has at the distal end a small, rounded, thin, flat, leaf-like appendage, with the tip acuminate. The stylocerite is strong, acuminate on the inner edge, acute at tip, and reaches to the end of the first article. The outer branch of the flagellum is

stout, nearly as thick as the peduncle and much longer, tapered but little, and is composed of about 15 articles. It is thickly covered on the inner side with long, soft, crooked olfactory hairs, longer than the diameter of the stalk. The outer flagellum, beyond the thick part, is very slender and not so long as the thick part. The other flagellum is slender and longer.

The carpocerite is shorter, cylindric, about half as long as the antennal scale, somewhat tapered. The antennal scale is large and wide, subovate; its distal end is sinuous or slightly three-lobed; its outer angle is dentiform, but scarcely spiniform; inner edge is rather evenly convex; outer edge nearly straight. The basicerite has a small acute spine; the scale is elongated, twice longer than wide, end obtuse, projecting beyond the spine.

The third maxilliped (pl. 46, figs. 2b, 2c; pl. 47, fig. 4) is elongated and slender with a long terminal article, about three times longer than the preceding one. The terminal article is very hairy having about ten transverse rows of hairs, with clusters of long ones on the margin; distally the tip is curved to one side and the convex surface and tip are covered by sharp spines, usually about eight, mixed with longer stiff hairs. This is an arrangement of spines that I have not seen in any other genus.

The first leg or cheliped (pl. 35, fig. 2c) is small, rather short, and usually incurved. Its chela is bent down, not much longer than the carpus and the palm, carpus and merus are about equal in length; ratio of fingers to the palm is about 1:2.5. Palm tapers distally; carpus is enlarged distally. Tips of fingers curved, thickly covered with hairs; dactyl is more acute and more curved.

The legs of the second pair (pl. 47, fig. 4a) are very slender, with the simple chela slightly thicker than the carpus and about half as long; palm is longer than the fingers. First two articles of the carpus are about as long as the last three combined; first and second are similar in length; fifth is a little shorter; fourth is the shortest, about half as long as the first; the merus is about as long as the first four carpal articles combined.

The ambulatory legs are biunguiculate. Those of the third and fourth pairs (pl. 46, 2d) have the two terminal claws curved nearly in line with the edges of the curved dactyl, and not much divergent, and the dactyl has four spinules on the inner edge. The propodus is long, about three and a half times longer than the dactyl; it has about seven or eight spines along the inner margin, besides

the distal pair, and about the same number of clusters of hairs on the outer margin. The carpus is stouter, about half as long, and has a distal outer spine.

The legs of the fifth pair (pl. 35, figs. 2d, 2d') are quite different and have a complex comb of hairs and spines on the propodus and dactyl. The dactyl is slender, elongated, incurved at the base, and has numerous spinules (12 or more) on the inner edge; the terminal hooks are slender and not much curved. The propodus is flattened, widest in the middle, convex on the inner edge, and concave on the outer edge. It has on the convex distal half of the inner edge, a long comb of about 24 rows of small acute spinules. The carpus is not quite half as long as the propodus. The merus is about two and a half times longer than the carpus.

The sixth abdominal somite ends in a small dorsal median spine and dentiform angles at the bases of the uropods. The outer margin of the outer lamella of the uropods has a row of small hairs along its entire length, proximal to the suture. A tooth and an articulated spine occupy the sutural notch. The outer lamella is the larger and longer.

The telson is long and narrow, regularly tapered to a small tip, which is entirely occupied by six terminal unequal spines, except for a minute median papilla (pl. 35, fig. 2e, t). There are four or five pairs of small spines on its dorsal surface, with rudiments of one or two more; near the base there is an incurved ridge, with a spiniform tooth toward the margins; the lateral margins are turned down.

Females dredged by us in "The Reach," in 2 to 3 fathoms, May 5, 1901, carried large eggs, rather few in number. Key West (type locality); Harbor Key and Sarasota Bay, Fla. (Kingsley). Gulf of Mexico, 25 fathoms, Station 2370; off Cape Catoche, Yucatan, 24 fathoms, Station 2365; St. Thomas and Porto Rico (Rathbun). I have examined cotypes from Key West, Florida. It occurs most frequently among algæ, sponges, etc. in shallow water.

Our Bermuda specimens differ somewhat from those described by Prof. Kingsley and M. J. Rathbun from Florida and the West Indies, especially as to the rostrum, and should perhaps constitute a distinct species or subspecies. But details of the typical form have not been figured, except the rostrum by Kingsley (see our plate 16, fig. 7), which he described as having five teeth on the

upper side and the tip less acute. In our Bermuda specimens (pl. 46, fig. 2, a; pl. 47, figs. 4, 4a) the rostrum is somewhat elongated with an acute tip, and with only three sharp teeth on the upper side, except the one at the bifid tip, usually present. That of a half grown specimen is more slender and the very acute tip is not at all bifid, there being only three teeth.

Family **PROCESSIDÆ.**

Lysmatidæ of many authors.

The mandibles have no palpus and no incisor lobe. Rostrum is usually small and horizontal. One or both of the legs of the first pair of legs chelate. Legs of second pair slender; carpus is much subdivided; their chelæ are small and simple.

Processa Leach, 1815.

Nika Risso, Hist. Nat. Crust., p. 85, 1816.

One of the legs of the first pair is chelate, the other usually simple, but sometimes chelate; legs of the second pair slender, unequal; merus channelled. Rostrum small, dentate.

Processa canaliculata Leach, var. **bermudensis** (Rankin). *Changeable Shrimp.*

Processa canaliculata Leach, Mal. Podoph. Brit., pl. xli and text, July 1, 1815. Rathbun, M. J., Brachyura and Macrura of Porto Rico; Decapod Crust. N. W. coast N. A. Harriman Exped., p. 110, 1904, p. 104, 1901 (descr.). Stebbing, Crust. S. Africa, Part iii, p. 91 (synonymy, etc.). Schmitt, Dec. Crust. Calif., p. 81, pl. 12, fig. 6, 1921.

Nika edulis Risso, Hist. Nat. Crust., Nice, p. 85, pl. iii, fig. 3, 1816. Bell, Brit. Stalk-eyed Crust., p. 275 and fig., 1863. Bate, op. cit., p. 527, pl. xcv, 1885. Heller, Crust. S. Europe, p. 332, pl. 7, figs. 17-19, 1863. Jourdain, Comptes Rendus, lxxxvii, p. 302, 1838 (changes in color). Faxon, op. cit., p. 252 (color changes).

Nika bermudensis Rankin, Ann. N. Y. Acad. Sci., xii, p. 536, pl. xvii, fig. 2, 1900.

PLATE XVI, FIGURES 6-6b. PLATE XXXV, FIGURES 1-1g. var. PLATE XLI, FIGURE 4, photo. PLATE XLVII, FIGURES 8, 8a, 8b (after Bate).

The rostrum is not dentate, small and short, slender, nearly straight, shorter than the eyes, obscurely bifid at the tip, which bears a few slender hairs (pl. 35, fig. 1, r). The antennal flagellum is about as long as the body. The telson has six unequal

apical spines (fig. 1g). The anterior legs are usually unsymmetrical. One of the first pair is chelate, the other generally not so (figs. 1d, 1d'), but exceptions often occur; those of the second pair are very unequal in length, but both are chelate, long and slender, the longer one about two-thirds the length of the body; tips of chelæ cross. The chela and carpus of the second legs fit into a channel in the merus and ischium. Ambulatory legs are very slender (fig. 1f).

According to Miss Rathbun the American specimens have the legs more slender than in the European specimens examined by her. Dr. Rankin considered it distinct. The species is variable in the length of the rostrum, size of eyes, antennal articles, etc., and is said to have unusual ability in changing its colors. It is sometimes over two inches long.

This species was first taken in Bermuda by Mr. Goode in 1877. It was also taken by Dr. Rankin, in Harrington Sound, 1 fathom.

Widely distributed in the Atlantic and Pacific, and from 1 to 111 fathoms; Europe; Mediterranean Sea; Madeira (Stimpson); Japan (Ortmann); off North Carolina, 32 and 25 fathoms; West Coast of Florida, 17 and 45 fathoms; off Cape San Blas, Fla., 25 and 111 fathoms; Trinidad, Porto Rico; Old Providence, W. I. (Rathbun). Bermudas (G. Brown Goode, coll.); also by Dr. Rankin. S. Africa (Stebbing). West Indies to Trinidad; San Diego, Cal. to Panama (Schmitt).

My figures (plates 35 and 41) were made from a cotype, sent by Dr. Rankin, of his species (*P. bermudensis*), which I have here treated as a variety, for lack of foreign specimens for comparison.

The following description is from a cotype sent by Dr. Rankin: Rostrum small, narrow, slender, about equal in length to eyestalks; lower margin is slightly concave, but the edges are nearly parallel, minutely bifid (pl. 35, fig. 1, r); eyes large, on short stalks. Antennules stout, incurved and excavate at the base, under the eyes (fig. 1a); first article longest, second 1.5 longer than the third; outer flagellum has the thick part slightly fusiform.

Antenna (figs. 1a, 1b) slender; carpopercite about equal to one third of the first antennular article; its scale (s) is long and narrow, breadth to length about 1:14; its margins beyond the base are nearly parallel; tip sub-acute; it reaches beyond the carpopercite and about to the middle of the third antennular article; basipercite (b) is oblong ovate and blunt.

Third maxilliped is large and long, reaching beyond the antennular peduncle; basal article is very long, a little curved, and reaches the end of the carpocerite; carpal article is nearly as long as the terminal one, which tapers to a spiniform tip; an oblique row of small spinules runs back from close to the tip; other less oblique rows cross it (fig. 1, mp.); the outer side has two or three slender acute spines, a similar one is on the end of the carpus; hairs long, not numerous.

Legs of the first pair or chelipeds are unequal in size and structure, though about equal in length (pl. 35, figs. 1d, 1d'). One is strongly chelate (1d') and is the stouter one. The chela is not distinctly thicker than the merus and carpus; it is elongated and tapered from near its base, and about as long as the carpus; margins of the palm are a little convex; fingers are slender, incurved, acute, about equal in size; the tips cross when closed; length of dactyl to palm 1:1.7; marginal hairs few; small apical groups on the fingers. Carpus is longer than wide, about as 1:1.5, and distally about as thick as the chela and about half as long as the chela; merus is long and stouter than the carpus; length to carpus about as 1:3.25; its breadth to length about 1:4.6; slightly swollen in the middle. The other leg of the first pair (1d) is rather more slender, especially the carpus and propodus, and it is not chelate. The propodus tapers from the base to the narrow end at the base of the dactyl, which is somewhat incurved and acute, about one sixth the length of the propodus.

Legs of the second pair (figs. 1e, 1e') are both chelate but very unequal; one (1e) is much more slender than the other (1e') and has the carpus multiarticulate. Both have the chela elongated with the fingers incurved, acute, and crossed when closed. The ambulatory legs (1f) are long and slender, with the carpus and propodus elongated and subequal; dactyl simple, long and slender, little curved.

The uropods (fig. 1, g, u) are elongated; outer one is oblong, obtusely rounded distally; inner one is rather wider, shorter and more ovate; distal sutural spine is acute. The telson (t) is narrow, elongated, regularly tapered to a narrow tip, which bears three pairs of unequal spines, the intermediate pair much the longer; others subequal; a minute denticle occupies the middle. The four dorsal spines are relatively long and acute.

Family PALÆMONIDÆ (*pars*) Leach, 1819.

Palæmonina Dana, op. cit., 1852, p. 569.

Palæmonida Bate, op. cit., 1888, p. 778.

The carapace is well rounded above, not much compressed; rostrum is usually long and compressed, generally with denticles. Eyes are usually pryiform and rather large, often with an adjacent ocellus on the outer end of the stalk. Antennules with the basal joint wide and excavated above, externally with a spine and scale; outer flagellum often branched.

Antennæ with a large foliaceous scale or scaphocerite, its thickened outer margin ending in a tooth-like point or spine. Mandibles deeply cleft; furnished with a molar and a cutting edge; palpus sometimes lacking, usually with two or three joints.

Outer maxillipeds are slender, very hairy, leg-like. First and second legs are long, chelate; chelæ of the second pair usually the larger; its carpus is not subdivided. Second pair of legs often very long and strong. Telson is usually narrow, with the margins turned down; tapering to a narrow tip, armed with two or three pairs of spines.

Key to the Bermuda genera of Palæmonida.

- A.—Carapace lacks a hepatic spine, mandibles have a palpus. Dactyls simple. *Leander*.
- A'.—Carapace has a hepatic spine.
- B.—Mandible has a palpus.
- a.—Rostrum strong, with a lateral rib. Legs of second pair are notably long and large. *Palæmon*.
- a'.—Rostrum slender and thin, toothed above and below. Second legs not unusually large. *Palæmonella*.
- B'.—Mandible is without a palpus.
- b.—Abdomen unusually elongated and compressed. Dactyl of ambulatory legs bifid. *Urocaris*.*
- b'.—Abdomen of the usual form, not notably elongated. Dactyl of ambulatory legs simple. *Periclimenes*.

* *Urocaris longicauda*, the type, is not yet positively known to occur at Bermuda. Its range is from Brazil to Beaufort, N. C. Common in the West Indies and Florida Keys. The type-species has the dactyls of the ambulatory legs biunguiculate; others referred to the genus have them simple.

Leander Desmarest.

- Leander Desmarest*, Ann. Soc. Ent. France, vol. vii, pp. 87, 91, 1849.
 Stimpson, op. cit., 1860, p. 40. Ortmann, op. cit., vol. v, p. 513, 1890.
 Stebbing, op. cit., 1893, p. 246; op. cit., 1914, p. 286.
Palæmon Bate, op. cit., 1888, p. 781. M. J. Rathbun, op. cit., 1901, pp. 123, 125.

The carapace is usually not much thickened; it has no hepatic spine, but has antennal and branchiostegal spines. Mandibular palpus either 2-jointed or 3-jointed. The legs of the second pair are not unusually elongated. Telson subacute, with apical spines.

Mostly marine and of rather small sizes, as compared with the species of *Palæmon*.

Leander affinis (H. Milne-Edwards). *Transparent Shrimp*.

- Palemon affinis* Milne-Edwards, Hist. Nat. Crust., ii, p. 391, 1837.
Palæmon affinis Dana, Crust. U. S. Expl. Exped., p. 584, 1852; Atlas, pl. xxxviii, figs. 5-5g, 1855. Bate, Challenger Reports, Zool., xxiv, p. 782, pl. cxxviii, fig. 5, 1888. Stone in Heilprin, The Bermuda Is., p. 151, 1889 (Bermuda). Rathbun, M. J., Brachyura and Macrura of Porto Rico, p. 125, 1901.
Leander affinis Ortmann, Zool. Jahrb., vol. v, p. 521, 1890. Stebbing, Ann. S. African Mus., vol. iv, p. 386, 1910; Trans. Royal Soc. Edinburgh, vol. 1, part 2, No. 9, p. 287, 1914.

PLATE XLIII, FIGURES 3, 3a, 3b. PLATE XLVII, FIGURE 7. (Both after Bate.) PLATE XLVIII, FIGURES 4-4d. By A. E. V.

The rostrum is rather long, acute, usually with 8 to 10 teeth above (sometimes 7), 2 or 3 of them are on the carapace; and with 3 or 4 below. From the rostrum a dorsal carina extends back to the middle of the carapace. Antennal scale is usually broad; its spine shorter than the scale.

The following description is from Bermuda examples: The antennular scale is large, flat, and reaches the second segment of the peduncle; it has two sharp spines on its edge. The antenna has two small basal spines and a large scale, longer than the antennular peduncle and nearly as long as the rostrum; its spine is not quite so long as the lamellar part. The mandibular palpus is 3-jointed.

The rostrum is elongated, curved upward distally; acute at tip, which appears bifid; its upper edge has ten teeth, of which three are behind the eye-socket and the last is close to the tip; about four

strong teeth are situated below. There are two small, submarginal teeth below the eye; the upper one is the larger.

The telson is long and narrow, tapered, subacute, with two pairs of sharp spines at the narrow end, and a smaller one at each angle; two plumose hairs at the center, which is dentiform.

One of the larger specimens has the total length, from tip of telson, 45 mm; length of carapace from orbit, 8 mm; of rostrum, 9 mm; of telson, 7; of the four longer antennular, flagella from base of stalk, 25 mm; of antennal flagella, 50; outer antennular flagella from base of stalk, 10; length of stalk, 4; antennal scale, 8.5, length of second leg, 18.5 mm; chela, 5; carpus, 4.5; merus, 4.5; ischium and base, 4.5 mm.

This species is nearly colorless and transparent when living, and not very easy to see when swimming. Common at Bermuda, in 1898. It occurred in schools close to the shore and around wharves. It was also in the early collections of J. M. Jones. It is widely distributed in the warmer parts of nearly all the oceans. New Zealand (Milne-Edwards, Dana). Port Jackson, Australia (Bate). Bermudas (Heilprin, Ortmann). Porto Rico (Rathbun).

Leander tenuicornis (Say). *Common Gulf-weed Shrimp.*

Palæmon tenuicornis Say, Journ. Acad. Nat. Sci. Philad., i, p. 249, 1818.

Hay and Shore, op. cit., p. 392, pl. 27, fig. 6, 1918.

Palæmon tenuirostre M.-Edw., Hist. Nat. Crust., ii, p. 395, 1837. Bate, Voy. Chall., vol. xxiv, p. 784. (*tenuirostris*.)

Palæmon natator M.-Edw., Hist. Nat. Crust., ii, p. 393, 1837 (*Palæmon*). Goodsir, Ann. Mag. Nat. Hist., xv, p. 74, pl. vii, fig. 3, 1845. White, List Crust. Brit. Mus., p. 77, 1847. Dana, U. S. Expl. Exped., Crust., p. 588, 1852; Atlas, pl. xxxviii, figs. 11-11a, 1855. Heller, Crust. sud. Europ., p. 268, pl. ix, figs. 11, 12, 1863. Bate, op. cit., 1888, vol. xxiv, p. 784, pl. 128, figs. 6, 7, 1888.

Leander erraticus Desmarest, Ann. Soc. Entom. de France, Ser. II, vol. vii, p. 92, cut, 1849.

Leander natator Stimpson, Proc. Acad. Nat. Sci. Philad., p. 40, 1860.

Leander tenuicornis Kingsley, Bull. Essex Inst., x, p. 66, 1878. S. I. Smith, these Trans., vol. v, p. 122, 1879. Rankin, Ann. N. Y. Acad. Sci., xii, p. 538, 1900. Stebbing, op. cit., p. 288 (descr.), 1914.

Pandalus tenuicornis Rankin, Ann. N. Y. Lyc., xii, p. 544, 1900. (Error for *Palæmon*.)

PLATE XLIII, FIGURE 4, female; 4a, male (after Bate).

The rostrum of the female is broad and thin, not acute; it has about 10 to 12 teeth above and 6 or 7 below, often obscured by hairs. The carapace has no hepatic spines. Mandibular palpus slender, 2-jointed, the second joint longer.

Chelæ of the first pair of legs have fingers distinctly longer than the palm; those of the second legs about equal to the palm. It is nearly transparent when living. Length 30 to 45 mm. The rostrum of the male is longer and more acute.

It is very common among Gulf-weed (*Sargassum*) and is very widely distributed in the tropical Atlantic Ocean. Bermuda (coll. Goode, 1876). Many specimens were taken at Bermuda by my parties, both in 1898 and 1901. Harbor of Beaufort, N. C. (Hay and Shore).

Palæmon Fabr. (restricted). *Long-clawed Shrimps; River Crawfishes.*

Palemon (pars) M.-Edw., op. cit., p. 387, 1837.

Palæmon (pars) Fabricius, op. cit.; M. Edw.; Dana, etc.

Palæmon E. Desmarest, op. cit., 1850, restriction. Stimpson, op. cit., 1860.

Bithynis Phillippi, Weig. Arch. Naturg., vol. xxvi, p. 161, 1860.* Faxon, 1895, etc.

Macrobrachium Bate, Proc. Zool. Soc. London, p. 363, 1868.

This genus, as restricted by Desmarest and Stimpson, differs from *Leander* in having hepatic spines, but no branchiostegial spines, and in having the second pair of legs very large and much elongated, usually becoming longer than the body, in the adult; their elongation is due mainly to the unusual length of the carpus and propodus, which are nearly terete. The carpus is sometimes short. Antennules have three flagella.

* Stimpson, in the same year (1860), made the same divisions as did Phillippi, adopting *Palæmon* (restricted) as the name of this group, and *Leander* Desm. for the other division, including such species as *L. tenuicornis* and allies, which have no hepatic spine. In doing this he followed E. Desmarest, who had proposed these names for the same two divisions made by him, though on other characters. He evidently intended to differentiate these two genera, which were later better established by Stimpson. Many subsequent writers follow Desmarest and Stimpson in the use of the generic names; others follow Phillippi. Strict rules of priority should compel us to use the names proposed by Desmarest unless some better reason can be discovered than has yet been given for doing otherwise.

Mandibles have a 3-jointed palpus. The rostrum is toothed. Most of the species are essentially inhabitants of fresh or brackish water, though they may occur in small streams on remote islands, or off the mouths of rivers in brackish or sea water. Some, like *B. savignyi*, are true marine species. Perhaps some others live in the sea only while young.

The genus is circumtropical, and many of the species are very widely distributed on the oceanic islands, as well as on the continents. There being no fresh-water streams in Bermuda, the several large fresh-water species found in the West Indies are naturally lacking. Many species become large and are used as food in various countries.

***Palæmon savignyi* (Bate). Long-clawed Shrimp.**

Brachycarpus savignyi Bate, Voy. Challenger, Macrura xxiv, pp. 795, 800, pl. cxxix, fig. 4, 1888 (Bermuda).

Palæmon savignyi Rankin, Crust. Bahamas, Ann. N. Y. Acad. Sci., xi, p. 224, 1898. Verrill, these Trans., x, p. 579, 1900 (Bermuda).

Bithynis savignyi M. J. Rathbun, Brach. and Macr., Porto Rico, p. 124, 1901.

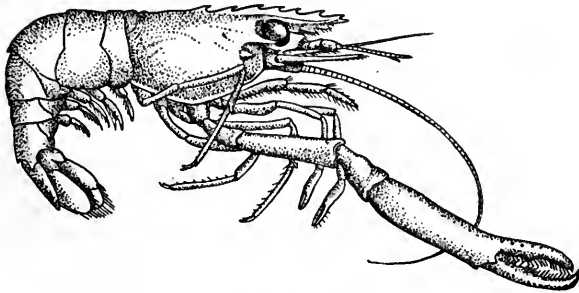


FIGURE II. *Palæmon savignyi*. After Bate.

This species is readily distinguished from its allies by the smooth body and very large legs of the second pair, which have a long cylindrical chela and a short carpal segment. Those of the first pair are slender with small hairy chelæ.

The rostrum, which is straight, extends back in the form of a dorsal carina to the middle of the carapace and has seven teeth above, of which three are over the carapace; there are three on the lower edge of the rostrum.

It belongs to that section of the genus that Bate named *Brachycarpus*, on account of the short carpus of the second pair of legs.

Reported from Bermuda by Bate. It was not taken there by the Yale parties, nor by later collectors, so far as reported. Porto Rico; off Havana, 78 fathoms; off Jamaica, 23 fathoms; Curacao (Rathbun); Bahamas (Rankin).

Periclimenes Costa.

Periclimenes Costa, Ann. Acad. Aspir. Nat. Nap., ii, 1, 1846.

Borradaile, Ann. Mag. Nat. Hist., vol. ii, p. 380, 1898.

Rathbun, Brach. and Macrura, Porto Rico, p. 121, 1901.

The carapace has antennal and hepatic spines. The rostrum is elongated and compressed, nearly straight, usually more or less dentate above and below; tip slender, acute. Antennulæ are biflagellate, the larger flagellum rather long, thick, and bifid; stalk is wide, excavate, with a large basal scale on the outer side. Antennal scale long and rather large.

Legs of first and second pairs slender with simple chelæ; second pair the longer and larger, about as long as the body. Other legs have acute dactyls. Telson narrow, tapered, subacute or acute, with four dorsal and four or six terminal spines. The statocyst contains a round concretion made up of concentric layers, without any sand grains.

This genus has been referred to the family *Pontonidæ* by several writers, but it seems to me more closely related to *Palæmonidæ*. It agrees pretty closely, in most of its characters, with *Leander*, *Palæmonella*, *Palæmonetes*, etc. while it is quite unlike *Pontonia* and allied genera, which have a small and mostly edentulous rostrum. It has the rostrum, telson, an excavate antennal stalk with a lamellate antennular scale, and a large antennal scale formed much as in *Leander*, etc. It closely resembles *Palæmonella*.

Periclimenes americanus (Kingsley) Borr.

Anchistia americana Kingsley, Proc. Acad. Nat. Sci. Philad., xxx, 1878, p. 96, 8 (Key West); Bull. Essex Inst., vol. x, p. 65; vol. xiv, p. 109, pl. ii, figs. 10-10a, 1882; American Nat., xxxiii, p. 718, figs. 10-10a.

Periclimenes americanus Borradaile, Ann. Mag. Nat. Hist., ser. (7), vol. ii, p. 383, 1898. Verrill, these Trans., x, p. 580, 1900, Bermuda. Rathbun, M. J., Brachyura and Macrura of Porto Rico, p. 121, 1901.

PLATE XLI, FIGURE 2. PLATE XLV, FIGURES 1—1c; 2—2t. By A. H. V.
PLATE XLVIII, FIGURES 1—1c. By A. E. V.

This can be easily distinguished from the other allied small shrimps of this region by the rostrum, which is rather slender, acute, nearly straight, with about eight to ten teeth above and two to four below, at its wider distal portion.

The telson is also characteristic. It is long-ovate, tapered to the narrow tip, which is armed with six unequal spines and has an acute median apex. The legs of the second pair are about as long as the body. The following description was made from females carrying eggs, taken April 19, 1898, at Long Bird Island, Bermuda.

Body gibbous, about 22 mm long, rather stout. Rostrum lanceolate, laterally carinate, as long as the antennular peduncle. It begins well back of the eyes at a dorsal tooth, well separated from the next; three teeth are behind the eyes; altogether there are 8 to 10 dorsal teeth; inferior teeth are smaller, usually three, often two, on the widest part. The end of the rostrum is thin, flat, moderately wide; tip very acute, a little turned up.

The antennal scale is large, wide, obtuse, more than twice as long as the stalk and longer than the antennular stalk; its distal spine is a little longer than the scale; it reaches about to the end of the antennular stalk (figs. 2b, 2b'), which is wide and excavated at the basal segment. Basal segment is about equal in length to the second and third combined; it has a small, wide, inner spine, and a large outer scale, reaching to the second segment and having a sharp spine on its outer distal angle, with a row of stiff plumose hairs on its end. The second segment has a narrow thin border fringed with hairs (pl. 45, figs. 1, 1a, 2a). The outer flagellum is thickened and at the ninth or tenth joint gives off a slender branch; the part beyond the branching tapers to a slender tip. The statocyst contains a roundish concretion made up of concentric layers.

The third maxilliped is very hairy and obscurely 5-jointed. Its third article is strongly incurved, enlarged distally, and bordered by small spinules and longer hairs (figs. 2n'', 2n'''). The fourth joint is about equal in length to the third, straight, and covered with long hairs, with a large distal cluster on the inner angle. The last article is somewhat shorter than the preceding and tapers to a narrow tip; it has about seven transverse rows of hairs and a longer terminal cluster, without spines.

The eye is large, cylindrical, with a separate ocellus (figs. 2a, 2e). The margin of the carapace has a single marginal spine below and close to the eye-socket, and a minute hepatic spine a little distance back of and below the eye.

Larger second chela is elongated, slightly swollen in the middle; the thumb is a little bent down; the palm is about one and one-third times longer than the dactyl; the fingers are slender, bent inward at the acute tips, which cross when closed; inner edges have three small obtuse denticles proximally. The left chela is usually rather smaller. The carpus is about as long as the palm, terete, gradually enlarged distally; merus is about seven-eighths the length of the carpus.

The legs of the first pair are more slender; the chela is not much wider than the carpus; its fingers are equal to or slightly longer than the palm; the chela is four-fifths the length of the carpus; the carpus is considerably longer than the merus, which is about equal to the chela. The merus is cylindrical, slender, and has a small distal spine.

The legs of the third pair are slender; the propodus is nearly twice as long as the carpus and has a row of five slender spines besides a longer and two smaller distal ones, all accompanied by one or two hairs; carpus much shorter; distal angle spiniform, hairy. Dactyl is slender, a little curved, acute; sometimes with a double tip (fig. 1c).

The telson is rather narrow, elongated, subtriangular, width to length about as 1:2.7, tapered regularly distally, with an acuminate tip, ending in a small, sharp, narrow apex; each side of the tip are three slender spines, the intermediate one about twice as long as the inner and four times as long as the outer one. The dorsal surface has two pairs of spines; sometimes two couples, side by side, anterior to the middle, one of each couple smaller; and a pair of more slender ones near the distal end. Uropods are long; outer lamella wide, ovate, with a spine and an acute denticle at the notch.

Other specimens of similar size (probably males) have the first and second pair of legs much longer (longer than the body), with more elongated chelæ. Otherwise they are similar to those described above.

The following note was made from living specimens: "Color, in life, translucent grayish white, with numerous small, round

darker spots, which form a row on the posterior margin of each abdominal segment; two larger median spots and two larger lateral spots on the caudal fin, which is tipped with orange-brown. Each segment is also crossed by a narrow brown band. On the carapace are three oblique orange-brown lateral lines, and a pair of dorsal lines running back from the base of the rostrum. The color so nicely matched that of the whitish shell-sand bottom of the tidal pools in which they were found, that it was difficult to see this shrimp when still." Long Bird Island flats, at low tide, April 29th, 1901. It swims in large schools, often near the surface.

Numerous Bermuda specimens of this species, from several different collections, are in the Yale Museum. It was common in shallow water, in April and May, 1898, and 1901. Some of the females carried eggs at that time (Yale Exp.). It is common in the West Indies and Florida. Key West (Kingsley). Gulf of Mexico, 26 and 33½ fathoms; off Yucatan, 24 fathoms; Old Providence; St. Thomas, W. I.; Jamaica; and Porto Rico, 6 to 23 fathoms (Rathbun).

This species has been referred to the Pontonidæ by several authors, but I can see no reason for separating it from the Palæmonidæ.

Palæmonella Dana.

Palæmonella Dana, U. S. Expl. Exped., p. 582, 1852; Bate, Voy. of the Challenger, xxiv, p. 786, 1888.

This genus is very near *Palæmon*. It has a tooth on the front edge of the carapace and another behind it, at nearly the same level, on the hepatic region, as in *Palæmon*. The rostrum is thin and slender, serrate above and below, and the carpal joint of the second pair of legs is much shorter than in the latter, and has a distal spine. The mandible has a two-jointed palpus.

Palæmonella tenuipes Dana (?).

? *Palæmonella tenuipes* Dana, U. S. Expl. Exped., p. 582, 1852; Atlas, pl. xxxviii, fig. 3-3d, 1855. ? Stone, in Heilprin, The Bermuda Is., p. 151, 1889. ? Rankin, Ann. N. Y. Acad., xii, p. 538, 1900. (Bermuda, no description.)

PLATE XLIII, FIGURES 2, a-c, after Dana.

This species was not taken by the Yale parties, nor by any of the later ones. Bermuda specimens may not be the true *tenuipes* of Dana. It may have been *Periclimenes*, which is very similar. Dr. Rankin stated that his Bermuda specimens differ somewhat from Dana's description of the type, from the Sooloo Sea, but no description of Bermuda examples has been given. Bermuda (Heilprin*; Rankin). Its occurrence at Bermuda needs confirmation. I have reproduced Dana's figures of the type.

Mr. Ives has more recently described another species of the genus from Yucatan. (See Bibliography.)

Family **GNATHOPHYLLIDÆ** Kingsley.

Drimoide Ortmann, op. cit., p. 425, 1896.

Body is rather stout; carapace is carinate anteriorly. The first and second pairs of legs are long, chelate, and plain; chelæ similar; the second pair are longer and larger. The rostrum is toothed, short and compressed or lacking. The third maxillipeds have the antepenultimate segment remarkably large and broad and operculum-like; two distal ones small and flat; last one ovate. The mandibles have no palpus and no cutting lobe; ambulatory legs are biunguiculate. In our species the third maxilliped is 5-jointed. The family contains only the following genus.

Gnathophyllum Latreille.

Gnathophyllum Latreille, Nouv. Dict. Hist. Nat., ed. 2, vol. xxx, p. 72, 1819. Cuvier, ed. 2, xxx, p. 72, 1829. M.-Edw., op. cit., 1837, p. 369. M. J. Rathbun, op. cit., p. 126, 1901.

Drimo Risso, Hist. Nat. Europe, Merid., vol. v, p. 70, 1826-29. Sharp, Proc. Acad. Nat. Sci. Philad., p. 124, 1893.

Characters of the genus are the same as for the family.

Gnathophyllum americanum Guerin. *Zebra Shrimp*; *Banded Shrimp*.

Gnathophyllum americanum Guerin, in LaSagra's Hist. Cuba, vii, p. xx, 1857; Atlas, viii, pl. ii, f. 14 (front only). M. J. Rathbun, Brachyura and Macrura of Porto Rico, p. 126, 1901. Verrill, Amer. Journ. Science, xi, p. 328, 1901; these Trans., vol. xi, p. 20, 1901 (Bermuda, descr.).

*It is not enumerated by Mr. Sharp as now in the Museum of the Philadelphia Academy, with the other crustacea from Heilprin's collection. (See Bibliography.)

Gnathophyllum fasciolatum Stimpson, Proc. Acad. Nat. Sci. Philad., xii, p. 28, 97, 1860; Haswell, Cat. Austral. Crust., 181, 1882. (t. M. J. R.)

Gnathophyllum zebra Richters, Meersfauna Mauritius u. d. Seychellen, p. 161, pl. xvii, figs. 18 to 20 and 22, 1880.

? *Gnathophyllum pallidum* Ortmann, Zool. Jahrb., Syst., v, p. 537, 1890. (t. M. J. R.)

PLATE XVI, FIGURE 7 (rostrum). PLATE XLI, FIGURE 3 (from photograph).
PLATE XLVI, FIGURES 1-1k. PLATE XLVIII, FIGURES 5, 5a. By
A. E. V.

The carapace is slightly carinate near the front; the carina extends to the rostrum; there is a small acute spine back of the orbit and a dentiform angle at the lower anterior angle.

The rostrum is short with a downward sloping upper margin, bearing five or six teeth; tip acute; sides have a lateral carina near the lower edge, which sometimes has a very small tooth near the tip. The eyes are large and prominent, cylindric, faceted part very convex, oblique; there is a small prominent faceted papilla at the apex.

The antennules are very small; the stalk is short; basal article with a wide stylocerite, having two subequal spiniform cusps; the outer branch of the flagellum is thick, with about six simple joints bearing many long soft hairs; at the sixth joint it branches, giving off a slender outer flagellum composed of about seven elongated articles; beyond the branching the terminal part is small, composed of about five or six obscure articles, which bear on the inner side many soft crooked hairs. The inner flagellum is slender, a little longer than the other, composed of about sixteen articles.

The antennæ are small, but larger than the antennules; the stalk is longer; the third article is cylindric; they are unequal; the larger one has an obtuse outer distal tooth, bearing a cluster of hairs (pl. 46, fig. 1b); its flagellum is long and slender; its scale is shorter and not so ovate; it is equally wide at the widest part, but tapers more rapidly, its widest part being at about the proximal third (fig. 1c'); its breadth to length is about 1:2.

The third maxilliped is very large, broad, foliaceous, convex, and 5-jointed; the principal part consists of the second and third articles united by a distinct oblique suture, with a small sutural notch on the inner edge. At this notch the marginal hairs or setæ change in form and size. The combined second and third articles are broad, obovate, convex, and operculum-like; when in place

they entirely cover the oral region. The inner edge, distal to the suture, bears a close comb-like row of short pinnate hairs or setæ (fig. 1d, h, and fig. 1d'); proximal to the sutural notch there is a row of longer and less close simple stiff hairs or setæ. The outer margin is stiffened by a marginal rib and bears only a few hairs. The exopod is long, flattened, and widest proximally, slender distally and tipped with hairs. The basal article has a thin foliaceous lobe over the base of the exopod. The fourth or penultimate article is relatively small, flat, thin, about as wide as long; inner edge is curved and bears a row of hairs; outer edge has an obtuse angle with a cluster of hairs. The last article is small, elliptical, flat, longer than the preceding, with a marginal row of hairs on the inner and distal edges. No spines are present on either article.

The two large foliaceous, convex articles are held, in life, with the inner edges in contact, thus forming a prominent convex roof or operculum over the oral region; in profile it looks somewhat like a large obtuse nose.

Legs of the first pair are long and slender, with a small, plain, elongated chela, not much thicker than the carpus; fingers with many short hairs distally; fingers two-thirds the length of the palm; the chela is about four-fifths the length of the carpus, which is about two-thirds the length of the merus.

The legs of the second pair are much larger. The right and left chelæ differ somewhat in size but are of the same length. The right one (fig. 1f), in the example figured, is stouter than the left one; both are flattened. The fingers are about two-thirds the length of the palm; the chela is about twice the length of the carpus, which is about equal to the merus. The ambulatory legs are all flattened and biunguiculate, not particularly elongated. Those of the third and fourth pairs have the dactyl rather moderately curved; terminal claws are short, strongly divergent, inner one is shorter and at base thicker; inner edge of the dactyl has two or three spinules. The propodus is elongated; the inner edge has a row of about four spines, besides the distal pair; the carpus is about half as long and has a distal blunt spine (fig. 1g).

The small detached leg, believed to be of the fifth pair (figs. 1h, 1h'), differs from the preceding in having five spinules on the inner edge of the dactyl, and a distal oblique dense brush of numerous hairs of different lengths, the longest pinnate, and a row of about 10 spines along the inner margin, with a corresponding

number of small clusters of hairs on the outer margin. There is also a larger and longer cluster of hairs on the outer distal angle.

The sixth abdominal segment has a pair of lateral denticles and another pair beneath and a pair of angular teeth at the base of the telson. The uropods have broad ovate lamellæ, nearly equal in length and breadth; the outer one has a prominent sutural tooth and an acute articulated spine (pl. 46, fig. 1j).

The telson (fig. 1k) is narrow, regularly tapered to a narrow tip, which ends in a minute papilla; otherwise the whole tip is occupied by six slender spines. The median pair are very slender and about half as long as the next pair, which are much stouter; outer pair short. There are two pairs of dorsal spines, but both are close to the margins; the distal pair are not far from the end and appear like marginal spines. When partly dry a slender median carina is visible. Length of the largest specimen from Bermuda, 22 mm; breadth, 6 mm.

The unsymmetrical development of the antennal scales, chelæ, etc., is a notable feature. In life the color is white, crossed by ten or more conspicuous, narrow, orange bands, some of which are incomplete. The bands are formed of small, close specks of orange; on the sides of the carapace are six to eight oblique divergent lines of the same color, one of which begins on each side of the base of the rostrum; three radiate from the orbits of the eyes; one is nearly transverse; there is also a spot on the cardiac region. Antennæ and antennules orange; legs are banded with orange.

The colors are distinct in some specimens nineteen years after preservation in alcohol.

This rare and curious species was taken April 5, 1901, at Hungry Bay, by A. H. Verrill, who made a colored sketch of it from life. One carried eggs. It was also in the earlier collections of Mr. Goode and J. M. Jones. Cuba (Guerin). St. Thomas, Porto Rico (Rathbun). Gulf of Mexico, 26 to 27 fathoms (Rathbun); Bermudas (G. B. Goode, coll.); Port Jackson, Australia (Stimpson); Mauritius (Richters); Tahiti (Ortmann).

Hay and Shore (op. cit., p. 395, pl. 28, fig. 1, 1918) have described another species as *G. modestum* (Hay, 1917), from off Beaufort, N. C. It differs from the above, among other ways, in lacking the color bands. Its body was brownish red; frontal organs, uropods and telson, white.

ADDENDA TO PART I.

During a short visit to Bermuda (Dec., 1915), subsequent to the publication of Part I, some additional observations were made, some of which it seems desirable to record.

Eupanopeus herbstii. var. *obesus* V. (Op. cit., p. 347.)

This large and very active species was found in considerable numbers under stones at low tide in places where the current was strong, in channels, near Grassmere.

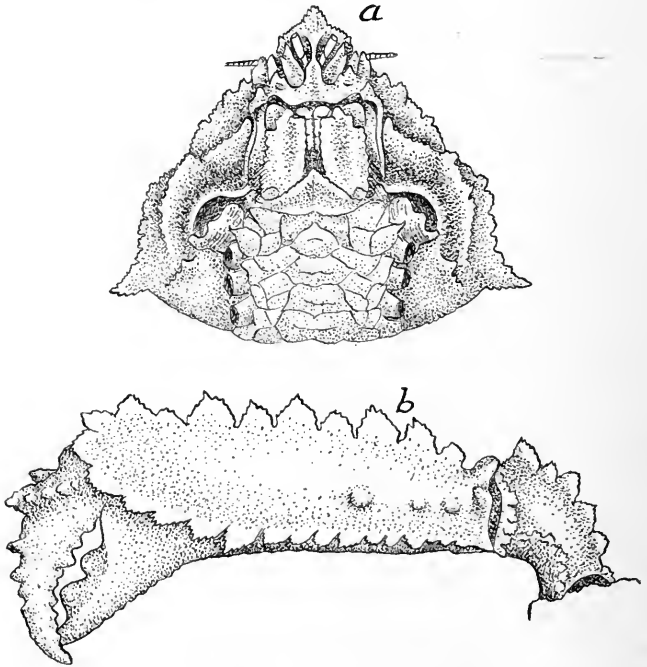


FIGURE 12. *Parthenope crenulata*; a, ventral side with the legs removed; b, one of the chelipeds. Both much enlarged. By J. H. Emerton.

Dromia erythropus. (Op. cit., p. 431, fig. 50.)

A full grown specimen of this interesting species, previously known there only from a single young specimen, was obtained. It was dredged in shallow water and had been kept alive in the

aquarium at Agars Island a short time. It was not accompanied by its protective sponge.

Parthenope crenulata. (Op. cit., p. 417.)

TEXT FIGURE 12.

I am now able to give a good figure of this interesting species from a Bermuda example.

ERRATA.

DECAPOD CRUSTACEA OF BERMUDA, PART I.

Page 429, line 10, for dorsal view read ventral view.

Page 117, line 11, for Plate XXVII read Plate XXVIII.

ERRATA FOR ARTICLE ON BERMUDA ALCYONARIA IN THESE TRANSACTIONS, VOL. XII.

By an unfortunate error of the printer in making up the plates of the work cited, four cuts, representing the spicules of four species, were transposed. Therefore the explanation of the plates should be changed: Plate XXXVa, fig. 4, should be Plate XXXVIa, fig. 4; Plate XXXVIa, fig. 3, should be XXXVIb, fig. 3; XXXVIa, fig. 4, should be XXXVa, fig. 4; XXXVIb, fig. 3, should be XXXVIa, fig. 3. Corresponding references to these figures should be changed in the text, under *Plexaura flavida*, p. 305; *Pseudoplexaura crassa*, p. 307; and *Euniceopsis grandis*, p. 373; and *P. esperi*, p. 305.

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Bate, C. Spence.—On a new Genus with four new Species of Freshwater Prawns, Proc. Zool. Soc. London, p. 363, pl. xxx, xxxi, 1868.

The genus *Macrobrachium* here proposed (= *Palæmon* = *Bithynis* Phil.) and part of the species are not tenable. *M. africanus* Bate was from Peru, and already had several names.

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Contains descriptions and figures of several Bermuda species.

Borradaile, L. A.—Annals and Mag. Nat. Hist., ser. 7, vol. ii, 1898. Op. cit., Ser. 8, vol. 16, 1915.

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This is a detailed monographic treatment of the group. It contains descriptions and figures of about forty American forms and many from other regions, with tables of distribution.

Coutière, Henri.—The Snapping Shrimp (*Alpheidæ*) of the Dry Tortugas, Florida. Proc. U. S. Nat. Mus., vol. xxxvii, pp. 485-487, 1910.

Contains descriptions of two new forms of *Synalpheus*.

Faxon, Walter—The Stalk-Eyed Crustacea. Reports on an Exploration off the West Coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the U. S. Fish Comm. Steamer Albatross during 1891 Lieut.-Commander Z. L. Tanner, commanding. Memoirs of the Mus. of Comp. Zoology, vol. xviii, 1895.

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This work treats of 84 species, many of which are described more or less fully, with valuable notes on their distribution and synonymy. Several species are described as new.

Mason, J. Wood.—*Nature*, vol. xvii, p. 11. On the explosive noises of *Alpheus*, etc.

Milne-Edwards, A. and Bouvier, E. S.—*Descrip. des Crustacés de la Famille des Paguriens recueillis pendant l'Expédition. Reports of the Results of Dredging by the U. S. Coast*

Survey Steamer Blake. Mem. Mus. Comp. Zool., vol. xiv, No. 3, pp. 1-172, pl. i-xii, 1893.

Milne-Edwards, A. and Bouvier, E. S.—Les Peneides et Stenopides. Reports on the Results under the supervision of Alexander Agassiz in the Gulf of Mexico, in the Caribbean Sea, etc. (1877-1880) by the U. S. Coast Survey Steamer Blake, Mem. Mus. Comp. Zool., vol. xxvii, No. 3, pp. 181-274, cuts in text, pl. i-ix, 1909.

An important work. Includes a revision of the families and genera, analytical tables, many morphological and anatomical details, and full descriptions of several Bermuda species. Also a full bibliography. The plates are excellent.

Newport, A.—Annals and Mag. Nat. History, vol. xix, p. 158, 1847.

Discusses the cause of the explosive sounds made by *Alpheus*.

Ortmann, A. E.—Bronn's Thierreich, vol. V, 1898.

Packard, Alpheus S.—Notes on the early Larval Stages of the Fiddler Crab and *Alpheus*. American Naturalist, vol. xv, 1881, pp. 784-789. Metamorphoses of *Alpheus*.

Parker, G. H.—The Histology and Development of the Eye in the Lobster. Bulletin Mus. Comp. Zool., Vol. XX, No. 1, pp. 1-60, 4 plates, 1890.

Contains also brief notes on the eye of *Alpheus*, *Gonodactylus*, etc.

Parker, G. H.—The Compound Eyes in Crustaceans, op. cit., Vol. XXI, pp. 45-140, 1891.

Contains descriptions of the eyes of *Palinurus*, *Alpheus*, *Gonodactylus*, with plate viii, etc.

Sars, G. O.—Phyllocarida and Phyllopoda, Fauna Norvegiæ, Bd. i, pp. 1-117, pl. i-xx, Christiania, 1896.

A very important work, handsomely illustrated, contains abundant details of anatomy and development. Includes *Nebalia* (two species).

Sars, G. O.—An Account of the Crustacea of Norway, with short descriptions and figures of all the Species, Bergen Museum. Five volumes, quarto.

This extensive and very valuable work has been published in numbers and is not yet completed. It is abundantly illustrated with autographic plates. The Cumacea, many of which are identical with New England Species, occupy volume iii, 1900. Volumes iv and v are devoted to the Entomostraca.

Schmitt, Waldo L.—The Marine Decapod Crustacea of California; Univ. of California publications in Zoology, vol. 23. 470 pages, 50 plates, including 10 charts of distribution.

Contains descriptions of all the species and good figures of most of them, with details of distribution. An important work.

Sharp, Benj.—Catalogue of the Crustaceans in the Museum of the Academy of Natural Sciences of Philadelphia. Proceedings of the Acad. Nat. Sci. Philad., for 1893, pp. 104-127 (no descriptions).

This contains the Stomatopoda and Caridea (*sens ext.*), 128 species. Several species are given as from Bermuda (coll. Heilprin). But the two doubtful species (*Palæmonella tenuipes* Dana and *Penæus velutinus* Dana), credited to Heilprin's coll. by Mr. W. Stone, are not included in this list.

Smith, Sidney Irving.—On some Genera and Species of Penæidæ, mostly from recent Dredgings of the U. S. Fish Commission, Proc. U. S. Nat. Mus., vol. viii, pp. 170-190, 1885.

Contains two Bermuda species, one of which (*Parapenæus goodii*) is described as new, from the Bermuda type. The genus *Parapenæus* is here first established (p. 170). *P. constrictus* is also recorded from Bermuda.

Stebbing, Thomas R. R.—Stalk-eyed Crustacea Malacostraca of the Scottish National Antarctic Expedition. Trans. Royal Soc. Edinburgh, Vol. L, part 2, No. 9, pp. 253-307, pl. xxiii-xxxii, 1914.

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Streets, T. Hale.—Catalogue of the Crustacea from the Isthmus of Panama collected by J. A. McNeil. Proc. Acad. Nat. Sci. Philadelphia, for 1871, pp. 238-243.

A brief list of species, partly Atlantic, mostly without definite localities. Several are described as new.

Verrill, A. E.—Geographical Distribution; Origin of the Bermudian Decapod Fauna. Amer. Naturalist, vol. xlii, pp. 289-296, cuts, 1908.

Verrill, A. E.—Decapod Crustacea of Bermuda, Part I, Brachyura and Anomura. Trans. Conn. Acad. Science, vol. xiii, pp. 299-474, pl. ix-xxviii, and text cuts, 1908.

Describes and figures all the known species. Includes also several New England species with illustrations.

Wilson, E. B.—Notes on the Reversal of Asymmetry in the restoration of the Chelæ of *Alpheus heterochelis*. Biological Bulletin, vol. iv, p. 197, 1903.

ADDITIONS TO BIBLIOGRAPHY.

Crawford, D. R. and DeSmidt, W. J. J.—The Spiny Lobster, *Panulirus argus*, of Southern Florida; its natural History and Utilization. Bulletin of the Bureau of Fisheries, vol. 38, No. 925, pp. 282-310, cuts 260-273, Aug., 1922.

An interesting and important article, received after this paper was in type; therefore it could not be utilized. Illustrations are good. Newly hatched larva (phyllosoma) is figured, fig. 273, p. 309. Sexual differences are well shown.

DeMan, J. G.—Siboga Expedition, Decapoda, Part III, Macrura, April, 1916.

Gruvel, A.—In Joubin, Ann. L'Inst. Océanographique, Tome iii, Paris, 1912. Fine plates of Palinuridæ.

EXPLANATION OF PLATES.

PLATE I.

Figure 1.—*Panulirus argus*; Bermuda lobster. Ventral side of cephalothorax and limbs of male, $2/3$ natural size. Photograph by A. H. Verrill.

PLATE II.

Figure 1.—*Panulirus argus*; Bermuda lobster. Dorsal view of cephalothorax of male; same specimen as shown on pl. I. About $1/2$ natural size.

Figure 2.—The same; distal part of legs; *a*, of second pair; *b*, of first pair. Enlarged; A. H. V.

PLATE III.

Figure 1.—*Phyllosoma* form of larva supposed to be that of *Panulirus argus*. Same as pl. III A, fig. 2b. From the Gulf Stream. Tips of all the legs are broken off.

Figure 2.—The same in a later stage in which the uropods have become free and rudimentary pleopods have appeared. Same specimen as pl. III A, figs. 3, 3a; *a'* antennule with a small branch to the flagellum; *a''* antenna; *mp*, third maxilliped; *ab*, abdomen; *p'''* leg of fourth pair; *pv*, rudiment of fifth leg. Original. A. H. V.

PLATE III A.

Figure 1.—*Phyllosoma* form of larva supposed to be of *Palinurus argus*. Youngest stage observed by me; *a*, antennule; *a'*, branch of flagellum; *a''*, antenna; *o*, eye; *oc*, median ocellus; *g*, green gland.

Figure 2.—The same specimen; *ab*, abdomen; *pv*, rudiment of leg of fifth pair; *u*, *t*, rudiments of uropods and telson seen within the integument. A. H. V.

Figure 2b.—The same, another example a little more advanced; same as pl. III, fig. 1. Letters as in fig. 1a. Original. A. H. V.

Figure 3. The same, a somewhat older larva, the same as pl. III, fig. 2. Letters as in fig. 1.

Figure 3a.—The same specimen; abdomen, *ab*, and fifth pair of legs, *pv*, which have become longer and two-jointed, while the uropods and telson have become free. Original. By A. H. V.

Figure 4.—A very different *Phyllosoma* larva referred by Bate to *Panulirus*, but perhaps a different genus. Although its fifth pair (*pv*) of legs are well developed the abdomen and its appendages are less

developed than in fig. 1; m, mouth; mp" and mp"', second and third maxillipeds; p'—p^v, five pairs of legs; other letters as in fig. 1. After Bate.

PLATE IV.

Figure 1.—*Scyllarides æquinoctialis*, male; ventral view, natural size.

PLATE V.

Figure 1.—*Scyllarides americanus*. Dorsal view, about natural size. No. 21607, U. S. National Museum. Photograph furnished by Miss M. J. Rathbun. From Bermuda.

PLATE VI.

Scyllarides americanus Ver. Type; from Bermuda; oblique view, about natural size. A. H. V.

PLATE VII.

Scyllarides sculptus bermudensis Ver. from Bermuda. No. 21608, U. S. Nat. Museum; coll. Dr. T. H. Bean. Photograph sent by Miss M. J. Rathbun.

PLATE VIII.

Figure 1a.—*Glypturus branneri*; 1a, larger chela; 1b, smaller chela; 1c, leg of second pair; 1d, leg of third pair; 1e, uropods and telson, much enlarged.

Figure 2.—*Panulirus argus*; rostrum (r) and base of antenna; c, eye; o, eye-stalk; s'—s"', four spines; p, tubercle; q, hard ridge.

Figure 2a.—The same; stridulating organs; see also pl. ix, fig. 1; m, hard tubercle; n, l, two smaller tubercles; s, t, transversely grooved and ridged area; s, spine. All original. By A. H. V.

PLATE IX.

Figure 1.—*Panulirus argus*. Stridulating organs, same as pl. 8, fig. 2a, enlarged; st., hardened, grooved and ribbed area; a, marginal tubercle; a', stout margin; b, rib on grooved area; c, inferior tubercle; d, wrinkled flexible area. Original. By A. H. V.

Figure 2.—*P. guttatus*. Stridulating organs, after Bate. Lettering as in fig. 1.

Figure 3. *Nephropsis rosea*; type, after Bate; side view, about natural size.

Figure 4.—The same; frontal parts, seen from above; about natural size.

Figure 4a.—The same, antennule; 4b, base of antenna; 4c, mandible; p, its palpus; 4d, uropods and telson; x 2½.

Figure 5.—*Stenopus hispidus*; carapace, after Brooks and Herrick; \times about 3; 5a, antenna and scale; 5b, a-e, branchial plumes; enlarged; after Bate.

PLATE X.

Figure 1.—*Sicyonia dorsalis*. Female, side view; after Bate; f, tip of second maxilla; g, uropods and telson; h, end of first maxilliped; i, tip of the same; la, anterior part of another specimen, side view; lb, sternum, genital orifices and thelecum of the female.

Figure 2.—*S. brevirostris*; leg of fifth pair; 2a, second maxilliped; 2b, tip of third maxilliped; 2c, 6th segment, uropods and telson.

Figures 3, 4, 5.—*S. dorsalis*; carapace and rostrum of three individuals to show variations in the denticles.

Figure 6—6d.—*S. brevirostris*; 6a, first maxilliped; 6c, endopod of 6a; 6d, third maxilliped; 6b, tip of dactyl of first leg; k, distal part of second pleopod. Figures 1-1b, 2, 6-6d are after M.-Edwards and Bouvier.

PLATE XI.

Figure 1.—*Stenopus hispidus*; from Bermuda; dorsal side, about natural size.

PLATE XII.

Figure 1.—*Stenopus hispidus*; showing tricolor pattern; the dark bands are bright red in life, ground-color white. After Brooks and Herrick (pl. V), about natural size; antennæ are foreshortened.

Figure 2.—The same in an advanced larval stage, from the same; much enlarged.

PLATE XIII.

Figures 1-3.—*Penæus brasiliensis*; young and adult, about $\frac{3}{4}$ natural size.

PLATE XIV.

Figure 1.—*Trachypenæus constrictus*. Female; \times about 3.

Figure 2.—The same; dorsal view of carapace and frontal organs; \times 3.

Figure 3.—The same; a, tip of palpus of 2d maxilla; b, palpus of first maxilla; c, part of first maxilliped; d, palpus of mandible; all much enlarged.

Figure 4.—The same; third maxilliped of male; figs. 1-2 are by J. H. Emerton; 3, 4, after M.-Edw. and Bouvier.

PLATE XV.

Figure 1.—*Penæopsis goodei* Edw. & B. Side view of female; 1A', first leg; 1A'', tip of dactyl, \times 250; 1A''', hair from branchial area, \times 250; 1AIV, sternum of female; p''—p'', bases of 2d to 5th legs; t, thelecum; 1a, telson of female; after M.-Edw. and Bouvier.

- Figure 2.—*Trachypenæus constrictus*. Female, from Virginia; side view, x about 2; 2a, rostrum and edge of carapace.
- Figure 3.—The same; leg of first pair; x about 13. Original.
- Figure 4.—The same; thelecum.
- Figure 5.—The same; petasma of male; much enlarged.
- Figures 1-1a, 2, 2a, 4, 5, are after M.-Edw. and Bouvier.

PLATE XVI.

- Figures 1, 2.—*Penæus braziliensis*; anterior parts and rostrum of two specimens; 2a, telson, enlarged. By J. H. E.
- Figure 3.—*Penæopsis goodii*; type, from Bermuda; side view of the carapace and frontal organs, enlarged.
- Figure 4.—*Parapenæus velutinus*; male; after Dana.
- Figure 5.—*Latreutes fucorum*; from Bermuda; scaphocerite x 20; 5a, telson and uropods, x 20; 5b, leg of third pair, x 20. By A. H. V.
- Figure 6.—*Processa canaliculata*; variety *bermudensis*, from Bermuda; base of antenna and the scaphocerite; 6a, leg of second pair, with canaliculate ischium; 6b, mandible; after Bate.
- Figure 7.—*Gnathophyllum americanum*; frontal parts, after Guerin.
- Figures 1, 2 and 3 are originals by J. H. Emerton; 5-5b, by A. H. V.

PLATE XVII.

- Figure 1.—*Leucifer faxoni*. Male. General view of anterior portion of body and head; legs are mostly omitted; mp", second maxillipeds; mp"', third maxillipeds; 1', leg of first pair; p', first pleopod, with the petasma, pt; p", second pleopod, with the male organ, v; p"', third pleopod; x 20..
- Figure 2.—The same; side view of the head of another example, a', antennule; a", antenna; s, scaphocerite; x 25.
- Figure 3.—The same. Male; distal part of 6th abdominal segment, with uropods, u; and telson, t, x 20.
- Figure 4.—The same; uropod of another example; x 20.
- Figure 4a.—The same specimen; telson, more enlarged.
- Figure 6.—The same; outline of petasma, x 32. Figures 1-6 original, by the author.
- Figure 7.—Petasma of a specimen from off Chesapeake Bay, after Faxon.
- Figure 8.—*Leucifer affinis* Borr. (*L. typus*, after Bate); c, carapace; g", g"', second and third maxillipeds; 1', 1"', legs of first and third pair; p', p", first and second pleopods; m, petasma or clasping organ on p'; u, uropods; t, telson; 8a, side view of frontal parts of the same, more enlarged; a', antennule; a", antenna; s, its scale; ot, oötocyst; 8b, petasma; 8c, tip of third leg; 8d, second pleopod of male.

Figure 9.—*Leucifer*, sp., early nauplius stage of larva; i, ii, first and second antennæ; iii, mandible, modified as swimming organs; oc, ocellus; lb, labium; mt, mouth; iv-vi, rudiments of mouth organs.

Figure 9a.—The same in a later or protozoëa stage; letters the same, adding v, vi, vii, two pairs of maxillæ and first maxilliped; a, anus; n, green gland.

Figure 9b.—The same, in a later zoëa stage; letters the same, adding viii-xii, rudiments of outer maxillipeds and thoracic legs; xix, uropods.

Figures 9-9b after G. O. Sars.

Figure 10.—*Penæus braziliensis*; A, carapace and rostrum; D, third maxilliped; E, second maxilla; F, tip of palpus of second maxilla. After M.-Edw. and Bouvier.

PLATE XVIII.

Figure 1.—*Leucifer faxoni*, male. Side view of head; a', antennules; a", antennæ; s, antennal scale; e, eye, x 20. Original. By the author.

Figure 2.—The same, another specimen. Male; general side view of body and dorsal view of head, x 10.

Figure 3.—The same, another example. Head more enlarged; mp'', tip of third maxilliped, x 24.

Figure 4.—The same; tips of second maxillipeds, more enlarged.

Figure 5, 5a.—The same. Male; second pleopod of male; v, male appendage; 5a, another view of male appendage; x 30.

Figures 6-9.—The same. Side views of the petasma of different males to show variations in form with mounted specimens; s, tubercle in front of petasma; x 32.

Figure 10.—The same; front margin of carapace, to show a pair of denticles; x 30.

Figure 11.—The same. Male; distal part of sixth abdominal segment, with uropods, u; and telson, t; x 20.

Figure 12.—The same. Male; telson; x, tubercle of under side supposed to be a phosphorescent organ; x 30.

Figure 13.—The same. Female; distal part of sixth abdominal segment, with uropod, u; and telson, t; x 24.

All the figures are original by the author, from examples mounted in glycerine jelly.

PLATE XIX.

Figure 1.—*Alpheus* (or *Crangon*) *formosus*; dorsal view of a specimen lacking the chelipeds. Enlarged.

Figure 2.—The same. Another Bermuda specimen, with the chelæ separated.

Figure 3.—*Alpheus* (or *Crangon*) *candei*; four views of the larger chela, carpus, and merus. From Bermuda specimens; a, b, d, views of inner side; c, outer surface. Enlarged. By A. H. V.

PLATE XX.

- Figure 1.—*Alpheus* (or *Crangon*) *candei*; side view of a Bermuda specimen with the chelæ.
- Figure 2.—*Alpheus* (or *Crangon*) *packardii*; side view of an entire Bermuda specimen.
- Figure 3.—*Alpheus* (or *Crangon*) *formosus*; dorsal view of an entire Bermuda specimen.
- Figure 4a.—*Alpheus* (or *Crangon*) *formosus*; side view.
- Figure 4b.—*A. armillatus=lancirostris*; dorsal view.
- Figure 5.—*A. packardii*; larger chela.
- Figure 6.—*A.* (or *Crangon*) *bahamensis*; side view of a cotype lacking the large chela, but showing the stout ambulatory legs; 6a, the same; chela separated. By A. H. V.

PLATE XXI.

- Figure 1.—*Synalpheus minus*; dorsal view of a Key West specimen, No. 1827. (See also pl. XXIII, fig. 3, and pl. XXXIV, figs. 2-2n).
- Figure 2.—*Alpheus armillatus=lancirostris*; dorsal view of an entire specimen.
- Figure 3.—*A.* (or *Crangon*) *bahamensis*; larger chela.
- Figure 4.—*A. armillatus=lancirostris*; large chela; 4a, the smaller chela.
- Figure 5.—*A. packardii*; large chela.
- Figure 6, 6a.—*A. candei*; larger chela; outer and inner surfaces. By A. H. V.

PLATE XXII.

- Figure 1.—*Alpheus* (or *Crangon*) *heterochælis*; side view of a large specimen from Sarasota Bay, Florida.
- Figure 2.—The same, var. ?, large chela.
- Figure 3.—*Alpheus*, sp. ?; large chela.
- Figures 4, a, b, c.—Three large chelæ, side views of *A. heterochælis* to show variations; x about 2.
- Figure 4b.—*A.* (or *Crangon*) *heterochælis*; from Key West, No. 1760.
- Figure 5.—*A.* (or *Crangon*) *beanii*. Type, dorsal view.
- Figure 6.—*Synalpheus fritzmulleri carolinensis* Ver.; x 4; No. 1831, dorsal view; 6a, smaller chela.
- Figure 7.—*Alpheus* (or *Crangon*) *packardii*; small chela, enlarged. By A. H. V.

PLATE XXIII.

- Figure 1, b.—*Glypturus branneri*; larger chela, enlarged.
- Figure 2, a.—The same; side view of the specimen described from Bermuda.

Figure 3.—*Synalpheus minus*; dorsal view of the front part of a large Key West specimen, No. 1827. (See also pl. XXI, fig. 1.)

Figure 4.—*Alpheus armillatus=lancirostris*; frontal parts of a large specimen; dorsal view, much enlarged.

Figure 5.—*A.* (or *Crangon*) *formosus*; a, larger; b, smaller chela, much enlarged.

Figure 6.—*A.* (or *C.*) *packardii*; c, larger; d, smaller chela.

PLATE XXIV.

Figure 1.—*Synalpheus bradleyi* Ver. Type; No. 742, larger chela.

Figure 2.—*Alpheus* (*Dienesia*) *candei*, from Bermuda. Larger chela dorsal view, enlarged. By. A. H. V.

Figures 3, 4, 5.—*A.* (or *Crangon*) *clamator*; inner and outer surfaces of a large chela of a San Diego, California, specimen.

Figure 6.—The same; view of the distal part of a chela with the dactyl raised.

Figure 7.—*A. heterochelis*; male; dorsal view of the smaller chela of a Florida specimen (No. 1125) with the dactyl removed.

Figure 7a.—The same; entire chela; side view. All by A. H. Verrill.

PLATE XXV.

Figure 1.—*Synalpheus longicarpus*. Female; after Coutière; a, frontal parts; a', carapocerite; b, larger chela; c, smaller chela; c', distal end, more enlarged; d, leg of second pair; e, leg of third pair; f, dactyl of same, more enlarged; g, dactyl of fourth leg; h, telson.

Figure 2.—*S. neptunus*, after Dana; a, the frontal parts; b, larger chela; b', the same open; c, smaller chela; d, leg of second pair; e, ambulatory leg.

Figure 3.—*S. minus* (*sauleyi*, type) from Cuba; after Guerin; frontal parts, much enlarged.

Figure 4.—*Alpheus* (or *Crangon*) *packardii*; after Bate. A Bermuda specimen, the type of *A. bermudensis* Bate; side view; and 4a, separated larger chela, enlarged.

Figure 5.—*Amphibetaeus simus*. Type; after Guerin; frontal parts.

Figure 6.—*A. formosus* (?) after Guerin. Type of his *A. poeyi*, frontal parts; 6a, larger chela, much enlarged.

Figure 7.—*A. candei*; after Guerin. Type; frontal parts, much enlarged.

Figure 8.—*A. candei*; distal part of larger chela, much enlarged. After Guerin.

PLATE XXVI.

Figure 1.—*Alpheus armillatus=lancirostris*; male, No. 65, from Bermuda; 1, a', antennule: 1", a leg of the second pair: 1b, antennal stalk and base of flagellum; c, carapocerite; s, its scale; s', its spine; 1c, telson

and uropods; u, basal spines; u', u'', lamellæ; 1 p, second pleopod of male.

Figure 2.—The same (?); female, less enlarged; a', flagellum of antennule: 1'', leg of second pair: 2a, telson (t) and uropods (u): 2d, p, p', p'', pleopods. By A. H. V.

PLATE XXVII.

Figure 1.—*Alpheus armillatus=lancirostris*; 1a, antennule; 1, 2, 3, three joints of stalk: 1b, antenna; s, scaphocerite or antennal scale; s', its spine: 1g''', outer maxilliped: 1l', smaller cheliped of first pair: 1l'', cheliped of second pair: 1l''', leg of third pair: 1o, three of the eggs: 1p, 1p', two of the pleopods: 1s, spinules, setæ, and hairs of the telson or the posterior lamella of the uropods (u''); very much enlarged. Original by A. H. V.

PLATE XXVIII.

Figure 1.—*Alpheus* (or *Crangon*) *bahamensis*; male, from Bermuda; slides h', h''; 1a, one of the antennules with its basal spine (s) and oöcyst (o); 1, 2, 3, joints of peduncle; 1b, one of the antennæ; b', flagellum; c, scaphocerite, with its long plumose hairs only indicated; s, scale; s', its spine; 1'', a leg of the second pair; 1n', n'', n''', maxillipeds of three pairs; 1m', m'', first and second maxillæ, x11; 1j, mandible, r, right, and l, left, x11; 1j', right, x 10; j'', j''', jaws x 28; 1t, telson; 1u, uropods, plumose hairs omitted; p, pleopod.

Figure 2.—*Alpheus*, sp. ?, from Bermuda; telson.

Figure 3.—*Alpheus* (or *Crangon*) *bahamensis*; cotype; 3l', smaller chela of first pair, with carpus and merus; 3l'', leg of second pair; c, tips of its fingers; 3l''', leg of third pair. All are much enlarged.

All on plate are original; 1n'', j-j''', 2, by A. E. Verrill; the rest by A. H. Verrill.

PLATE XXIX.

Figure 1.—*Alpheus candeï*, from Bermuda, 1901. Frontal organs; a, antennule; b, antenna; o, oöcyst; s, scale of scaphocerite; sp, its spine; s', basicerite, x 6½; 1a, basicerite and adjacent parts more enlarged.

Figure 1l''x.—Leg of second pair, x 6½; 1l''a, the same less enlarged, from another specimen. Figure 1l''', legs of third pair; 1n''', third maxilliped; 1p, pleopod; 1t, telson, and u, u'', uropods. By A. H. V., from slides c-c'''.

Figure 2.—*Alpheus clamator*, from San Diego, California; 2a, 1'', leg of third pair; 1'', leg of second pair; 1''''', legs of fifth pair. Figure 2b, the same; c, carapocerite; s', antennal scale; sp, its spine; all x 6½. By A. H. V.

Figure 3.—*Tozeuma carolinensis*; 3l', leg of first pair, $\times 15$; 3l'^x, tip of chæla of the same, $\times 30$; 3l''', third leg, $\times 15$; 3l''^x, dactyl of the same, $\times 30$; 3l''''', part of fifth leg, $\times 15$; 3m^x, first maxilla; $\times 20$; 3n''', tip of third maxilliped, $\times 24$. By A. E. V.

Figure 4.—*Alpheus formosus*, from Bermuda. Female; 4a, antennule. Figure 4b, base of antenna; c, carpocerite; s, scaphocerite; s', its spine. Figure 4, 4l'', leg of second pair. Figure 4n''', third maxilliped; 4t, telson; 4u, uropods. By A. H. V. All from one specimen.

PLATE XXX.

Figure 1.—*Alpheus* (or *Crangon*) *heterochalis*, female from Key West, Florida; 1a', antennule; s, stylocerite or aural spine; o, oötocyst; 1a'', antenna; c, carpocerite; s, scaphocerite; 1l'', leg of second pair; 1p, p', pleopods; o, eggs; 1t, telson and u', u'', uropods; $\times 6\frac{1}{2}$.

Figure 2.—The same. An example from Indian River, Florida, No. 1825; female; 2a, smaller chela of first pair of legs, $\times 6\frac{1}{2}$, from slide H'.

Figure 2b, third maxilliped; 2c, leg of third pair; c', another view of the dactyl and end of propodus, dactyl is nearly detached and out of position; 2d, leg of fifth pair; 2e, distal part of propodus of fifth leg to show details of the comb; 2d', dactyl of the same, detached. All on this plate are \times about $6\frac{1}{2}$; originals by A. H. V., except 2b, 2c', 2d, 2e, by A. E. V.

PLATE XXXI.

Figure 1.—*Alpheus* (or *Crangon*) *packardii*. From Long Bird I., Bermuda, 1901; 1l', smaller cheliped of first pair; 1b, antenna with its scale and spines; 1'', legs of second pair; 1''', leg of third pair, $\times 7$. By A. H. V.

Figure 2. The same species; a different specimen, No. 3062, from Bermuda; 2b, antennule with its basal spine and oötocyst; 2l'', leg of second pair; 2l''', leg of third pair; 2n'', outer maxilliped; $\times 7$. Original. By A. H. V.

Figure 3.—*Alpheus packardii*, u, uropods; t, telson; $\times 7$.

Figure 4.—*Synalpheus saulcyi* (= *S. minus*); from Cuba; general figure; after Guerin.

PLATE XXXII.

Figure 1.—*Alpheus* (or *Crangon*) *beanii* Ver. sp. nov. Type; 1a, antennule with its basal spine and oötocyst; 1b, antennal scale; 1c, third maxilliped, hairs partly omitted; m, third article; c, carpus; ex, exopod; 1d, smaller chela of leg of first pair with carpus and merus; 1e, 1e', legs of second pair; 1e'', chela more enlarged; 1f, leg of third pair; 1f', tip of the same, more enlarged; 1g, uropods; 1h, telson; 1i, leg of fourth pair. All much enlarged. Original. By A. H. V.

PLATE XXXIII.

- Figure 1.—*Alpheus* near *heterochælis* (?) No. 743, large cheliped.
 Figure 2.—The same; large cheliped; opposite side, enlarged. Panama?
 Figures 3, 3a.—*Synalpheus hemphilli*; large chela, from slide ddd.
 Figures 4, 4a.—*S. minus*. Large chela. Key West, No. 1827; female.
 (See also plates xxi, xxiii, fig. 3; xxxiv, fig. 2.)
 Figures 5, 5a.—The same; male; large chela. Original by A. H. V. and
 A. E. V.

PLATE XXXIV.

- Figure 1.—*Synalpheus minus, somersi* Ver. new var. Type, female from
 Bermuda, No. 62, notes. 1a, antennule; bc, first article; as, stylo-
 cerite; ot, oöcyst; 1b, antenna; cc, carapocerite; s, its scale; s',
 its spine; s'', broken spine or basicerite; 1b', the same from the
 opposite side; 1'', a leg of second pair; 1p, a pleopod; 1t, telson;
 1u, uropod. By A. H. V.
 Figure 2.—*S. minus* (typical). No. 1827, Key West; 2a, antennule, outer
 flagellum is broken, letters as in fig. 1, adding c, the eye; 2b, antenna,
 letters as in fig. 1b: 2n''', third maxilliped: 2n''''x, tip of same, more
 enlarged; 2l', smaller chela; 2l'', second leg; 2l''', 2l''''x, third leg
 and more enlarged tip; 2l''''', leg of fourth pair; 2l''''''x, dactyl more
 enlarged. By A. H. V. See also pl. xxxiii.
 Figure 3.—*A. saulcyi* var. *longicarpus*, variation, of Brooks & H. (*non*
 Guerin), "from logger-head sponge," their pl. 24, fig. 8; peculiar
 large chela: 3c, first maxilla, x 16.
 Figure 4.—*A. saulcyi*, var. *brevicarpus* of B. & H., male, variation, No. 8,
 their plate 24, fig. 3, smaller chela, x 16.
 Figure 5.—*S. pectiniger* C. (?) = *A. saulcyi*, var. *longicarpus*, variation, No.
 9, of B. and H.; their plate 24, fig. 2; smaller chela, x 16; 5a, the
 same; base of antenna, rudimentary scale, and small basicerite, x 16.
 Figures all original by A. H. V. except 3, 4, 5.

PLATE XXXV.

- Figure 1.—*Processa canaliculata bermudensis*. Cotype from Dr. Rankin.
 Frontal parts; r, rostrum; a', antennule; a'', antenna; s, its scale;
 mp''', third maxilliped; e, eye; x 15. 1a, the same; rostrum; x 33.
 Figure 1a.—The same; antenna (a'') and scale, s; b, basicerite; x 30.
 Figure 1b.—The same parts; x 16.
 Figure 1d'.—The same; chelate leg of first pair; x 12.
 Figure 1d.—The same; non chelate leg of first pair; x 12.
 Figure 1e.—The same; chela and part of carpus of leg of second pair;
 x 12; 1e; the same; x 30.
 Figure 1f.—The same; ambulatory leg; x 12.
 Figure 1g.—The same; uropods, u; and telson, t; x 15.

Figure 2.—*Thor floridanus*. Antennule, x 15; a', thick outer flagellum; aa', stalk.

Figure 2a.—The same; stalk of antenna or carpopercite, a", and its scale or scaphocerite, s, x 15; 2a', bases of carpopercite, a", and scale, s, x 30.

Figure 2c.—The same; cheliped, l', x 15.

Figure 2d.—The same; fifth ambulatory leg, x 15; 2d', the same, its propodus and dactyl, x 30.

Figure 2e.—The same; uropod, u, and telson, t, x 15; t', the tip of the telson more enlarged.

Figure 2f.—The same; rostrum, as seen from above; x 15; a variety with only three denticles above. By A. E. V.

PLATE XXXVI.

Figure 1.—*Synalpheus minus, somersi* Ver. Type, female, No. 62; 1, smaller chela of first pair; 1b, a leg of second pair; 1c, leg of fifth pair; 1d, d', leg of third pair; 1e, third maxilliped; 3, 4, 5, third to fifth articles of the same, spines and hairs mostly omitted. By A. H. V.

Figure 2.—The same (?), antenna of another specimen with abnormal tip to the scale (s).

Figure 3.—*S. brevicarpus* C.=*A. saulcyi*, var. *brevicarpus* (typical, from green sponge) of Brooks and Herrick (their pl. xxiii, fig. 3, male); mandible, x 32; j, cutting lobe; k, crushing lobe; p, palpus.

Figure 3a.—The same; antennule, dorsal view, x 16; (their pl. xxxiii, fig. 4); 3b, the same; antenna; x 16 (their fig. 8); 3c, third maxilliped, x 16; seen from outside, x 16 (their fig. 5); 3d, leg of second pair, x 16 (their fig. 1).

Figure 4.—*S. longicarpus*?=*A. saulcyi* B. & H. Their No. 8 (their pl. 22, fig. 18), base of antennule; e, median ocellus, x 13.

Figure 5.—*S. pectiniger*? Cout. (= *A. saulcyi* B. & H., "from logger-head sponge," pleopod (their pl. xxiv, fig. 5); 5a, first pleopod (their fig. 4); see also our pl. 33, fig. 3.

PLATE XXXVII.

Figure 1.—*Synalpheus goodei*, female, from Bermuda, coll. G. B. Goode, x 14; a, antennule; b, antenna; l", leg of second pair; m', m", first and second maxillæ; n", second maxilliped; pp, pleopods; telson, t, and uropods, u; x 11. By A. H. V.

PLATE XXXVIII.

Figure 1.—*Synalpheus goodei*; Bermuda, coll. 1898; x 16. 1, front of male; 1a, antennule; 1b, antenna stalk; 1c, c', large chela; 1c", smaller chela; 1l", leg of second pair; 1l'", third leg; 1l'x, its dactyl,

more enlarged; 1n", second maxilliped; t, telson; u, uropods; 1d, n"', third maxilliped; 1d'^x, its tip, more enlarged; 1p, pleopod.

Figure 2.—The same; female; 2p, pleopod; o, o', eggs containing larvæ; x 16. By A. H. V.

PLATE XXXIX.

Figure 1.—*Synalpheus fritzmulleri, carolinensis* Ver. From Fort Macon, N. C., No. 1831; 1a, smaller chela; 1a', the same; fingers more enlarged; 1b, leg of second pair; 1b', chela of the same, more enlarged; 1c, leg of third pair; 1c', tip and dactyl of the same, more enlarged; 1d, leg of fifth pair; 1d', dactyl of same, more enlarged. See also pl. xxiii, fig. 6. By A. H. V.

Figure 2.—*Synalpheus hemphilli longicornis*. From Bermuda. After Coutière; 2a, frontal parts; 2b, dactyl of a leg of third pair.

Figure 3.—*S. fritzmulleri, caribea* Ver. Dominica I. 3a, third maxilliped; 3a', tip more enlarged; b, leg of second pair; 3b', its chela more enlarged; 3c, leg of third pair; 3c', dactyl more enlarged. By A. H. V.

Figure 4.—*S. goodii*. Type. After Coutière; 4, frontal parts of female; 4a, large chela of male; 4b, smaller chela; 4c, telson; 4d, outer lamella of uropods.

PLATE XL.

Figure 1.—*Synalpheus hemphilli*. From Bermuda (ddd); 1, frontal parts; 1a, 1a', third maxilliped; 1c, 1c', leg of second pair and chela more enlarged; 1d, 1d', leg of third pair and dactyl more enlarged.

Figure 2.—*Synalpheus goodii*. From Bermuda; 2a, antennule; 2b, base of antenna; 2c, smaller chela and leg of first pair; 2d, leg of second pair; 2e, 2e', leg of third pair and its dactyl more enlarged; 2f, telson and uropods; x about 16. From slide bb. All by A. H. Verrill.

PLATE XLI.

Figure 1.—*Thor floridanus*. General, side view.

Figure 2.—*Periclemenes americanus*. General, side view.

Figure 3.—*Gnathophyllum americanum*. General, side view.

Figure 4.—*Processa canaliculata bermudensis*. General, side view.

Figure 5.—*Alpheus bahamensis*; dactyl of large chela. All enlarged from Bermuda specimens by A. H. V.

PLATE XLII.

Figure 1.—*Tozeuma carolinensis*. Female from Bermuda, 1901; a' stalk of antennule; a'', antenna; s, scaphocerite; bc, basicerite, c, acicle of antennule; e, eye; o, ocellus, x 6.

Figure 1a.—Leg of first pair, left side, x 12.

Figure 1b.—Leg of second pair, x 14.

Figure 1c, 1c'.—Parts of first maxilla, x 20.

Figure 1d.—Mandible, x about 20 (?).

Figure 1e.—Uropod, x 6.

Figure 1f.—Telson, x 6; 1f'; the same, x 12. By A. E. V.

Figure 2.—*Latreutes fucorum*. Frontal parts, x 14, rostrum is omitted; a', antennule; c, its acicle; e, eye; s, scaphocerite; x 14.

Figure 2a.—Antenna and its scale, x 14; 2a", antenna and scale of another specimen, x 14.

Figure 2b.—First maxilliped, x 20; 2i, second maxilliped.

Figure 2b, d.—Right cheliped; 2c, s, s', s'', left cheliped; three views; 2d, second leg, x 20; 2e, third leg, carpus and dactyl, x 12; 2f, fourth leg; 2g, fifth leg, x 7; 2r, rostrum; 2t, telson and uropod, x 14; 2tx, tip of telson, x 70. Original. By A. E. V.

PLATE XLIII.

Figure 1.—*Hippolyte acuminata*. After Dana; a, carapace and limbs; a', antennule; 1', 1'', 1''', first, second and third legs.

Figure 2.—*Palæmonella tenuipes*. After Dana; enlarged; a, anterior parts; a', antennule; b, third maxilliped; c, second maxilliped; d, mandible; d', outer branch of same with palpus.

Figure 3a.—*Leander affinis*. Female; after Bate, enlarged; 3a, third maxilliped; 3b, eye, more enlarged.

Figures 4, 4a.—*Leander tenuicornis*. After Bate. Female and male, enlarged.

Figures 5a, 5b.—*Barnacle, Octolasmis argus* Ver., new sp., parasitic on *Panulirus argus*; h, part of oral appendage to which it was attached; much enlarged.

Figure 6.—*Periclimenes americanus*. Tip of telson. By A. H. V.

PLATE XLIV.

Figure 1.—*Latreutes fucorum*. Female with eggs; after Dana; 1a, 1', cheliped or leg of first pair; 1'', leg of second pair; 1j, mandible; 1m', 1m'', first and second maxillæ; 1n'', second maxilliped. After Bate.

Figure 2.—The same. From Bermuda; a'', antenna, x 20; n', first maxilliped, x 20; n'', second maxilliped; n''', third maxilliped, x 20; 2l', cheliped, x 20; 2l'', leg of second pair, x 20; 2l', chela of same, x 20; 2l''', fourth leg; 2l'', fifth leg, x 20. Original. By A. E. V.

Figure 3. The same; distal article of the third maxilliped, x 50. Original. By A. E. V.

PLATE XLV.

Figure 1-1c.—*Periclimenes americanus*. From Bermuda; 1, antennule and scales, s', s'', o, statocyst, x 12; 1a, base of antennule, and scales,

s, s', and statocyst, o; 1b, smaller leg of first pair; 1c, third or fourth leg, x 12. By A. E. V.

Figure 2-2t.—*Periclimenes americanus*. From Bermuda; 2a, antennule and eye (c); s, s', scales; o, oötocyst, x 10; 2b, 2b', scaphocerite (s) and part of antenna; p, carpocerite; 2c, eye and ocellus; 2r, rostrum; 2l', right leg of first pair, x 10; 2l'', right leg of second pair, x 10; 2l''''', leg of fifth pair; 2m'', second maxilla; 2n', 2n'', 2n''''', first, second and third maxillipeds; nn''''', third, more enlarged; p, pleopod; 2t, telson and u, uropod, x 10; 2o, one of the eggs. Original. By A. H. V. and A. E. V.

PLATE XLVI.

Figure 1.—*Gnathophyllum americanum*; rostrum, eye, etc. x 6; 1a, antennule, x 30; 1a', the same, x 12; 1b, antenna, x 12; 1b', the same, x 30; 1b'', the opposite antenna; 1c, right scaphocerite; 1c', the same, left side; 1d, right third maxilliped, x 12; 1d', part of the same x 30; h, a plumose hair, more enlarged; 1d'', hairs of the inner edge, each side of the suture; 1e, leg of first pair, x 12; 1f, right leg of second pair, x 12; 1f', same, left side; c, carpus, x 12; 1g, third ambulatory leg, x 12; 1h, fifth leg; 1h', tip of the same, x 30; 1j, uropod, x 12; 1k, distal part of telson, more enlarged. Original. By A. E. V.

Figure 2.—*Thor floridanus*; eye, x 12; 2a, rostrum, seen from above, x 12; 2b, third maxilliped and 2c, its tip, x 30; 2d, third ambulatory leg, x 30; 2e, rostrum. Original by A. E. V.

PLATE XLVII.

Figure 1.—*Synalpheus minus*. Frontal parts; 1b, carpocerite; 1a, larger chela; 1c, smaller chela of first pair; 1d, dactyls of third leg; 1e, dactyls of third leg of variety; 1f, telson. After Coutière, his typical form.

Figure 2.—The same; frontal parts of a Bermuda specimen, not typical. After Coutière.

Figure 3.—*S. townsendii*; 3a, frontal parts; 3b, part of the larger chela; 3c, leg of second pair; 3d, part of telson. After Coutière.

Figure 4.—*Thor floridanus*; third maxilliped, x 20; 4a, leg of second pair, x 20. Original by A. E. V.

Figure 5.—*Hippolyte acuminata*; antennule; 5b, third maxilliped; 5c, end of ambulatory leg, third pair; 5d, larger chela. After Bate, as *bidentatus*.

Figure 6.—*Ogyris alphærostris*; mandible; after Coutière.

Figure 7.—*Palæmon affinis*; mandible. After Bate.

Figure 8.—*Processa canaliculata*; antennule; 8a, second maxilliped; 8b, first maxilliped. After Bate.

PLATE XLVIII.

- Figure 1.—*Periclimenes carolinensis*. Antennule and eye (c); o, larval median ocellus; x 12.
- Figure 1a.—The same; rostrum, x 12; 1b, leg of second pair; 1c, double dactyl of third pair; x 30.
- Figure 2.—*Alpheus armillatus*? variety, from Colon, No. 735; third maxilliped; x about 7; 2', exopod of the same, x 12; 2'', the same exopod, x 30.
- Figure 2a.—The same; leg of second pair, x 7; 2b, part of third leg, x 7; 2c, fifth leg, x 7.
- Figure 3.—*Synalpheus minus*; second maxilla; 3a, first maxilliped; b, part of second maxilliped; 3c, dactyl of large chela. After Coutière.
- Figure 4.—*Leander affinis*; antennule and its outer scale, x 12; 4a, part of third maxilliped; 4b, end of ambulatory leg; 4c, another view of the same; 4d, tip of antennal scale; x 12.
- Figure 5.—*Gnathophyllum americanum*; third maxilliped, x 12; 5a, dactyl of fifth leg, x 30. All original by A. E. V., except fig. 3.

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ADDENDA.

Through the courtesy of Dr. W. G. VanName, assistant Curator, I have been able to examine, in the American Museum of Natural History of New York, an additional species of *Macrura* from Bermuda, and also two other interesting species, as follows:

Palinurellus gundlachi Von Martens, Naturf. Berlin, 1878; Sitz. Berlin Ges., 1878. DeMan, Siboga Exp., Decapoda, Part iii, p. 31, 1916. = *Synaxes hybridica* Bate, Ann. and Mag. Nat. Hist., Ser. 5, vol. 7, p. 20, with figs., 1881.

One specimen, about 132 mm. long. Bermuda, from the stomach of a grouper, Louis Mowbray, coll.

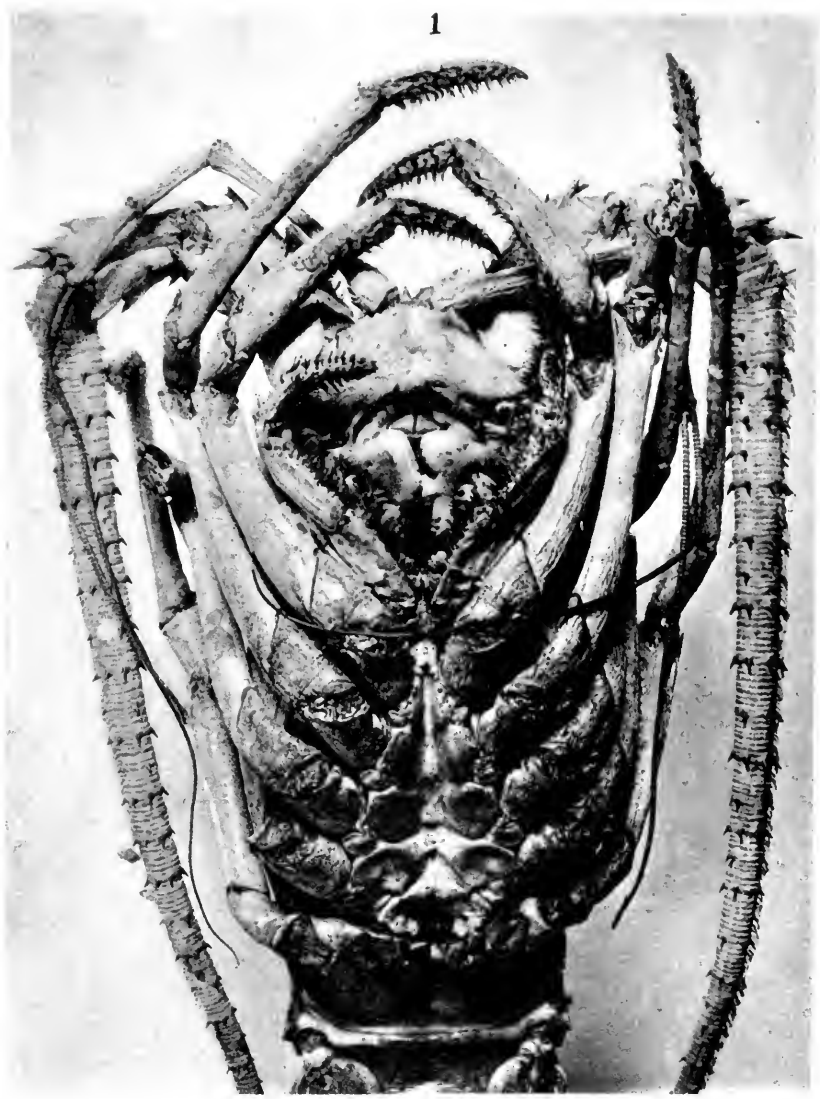
Panulirus lævicauda (Latr.) M.-Edw., 1837. DeMan, op. cit., p. 34. = *P. ornatus* Pocock (t. DeMan), No. 3298, S. E. coast of Florida; No. 3691, Key West, Louis Mowbray. Previously from Cuba and Barbados.

Differs from *P. argus* in having no transverse suture on the abdominal somites and single acute lateral lobes, also much shorter antennular peduncle. Sides of abdominal segments are dark greenish brown with numerous small roundish spots of light yellow; frontal horns and eye-stalks barred transversely with dark brown and yellow; legs conspicuously striped with dark greenish brown and light yellow, paler beneath.

P. guttatus. See above, p. 17. A fine example from Turks Island. The back of carapace, abdomen, antennal stalks, and legs above, are covered with conspicuous round spots of pale yellow on a dark green ground-color.



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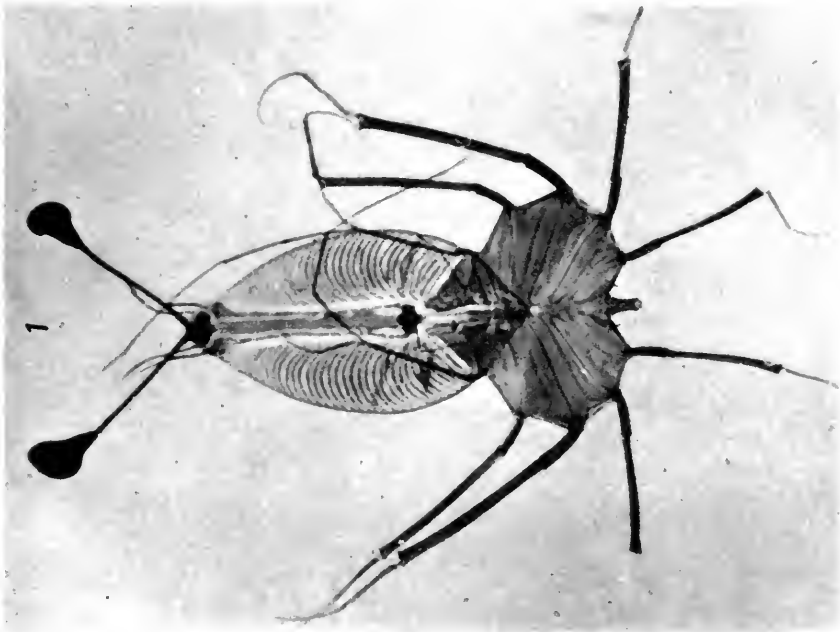


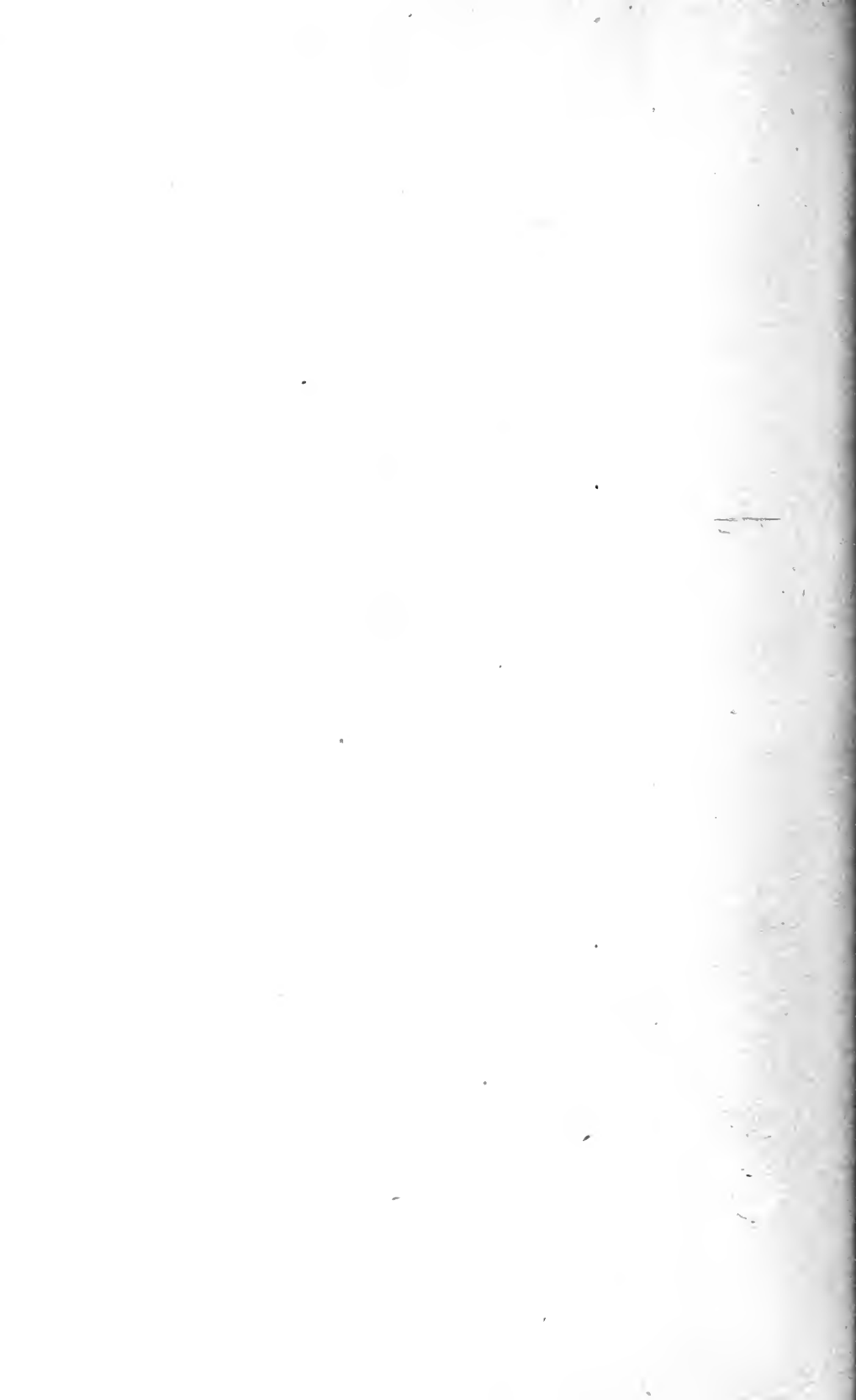
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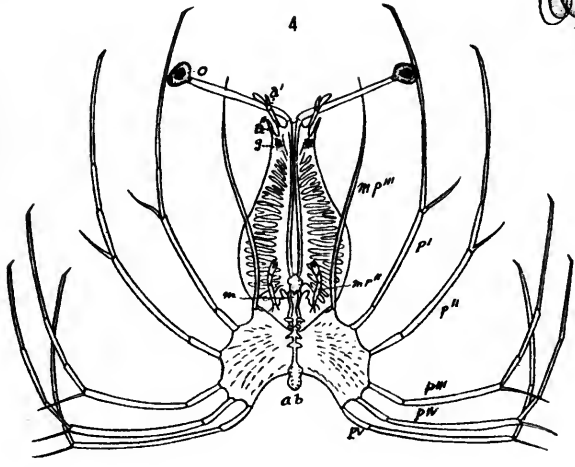
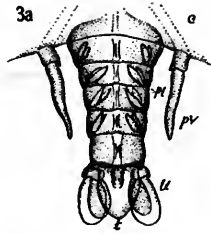
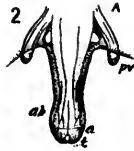
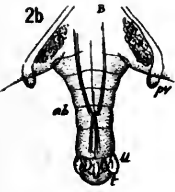
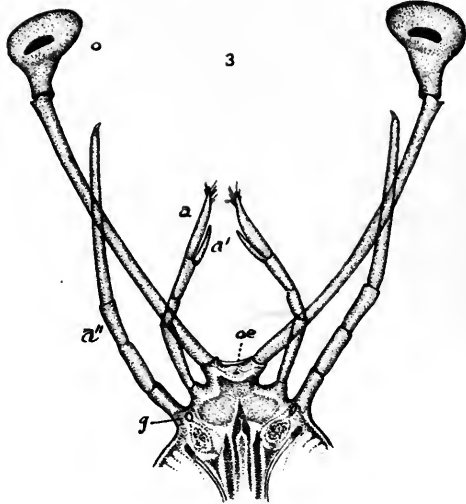
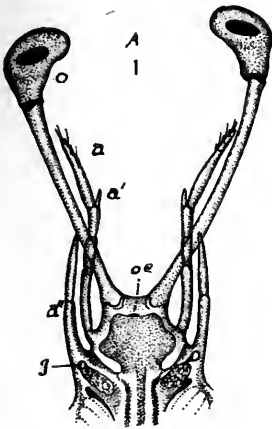
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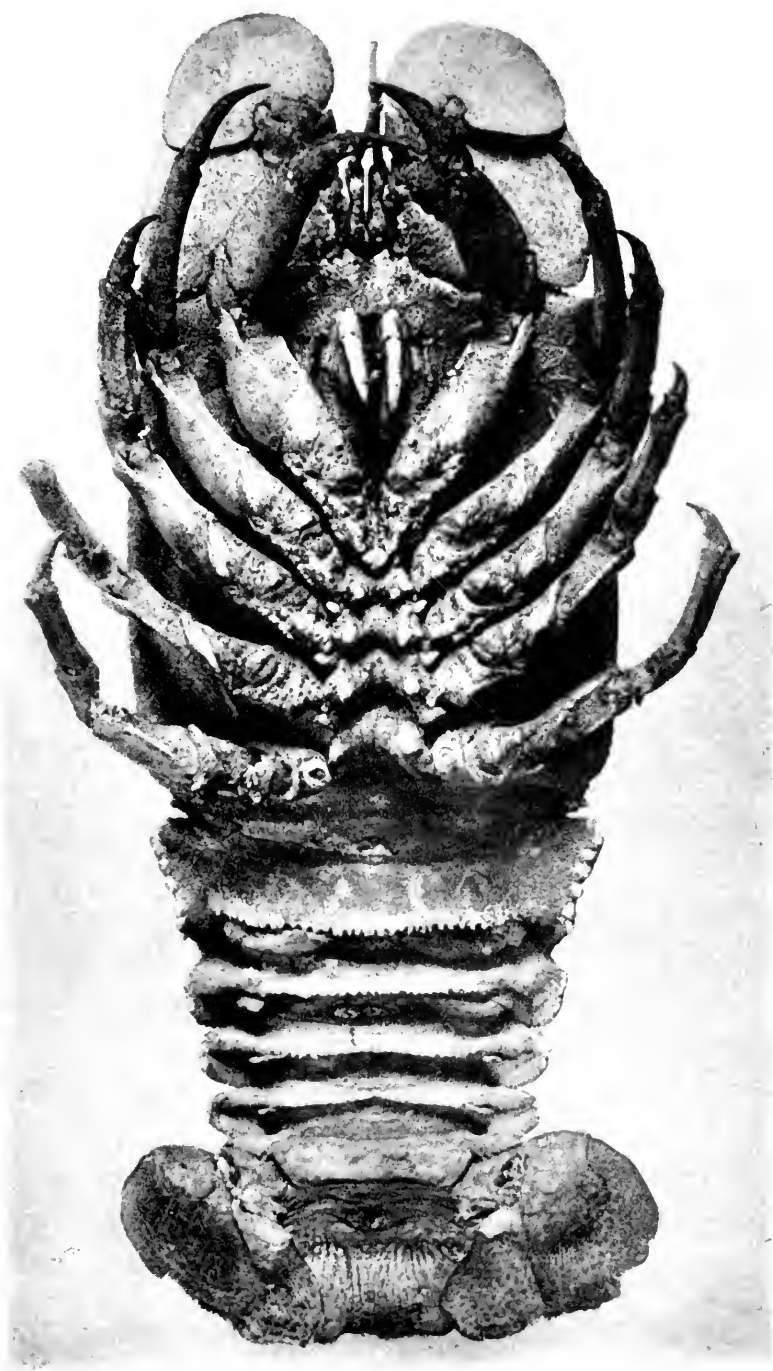






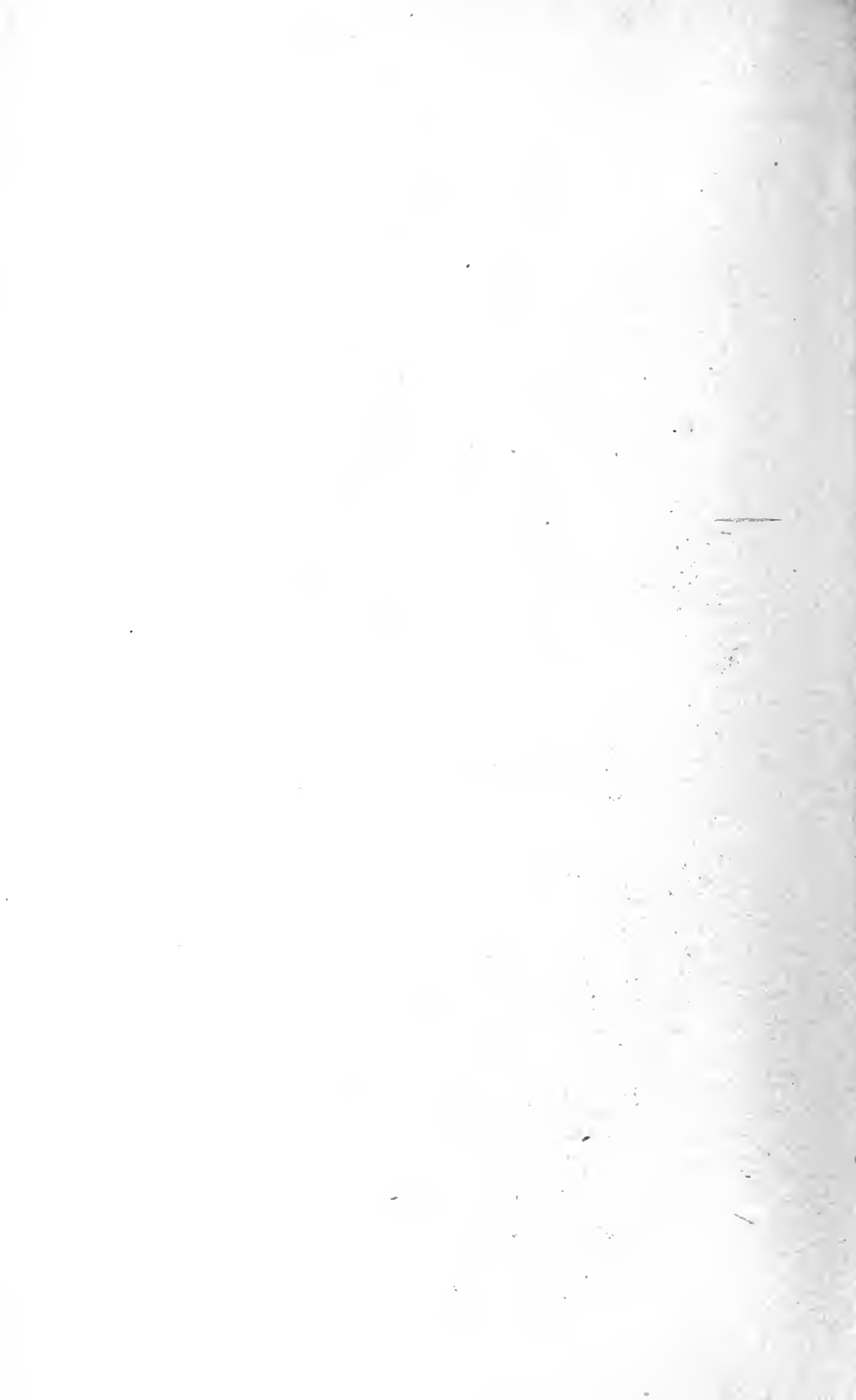








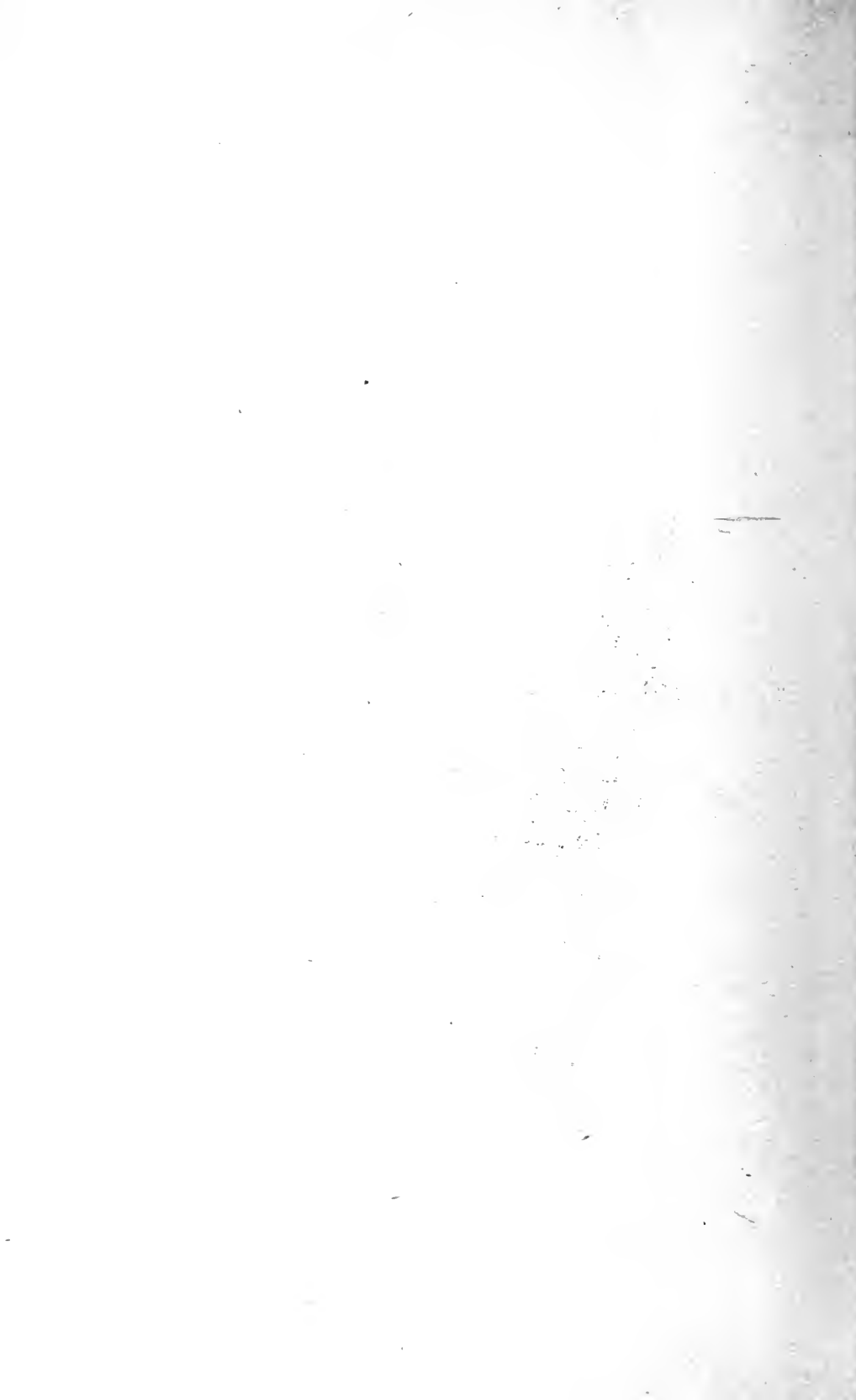


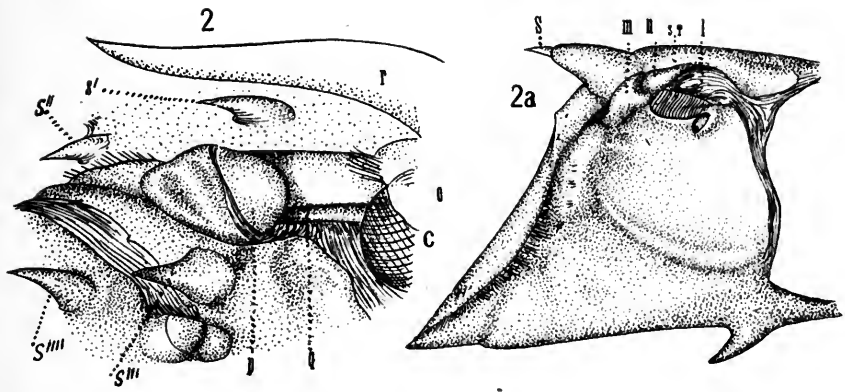
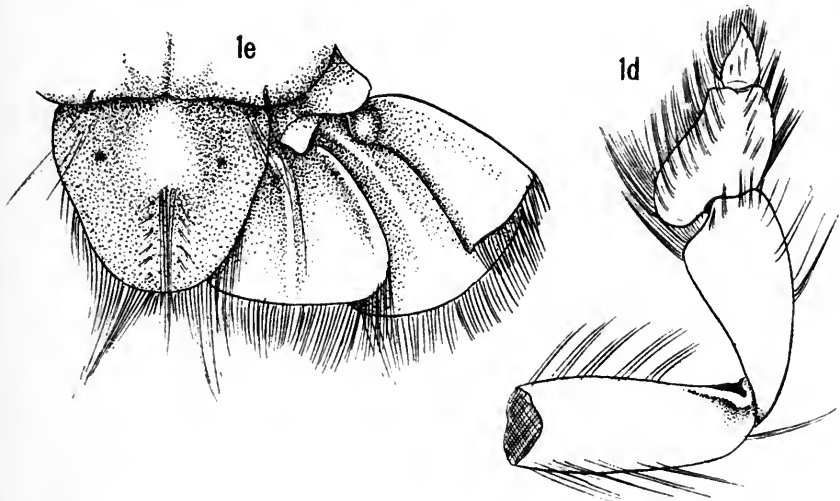
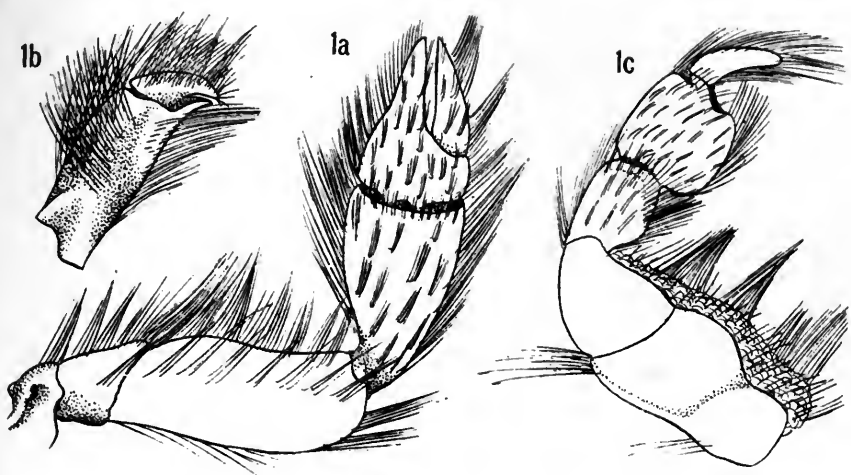


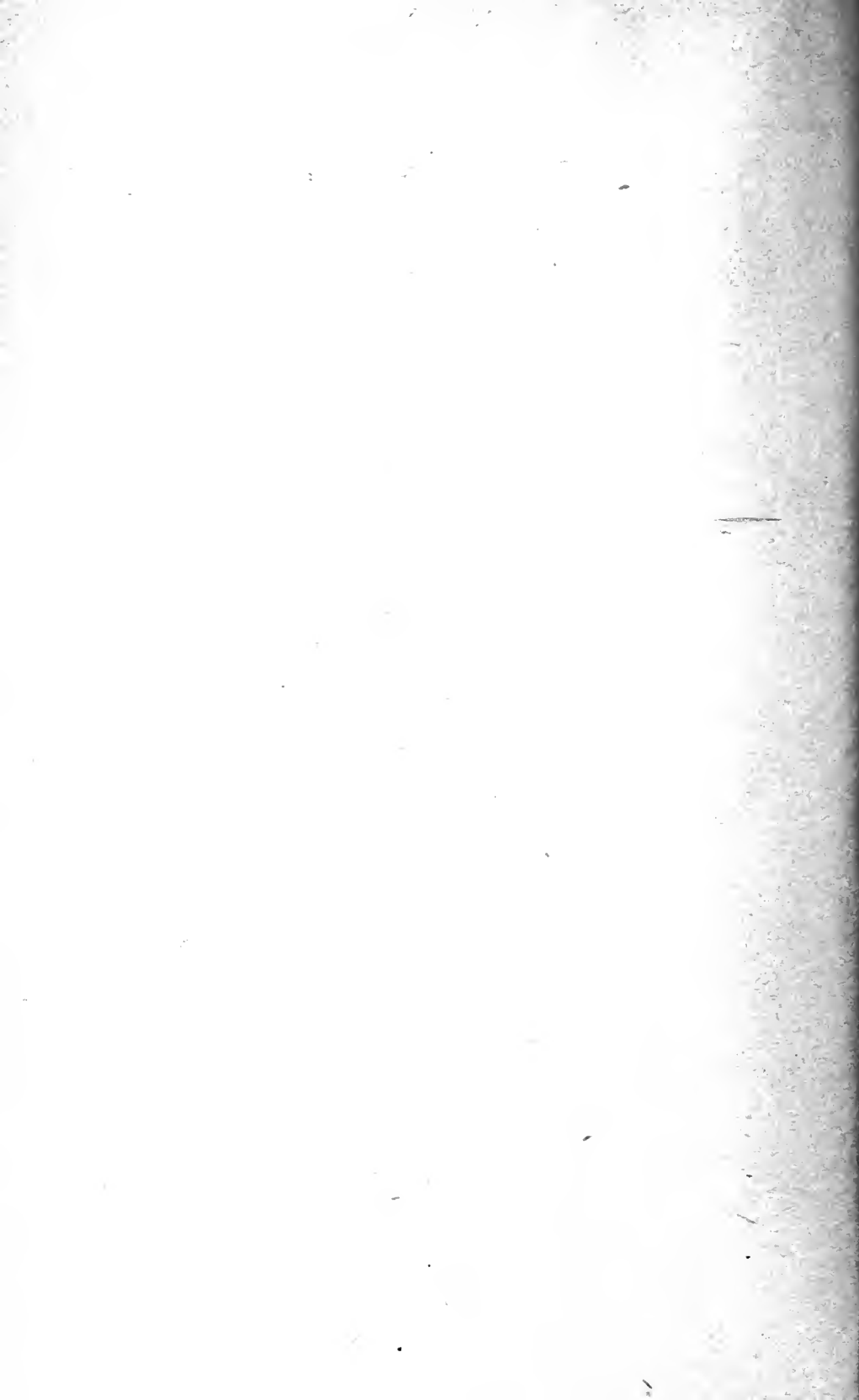


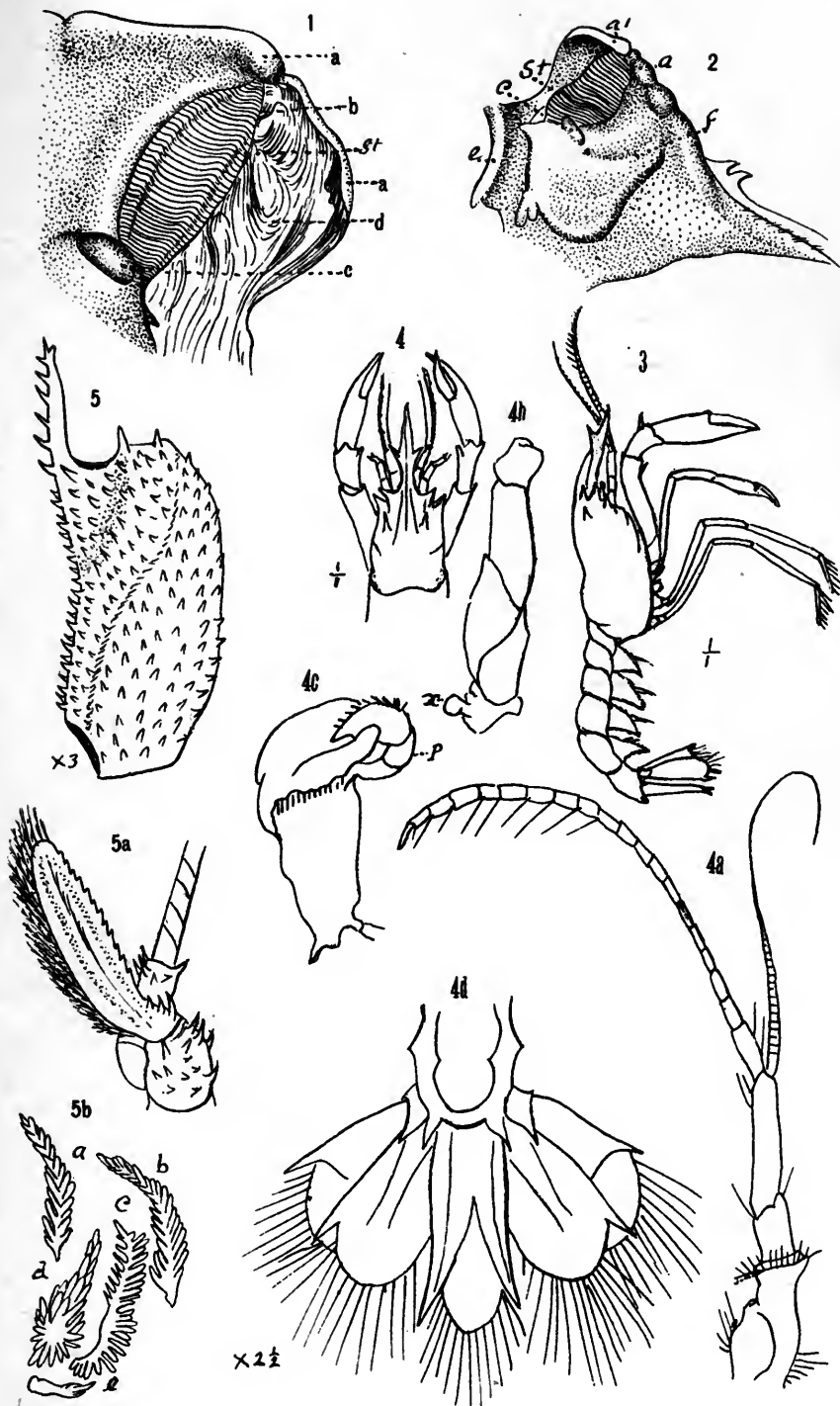


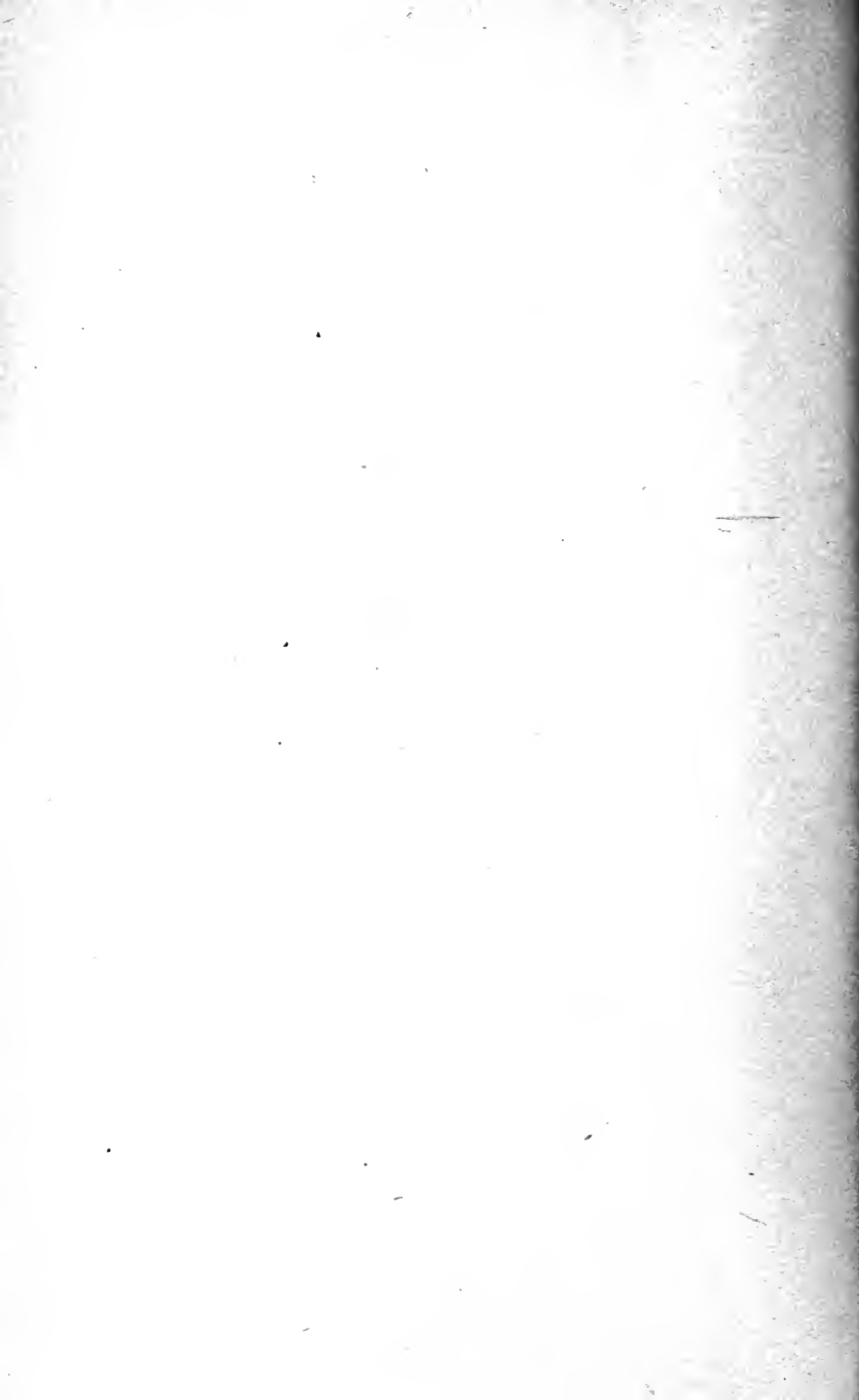


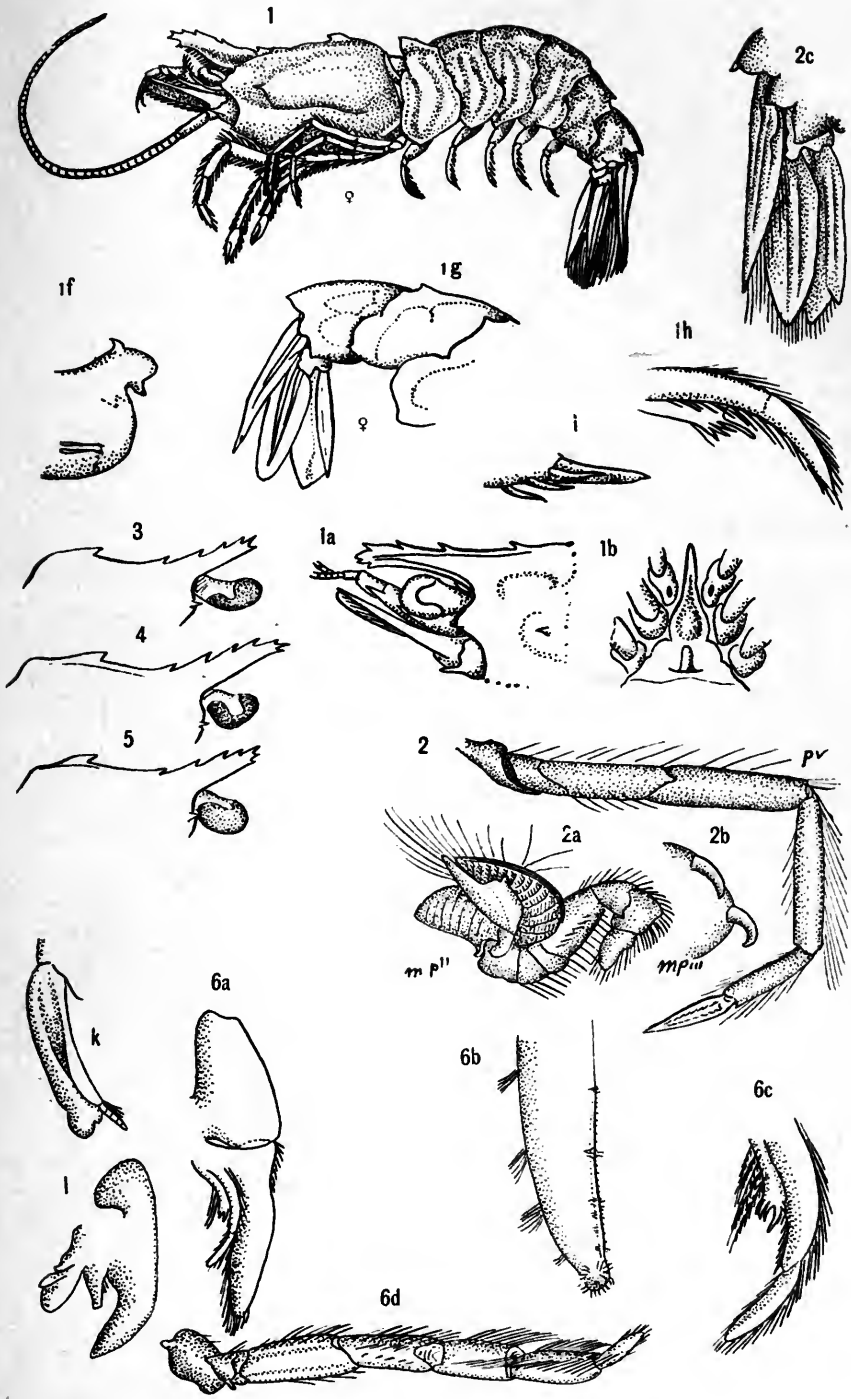


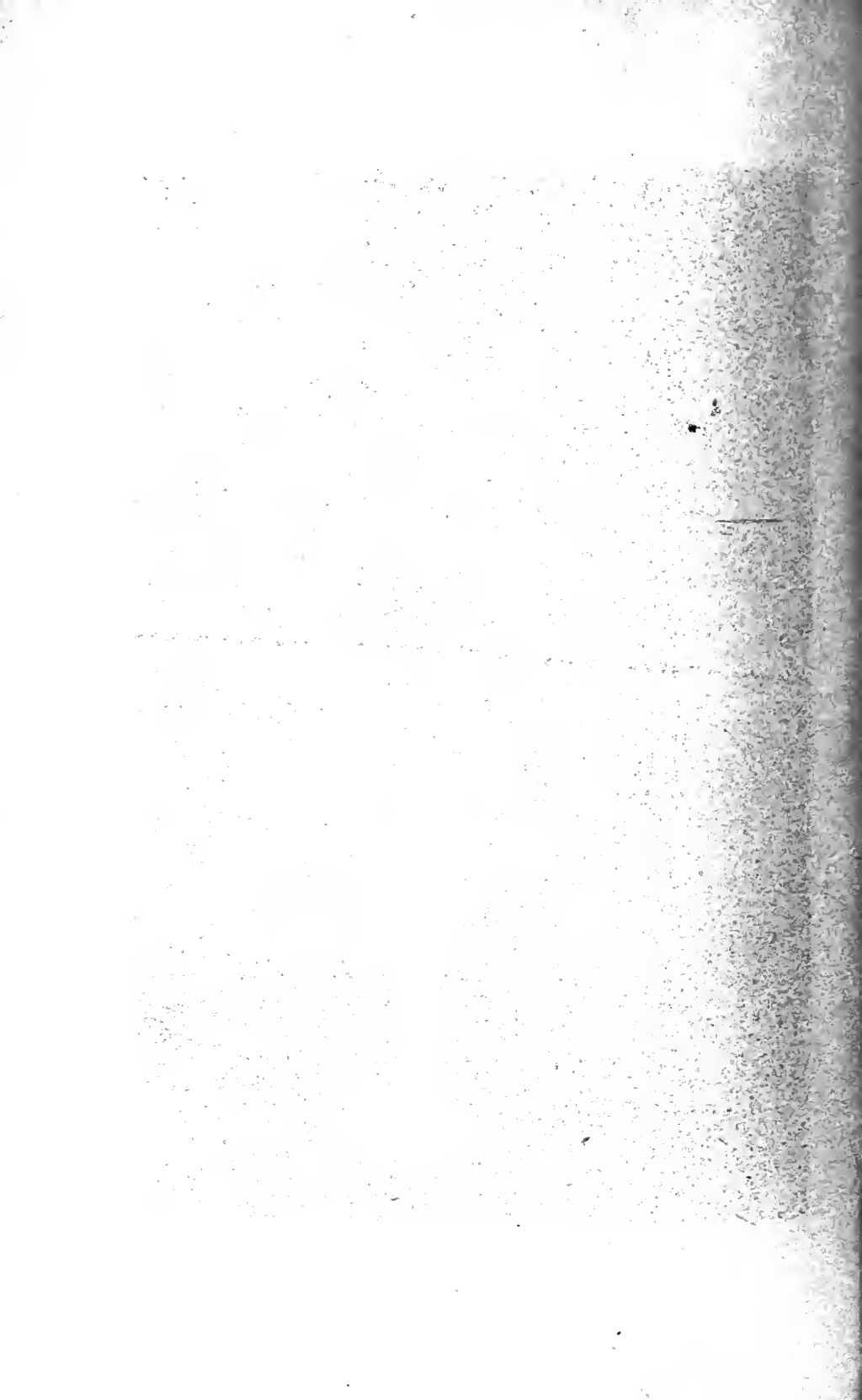


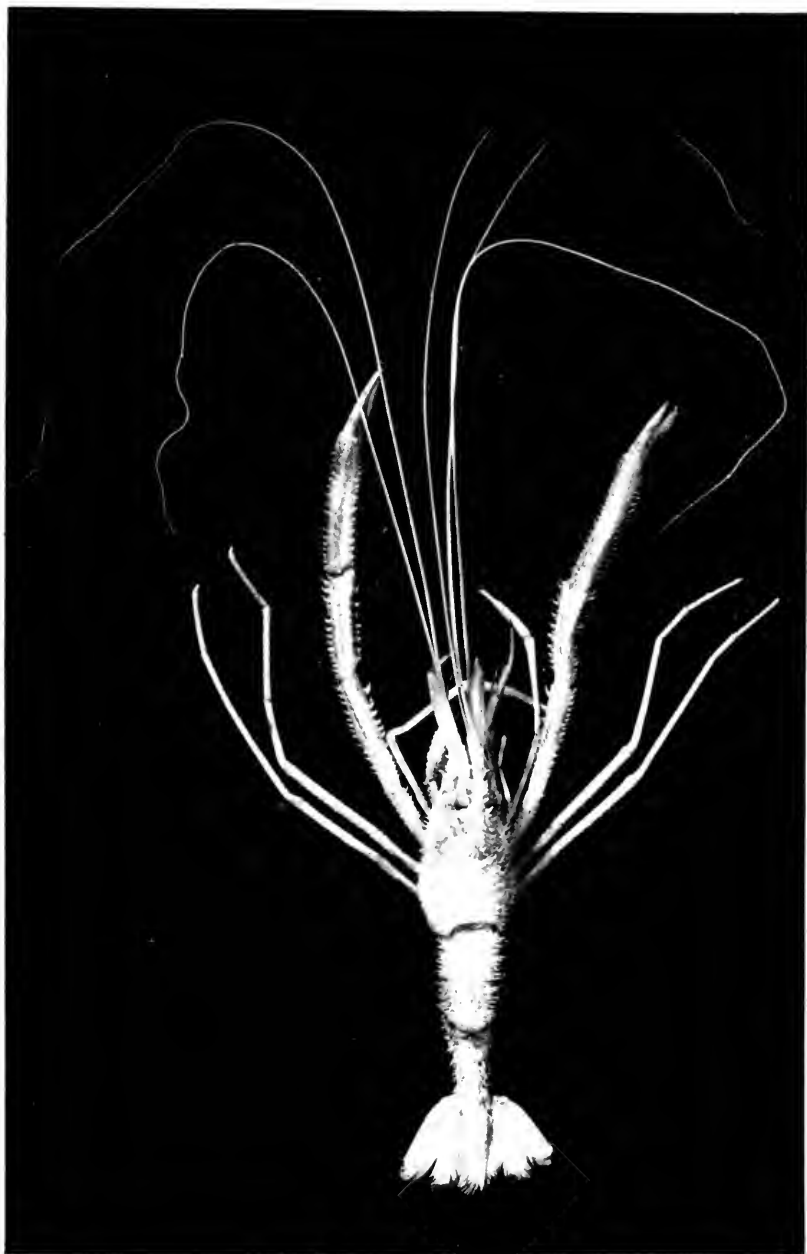




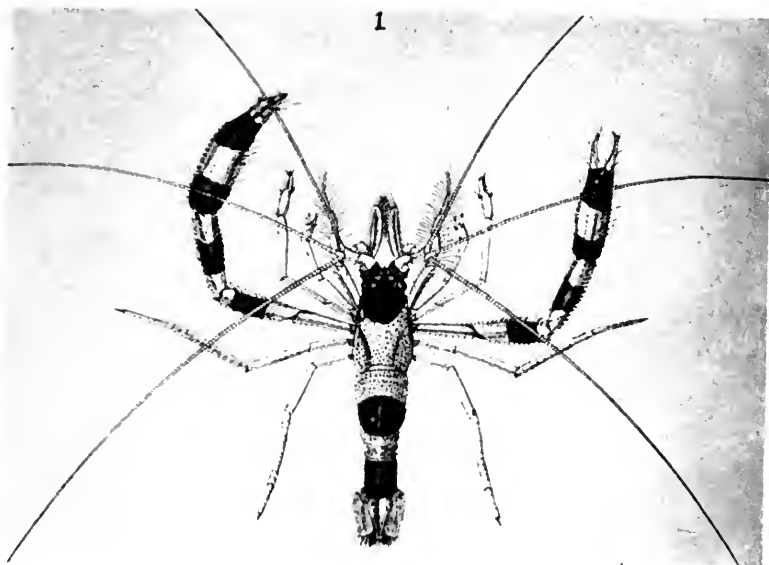
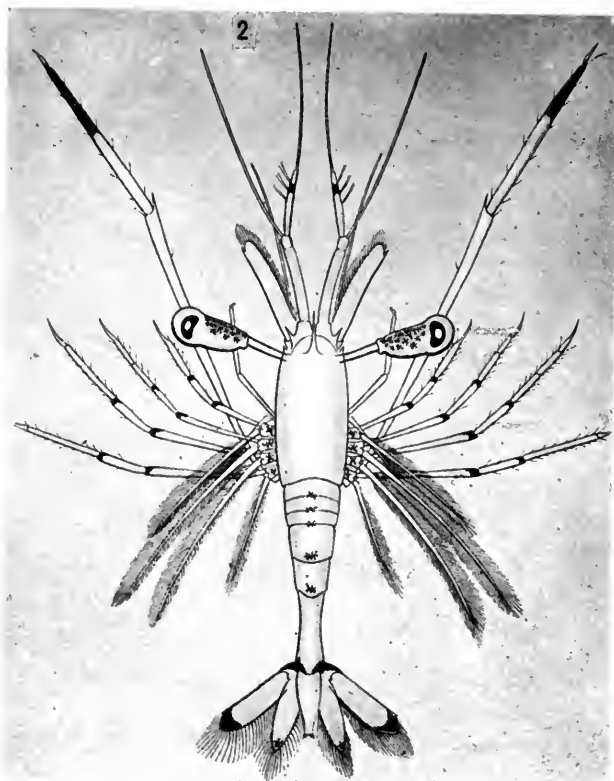








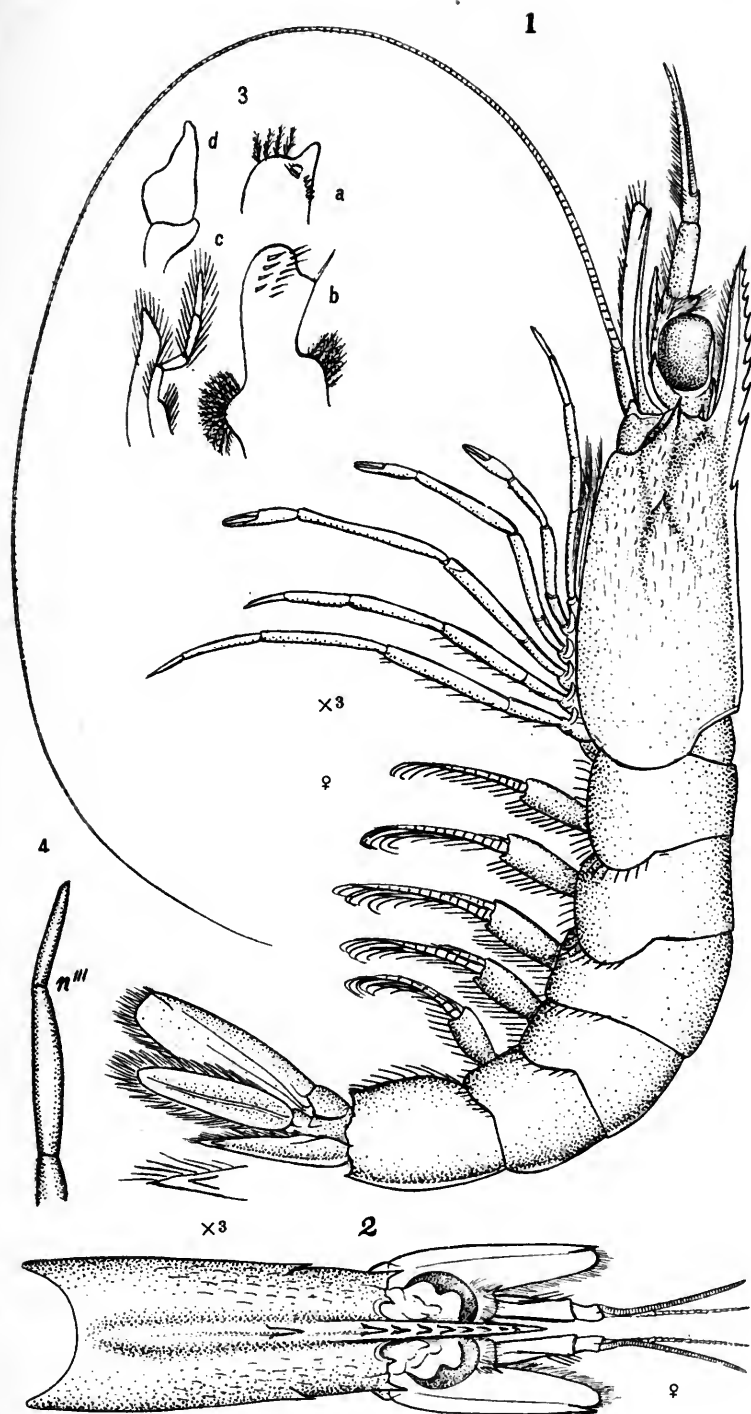


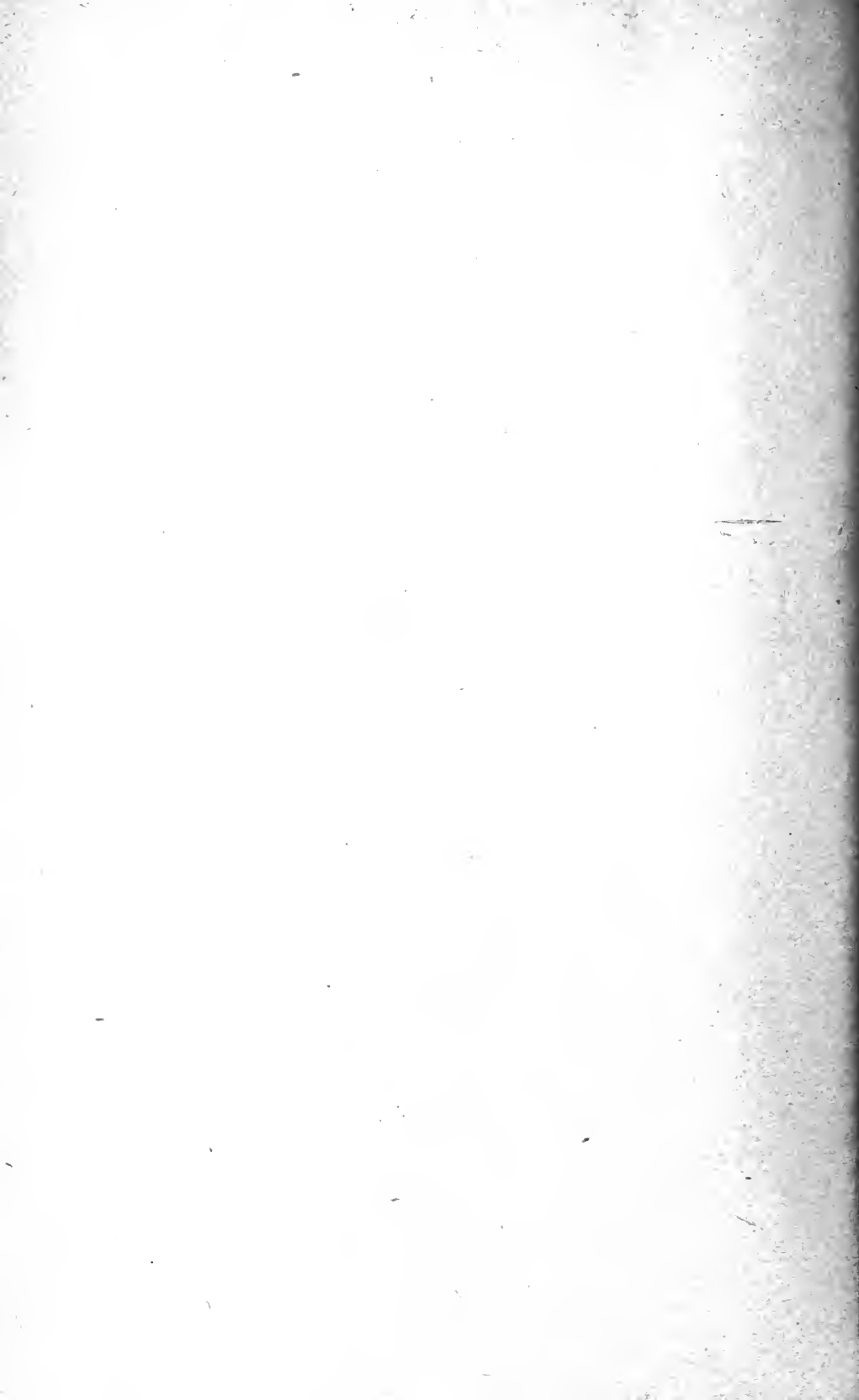


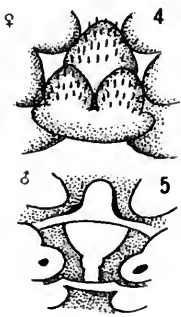
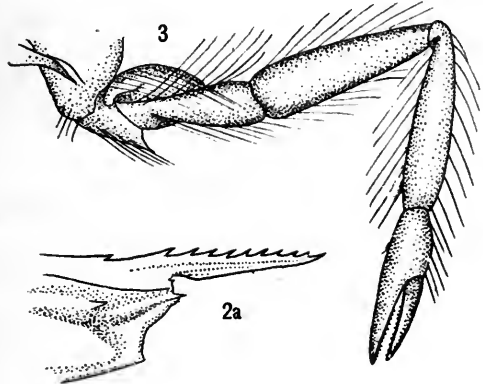
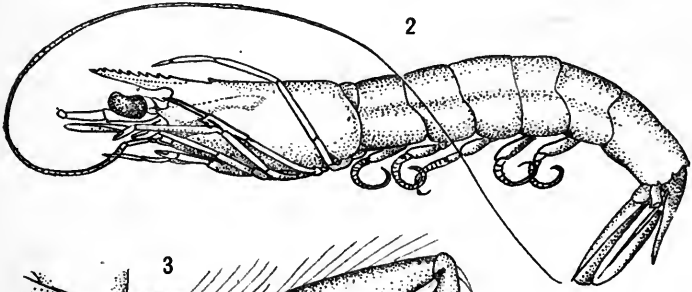
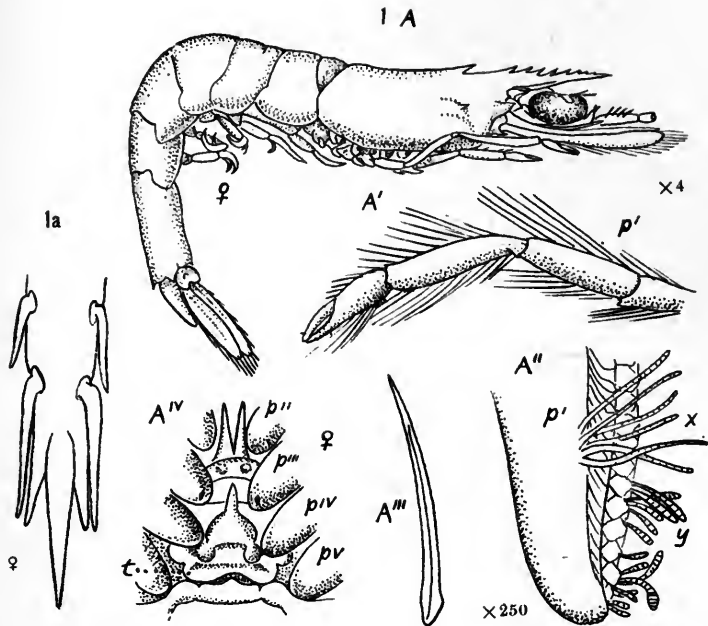


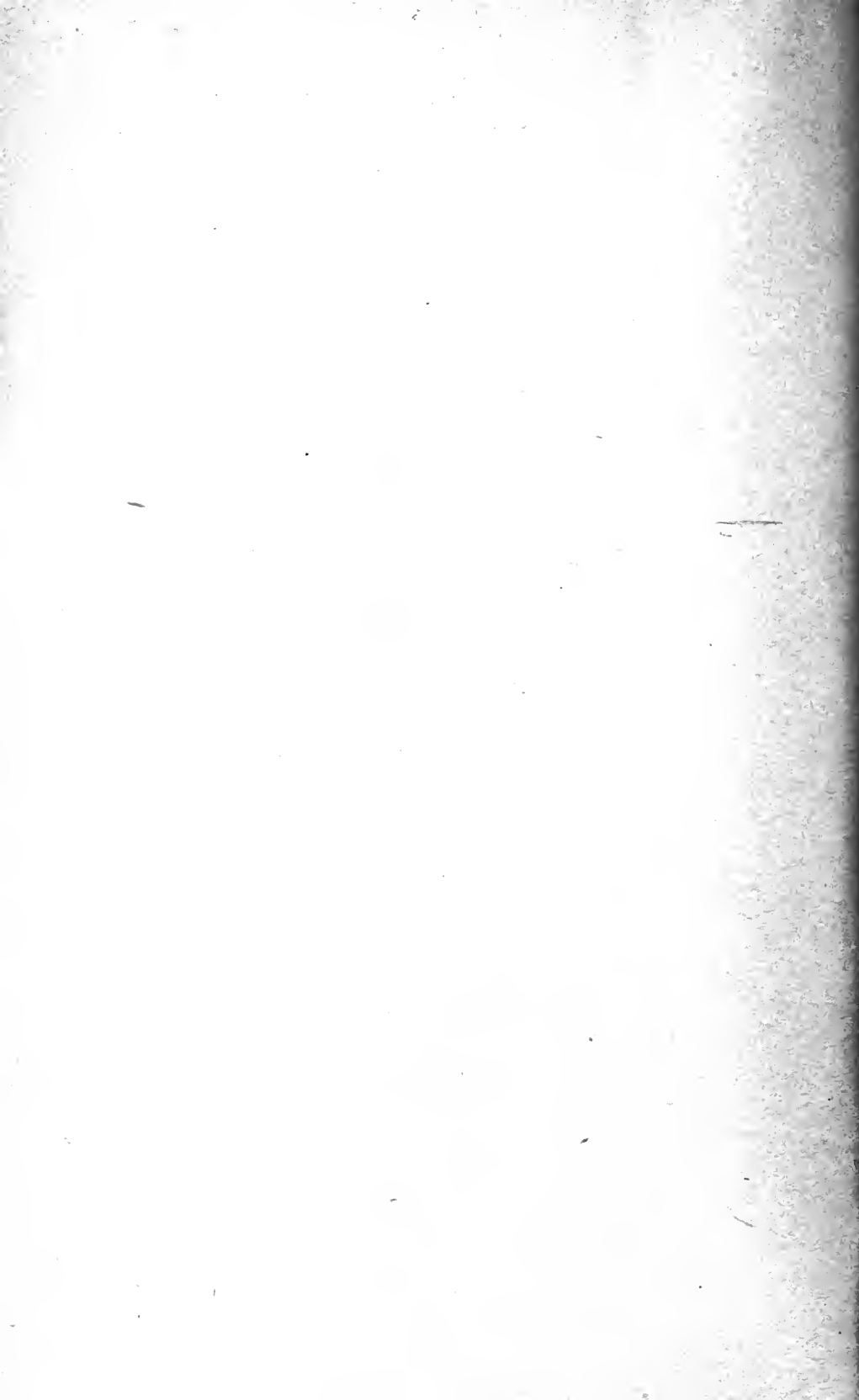


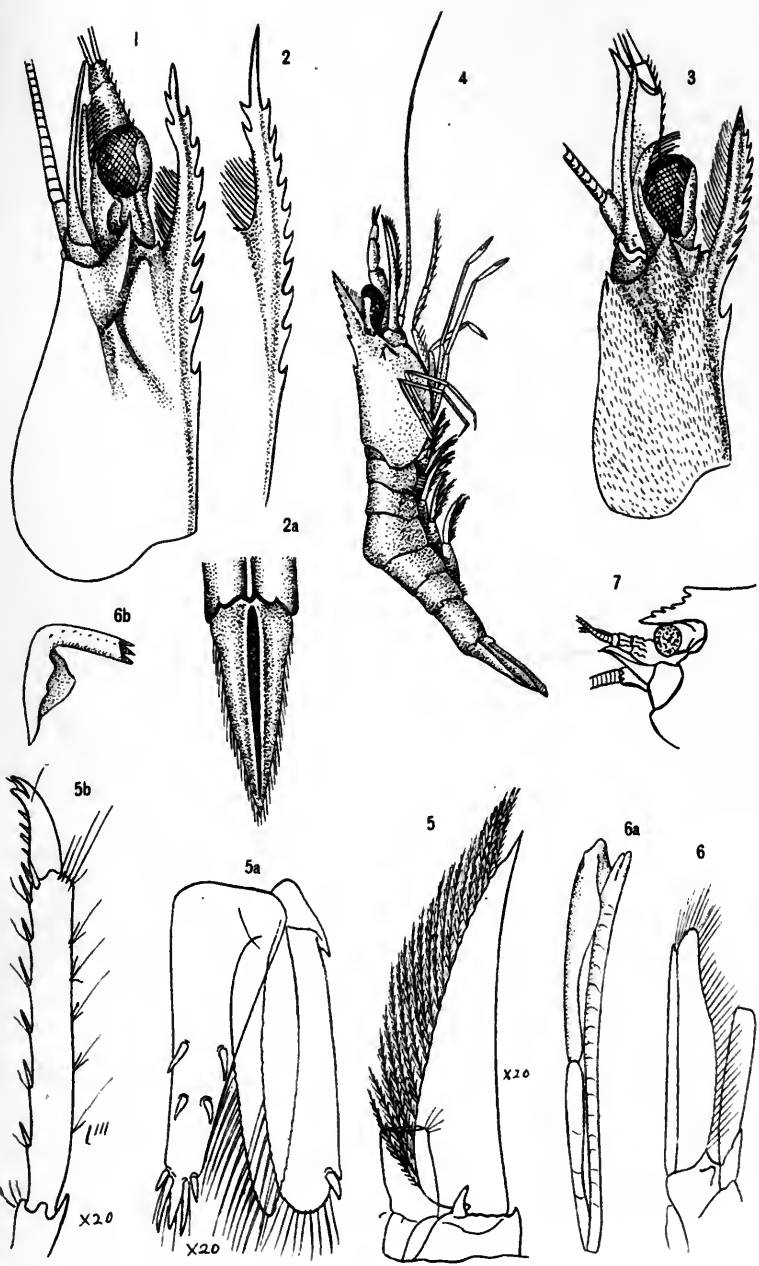


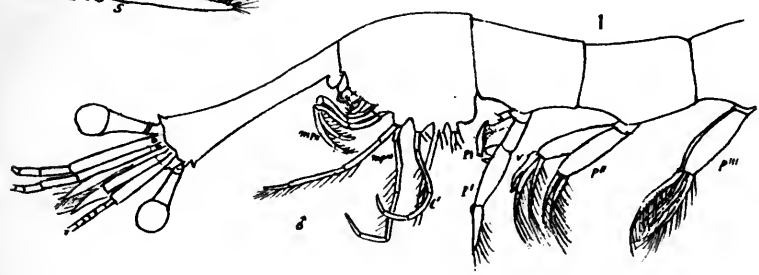
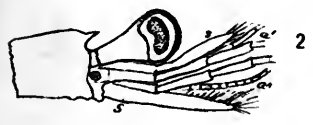
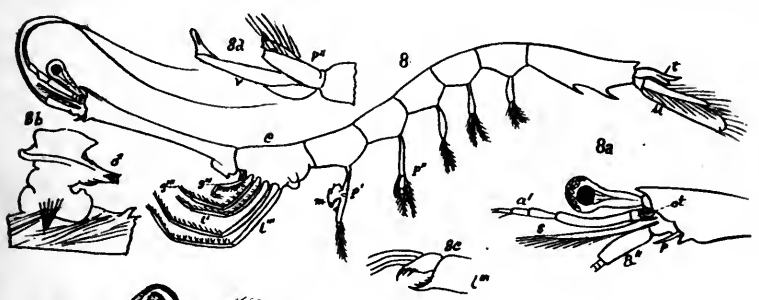
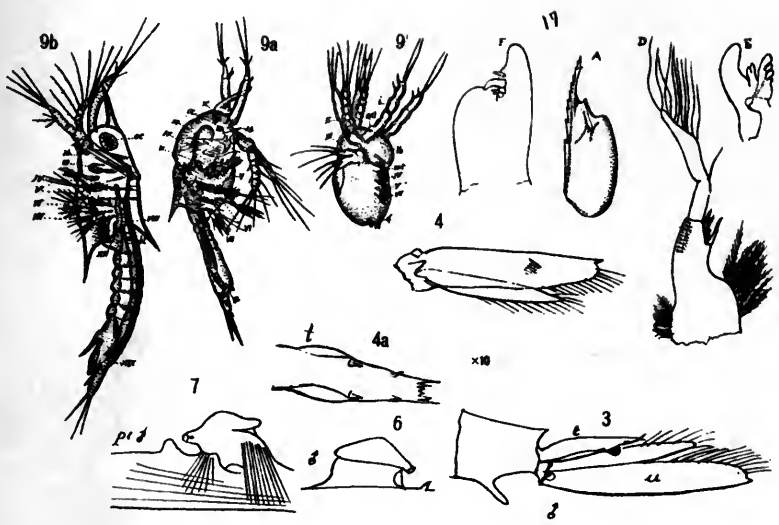


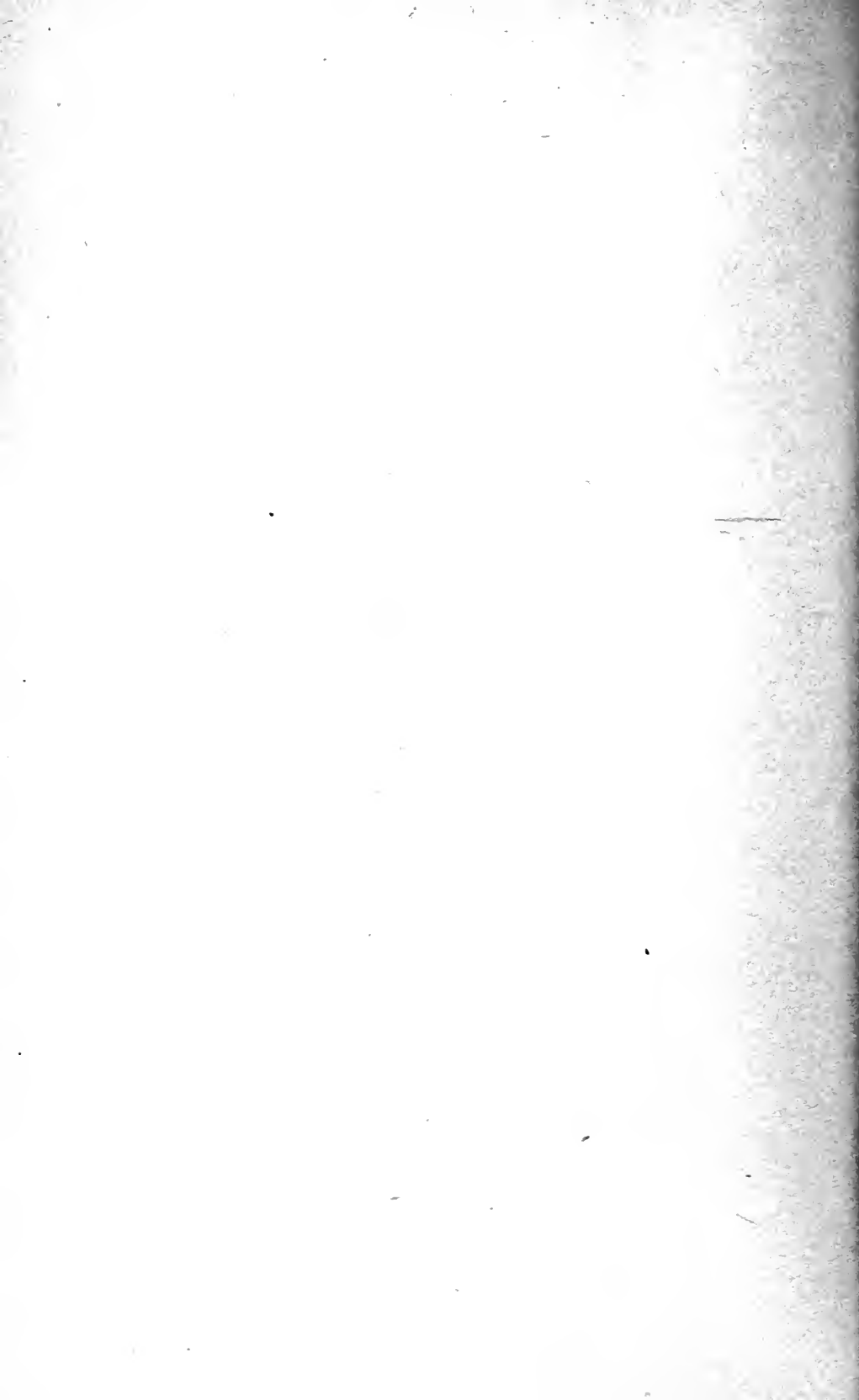


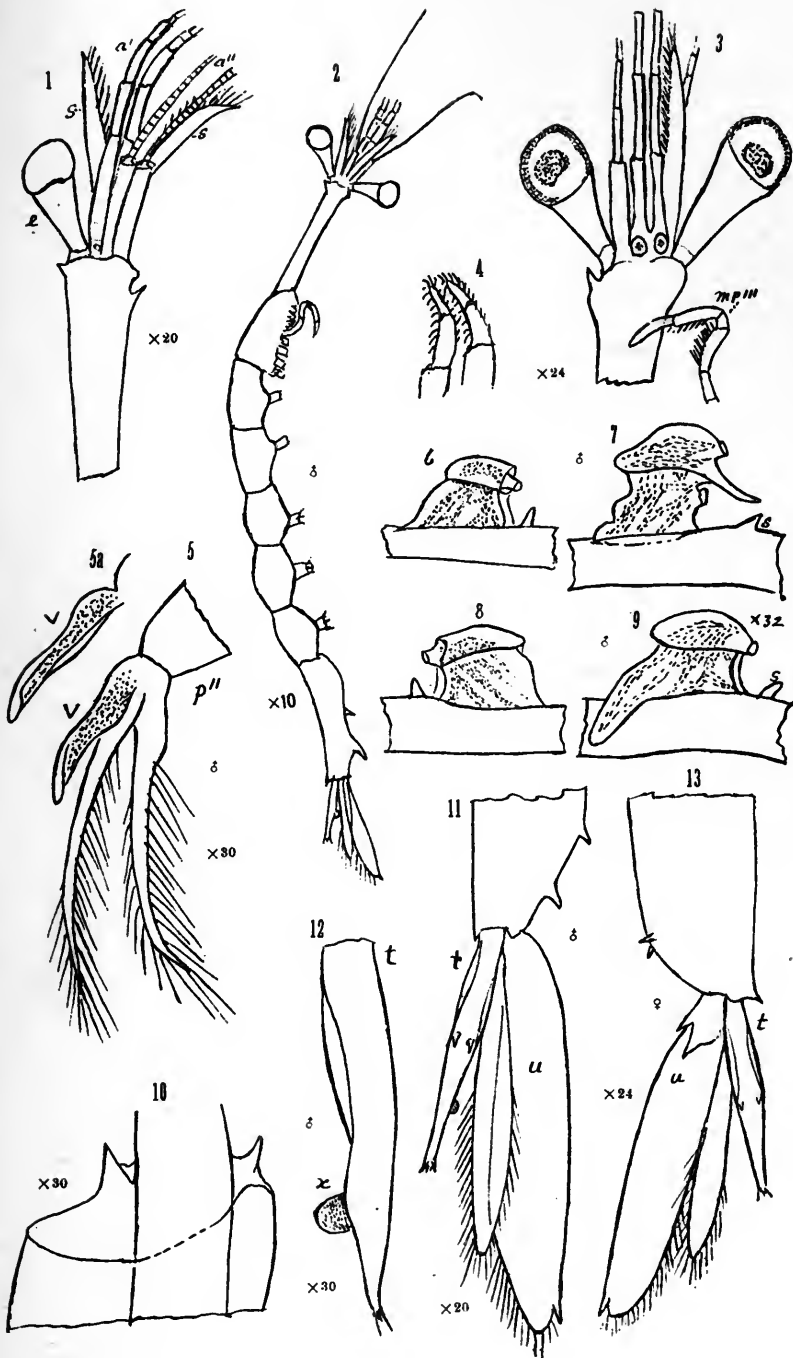




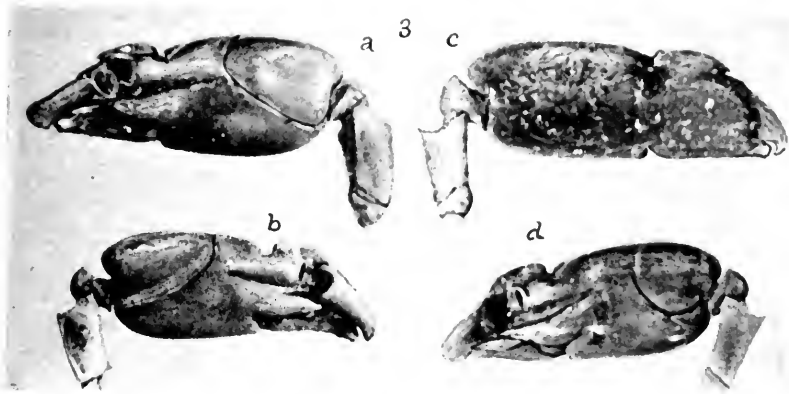
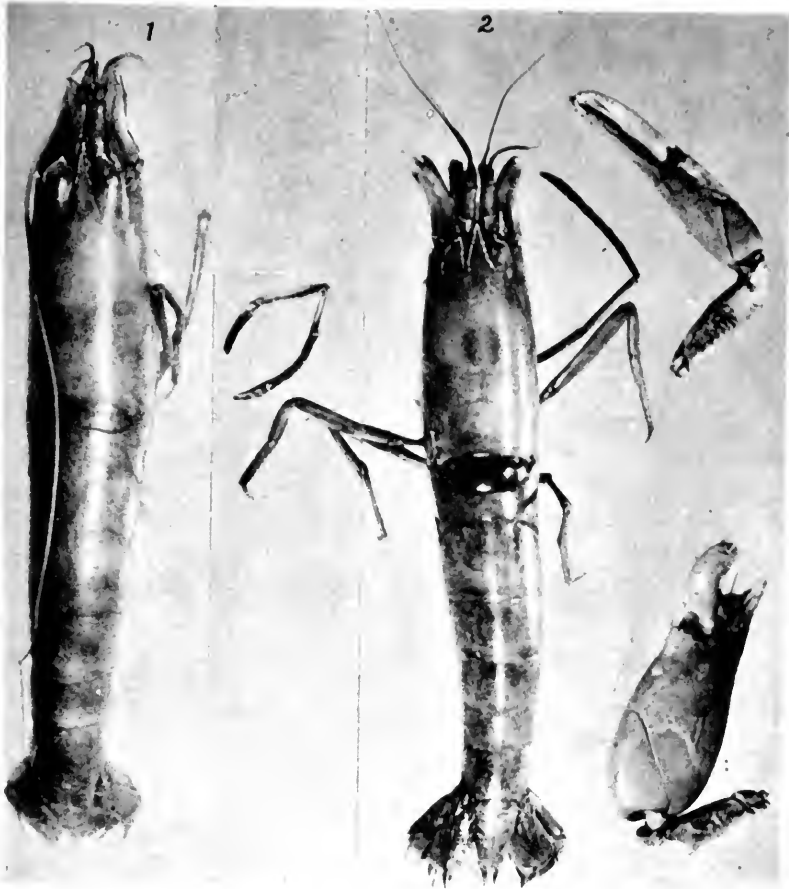




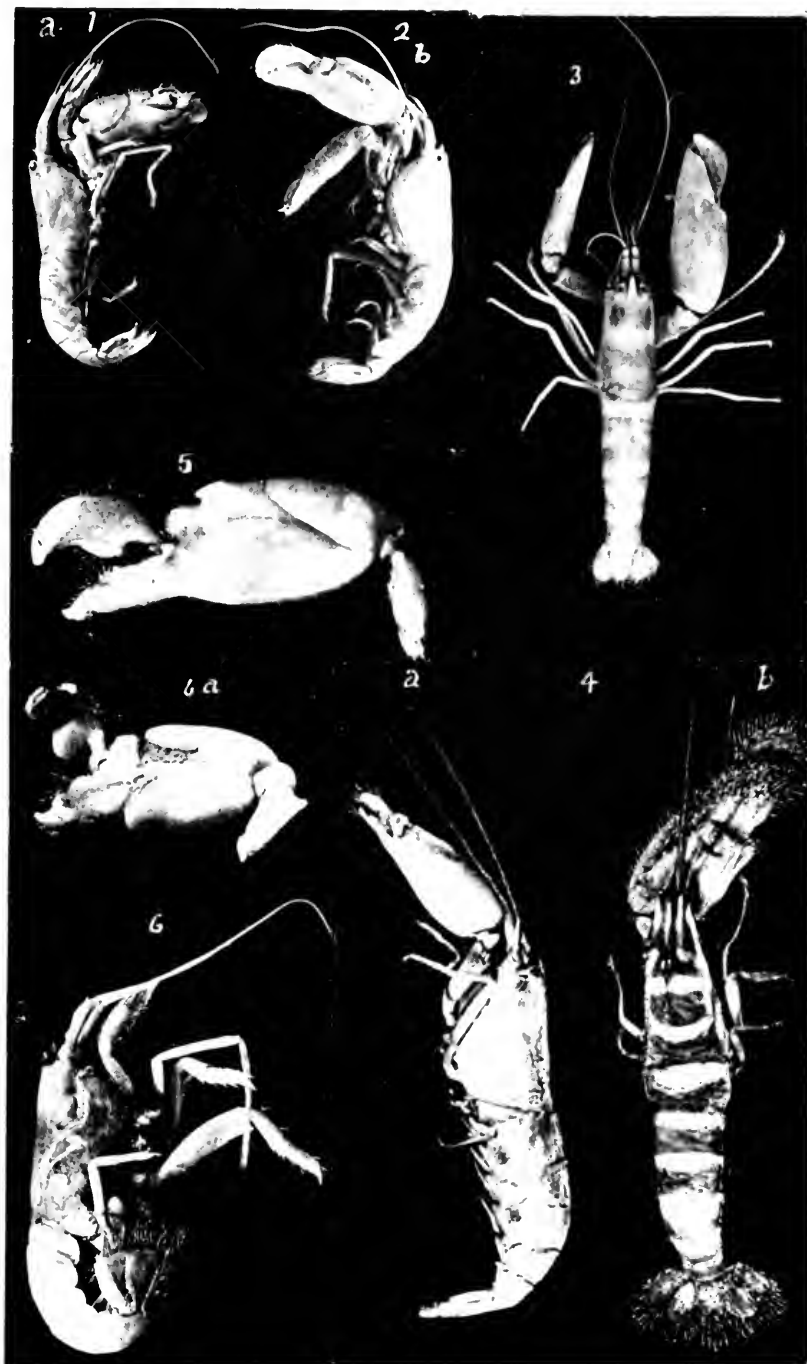


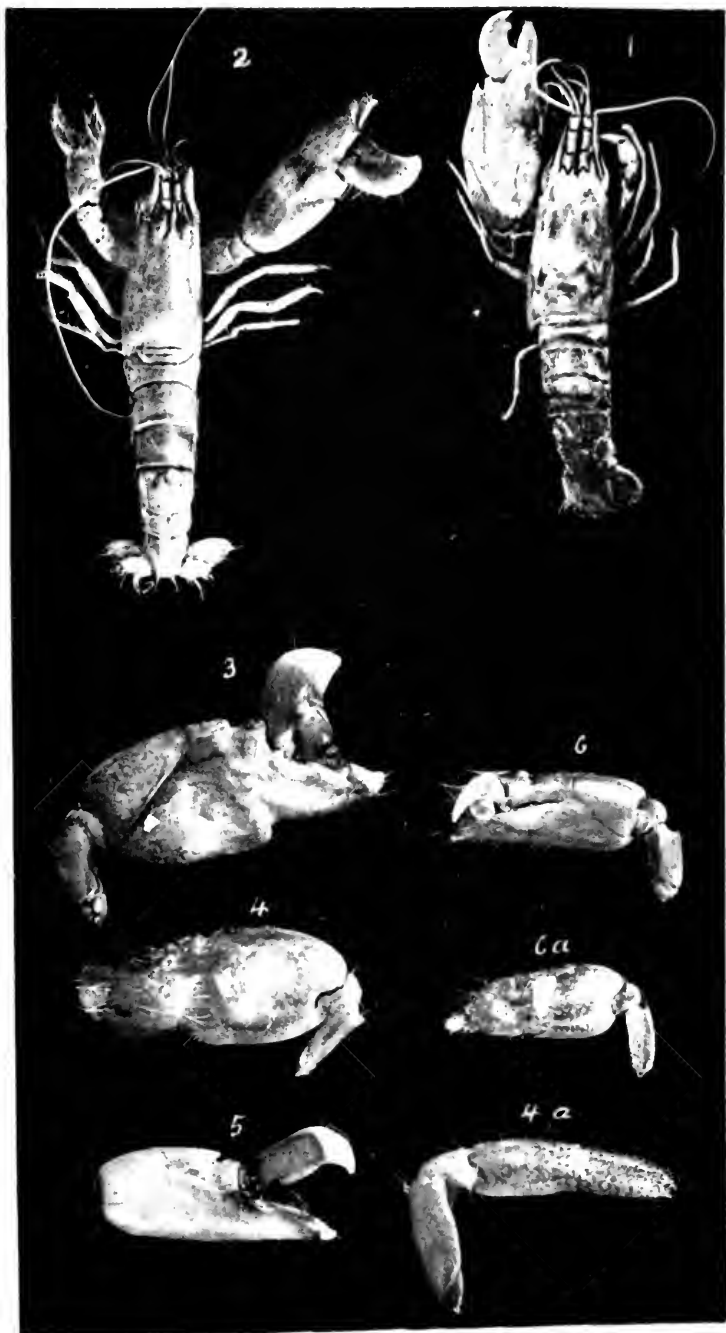


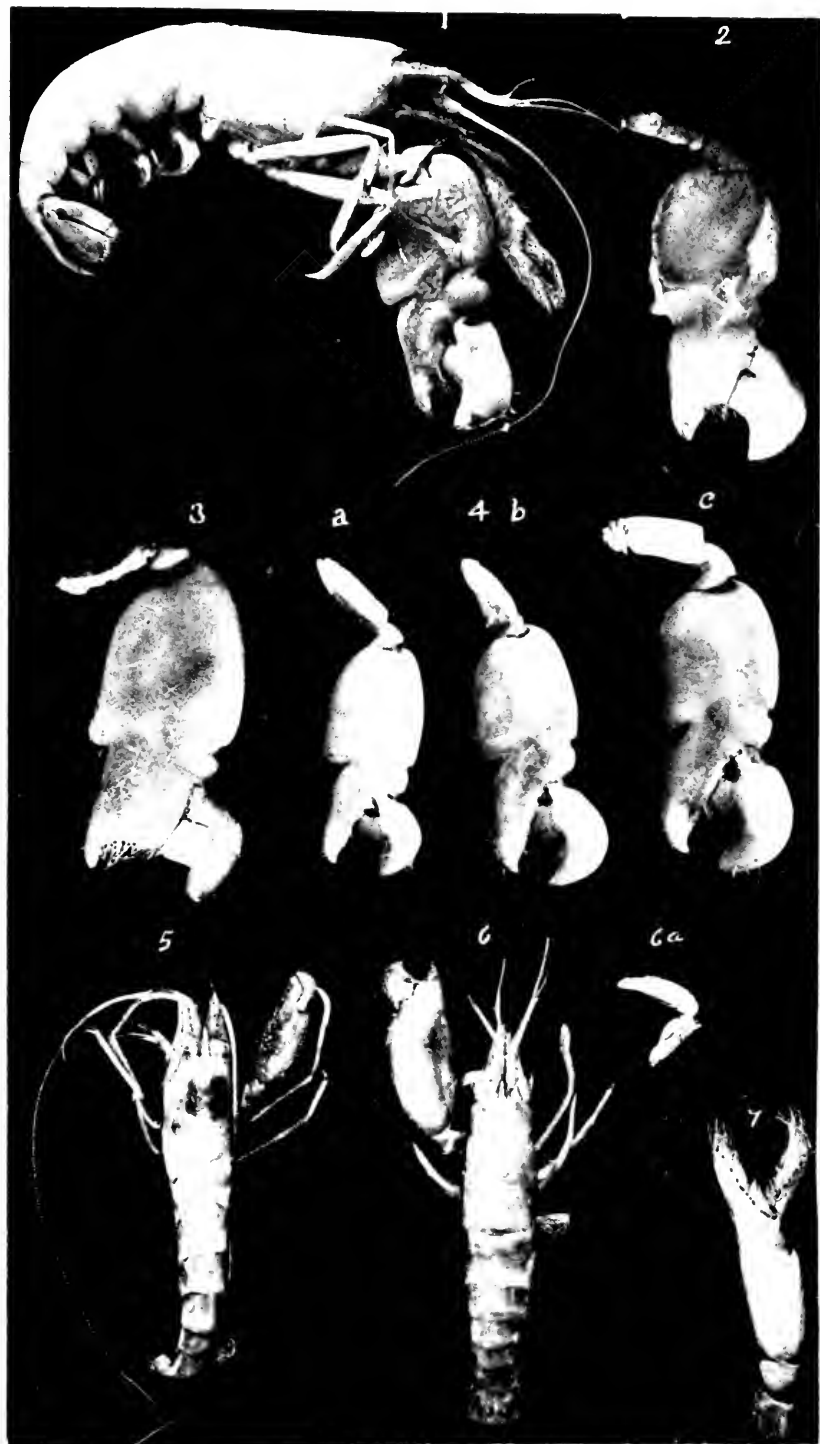


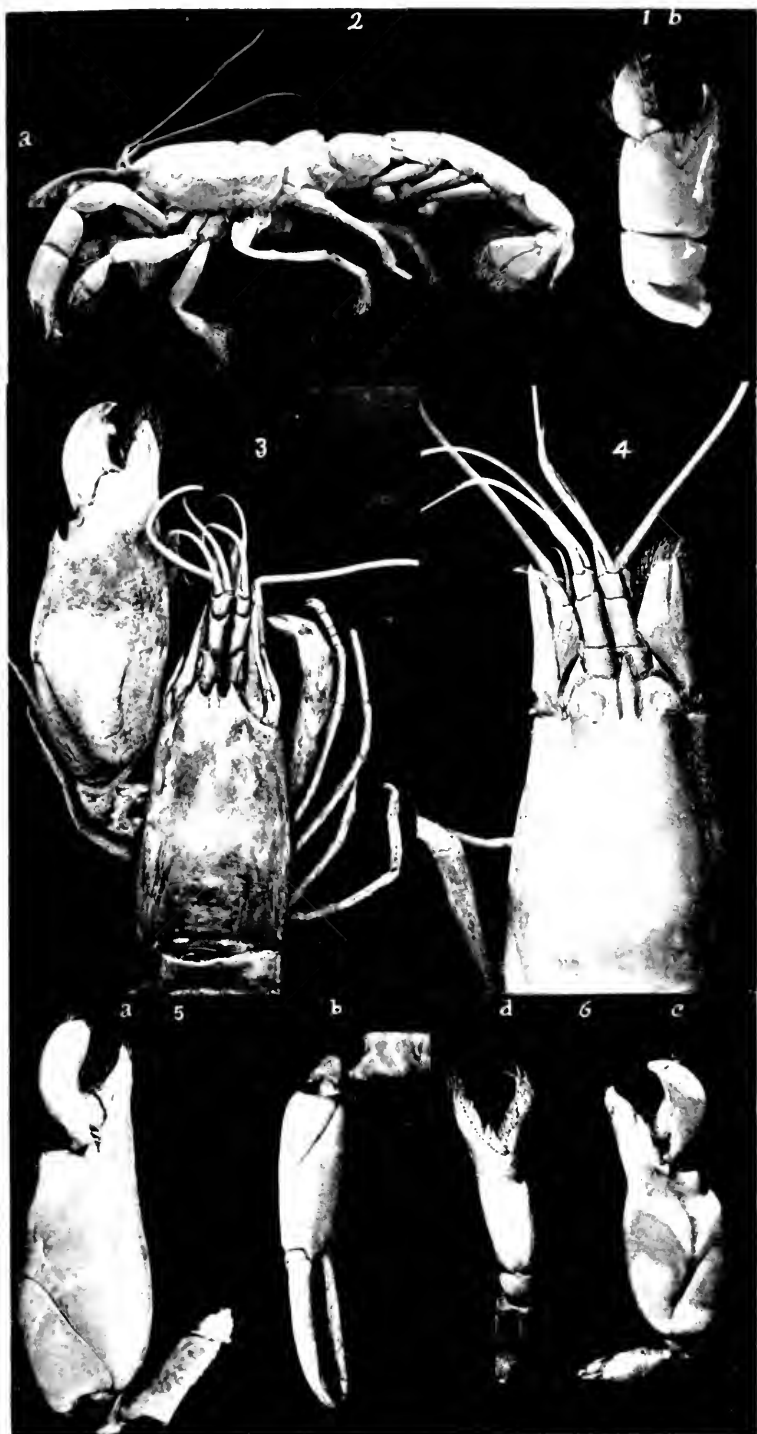


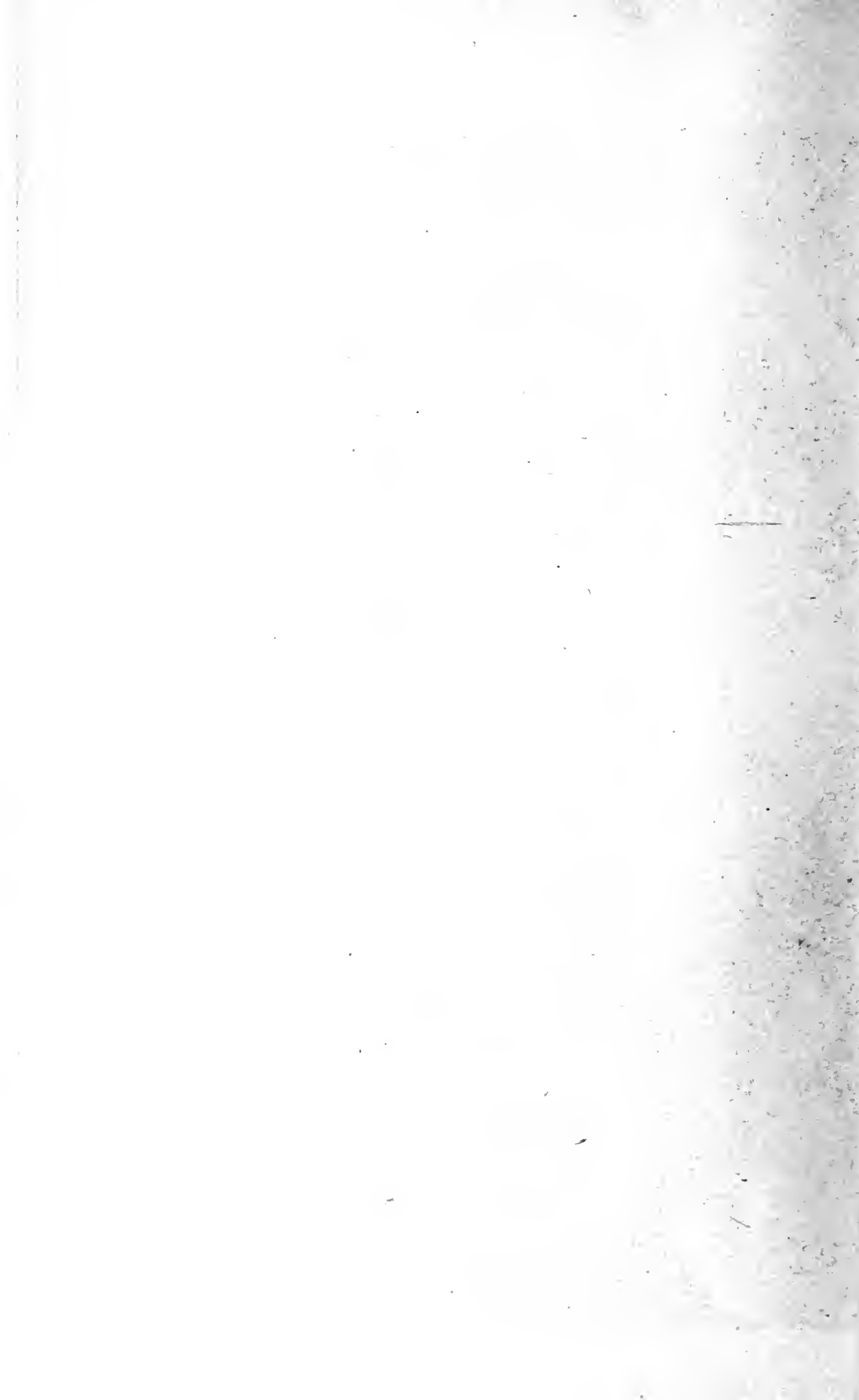


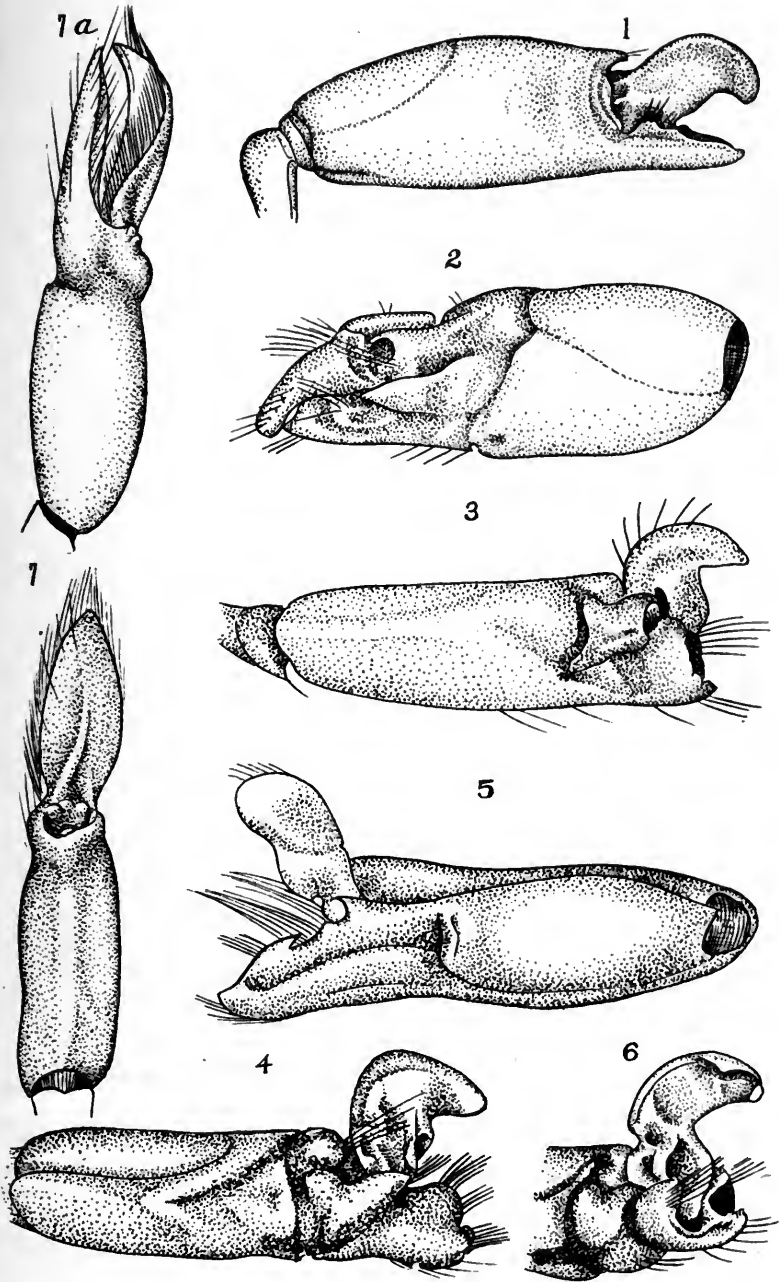




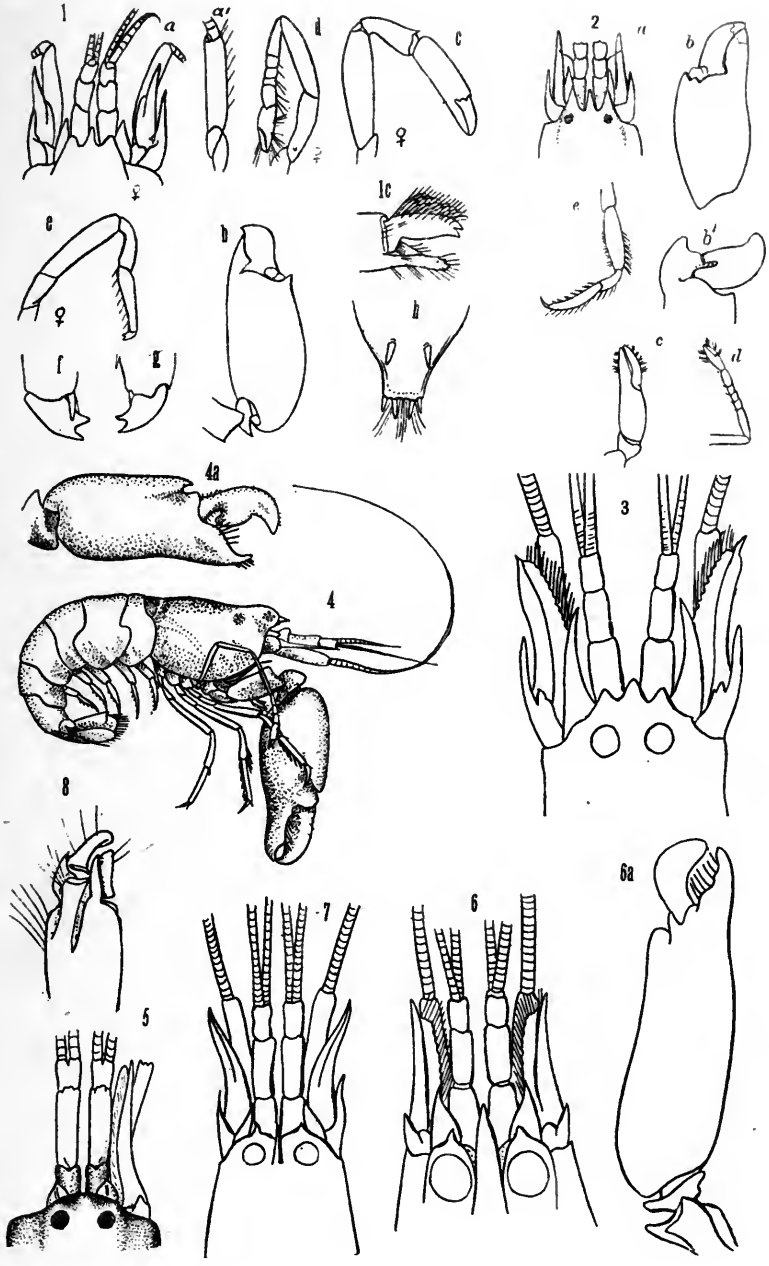


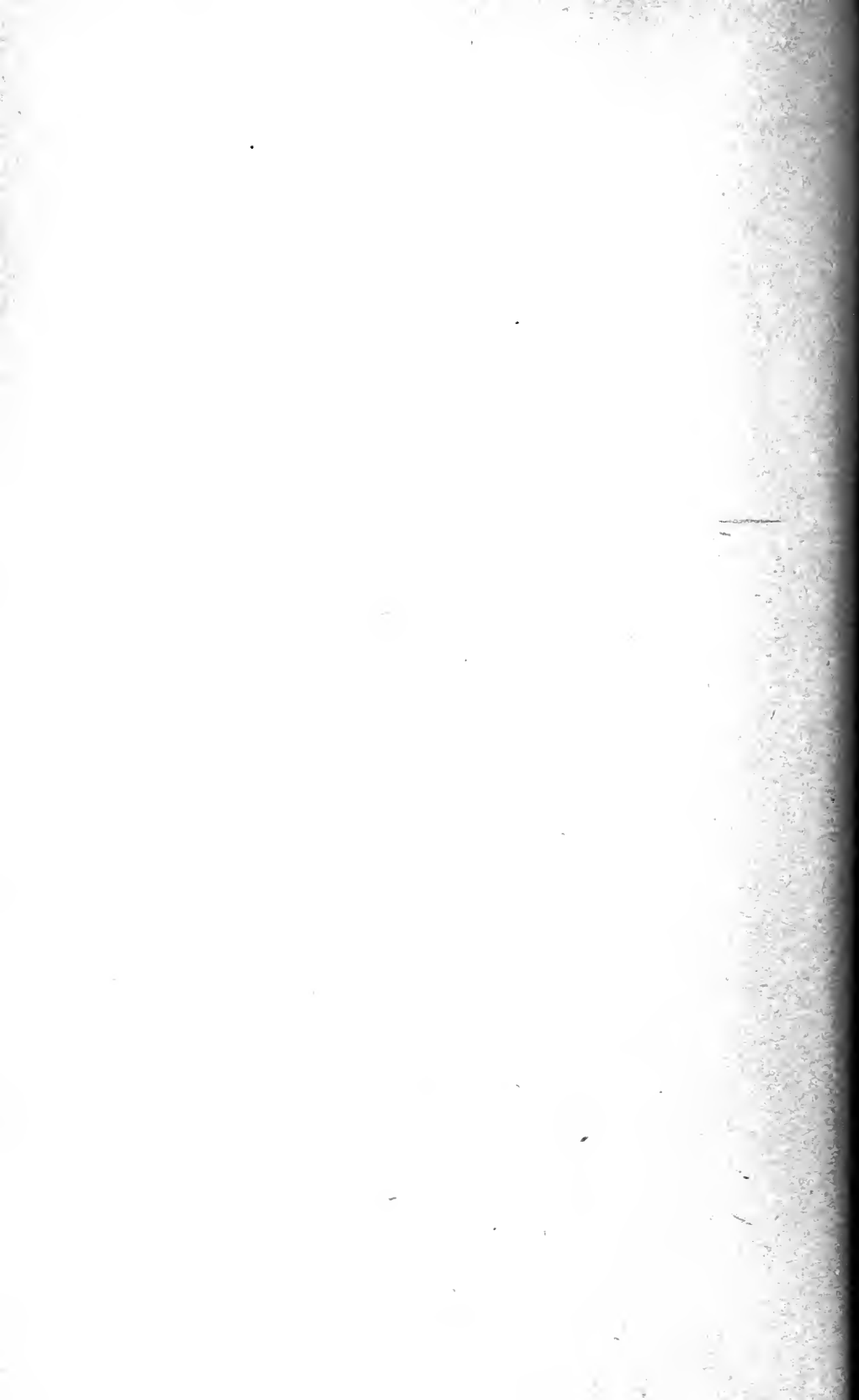


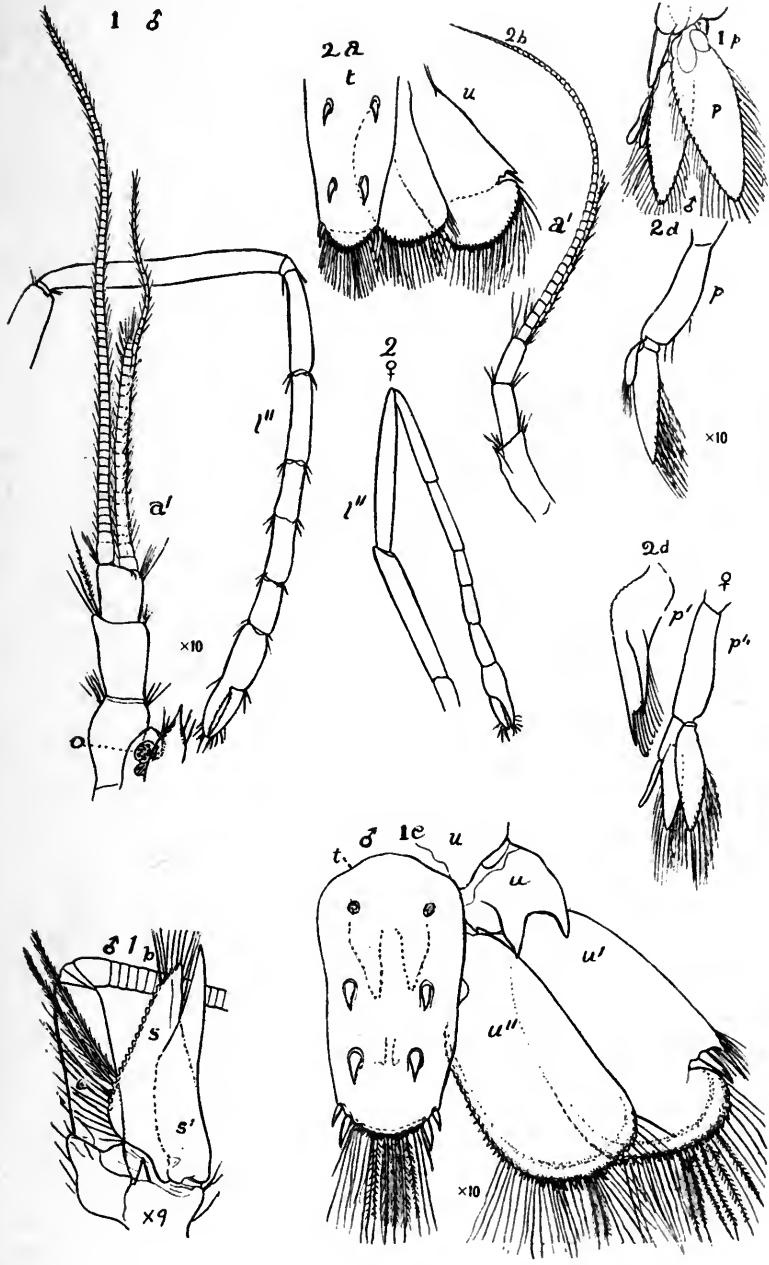


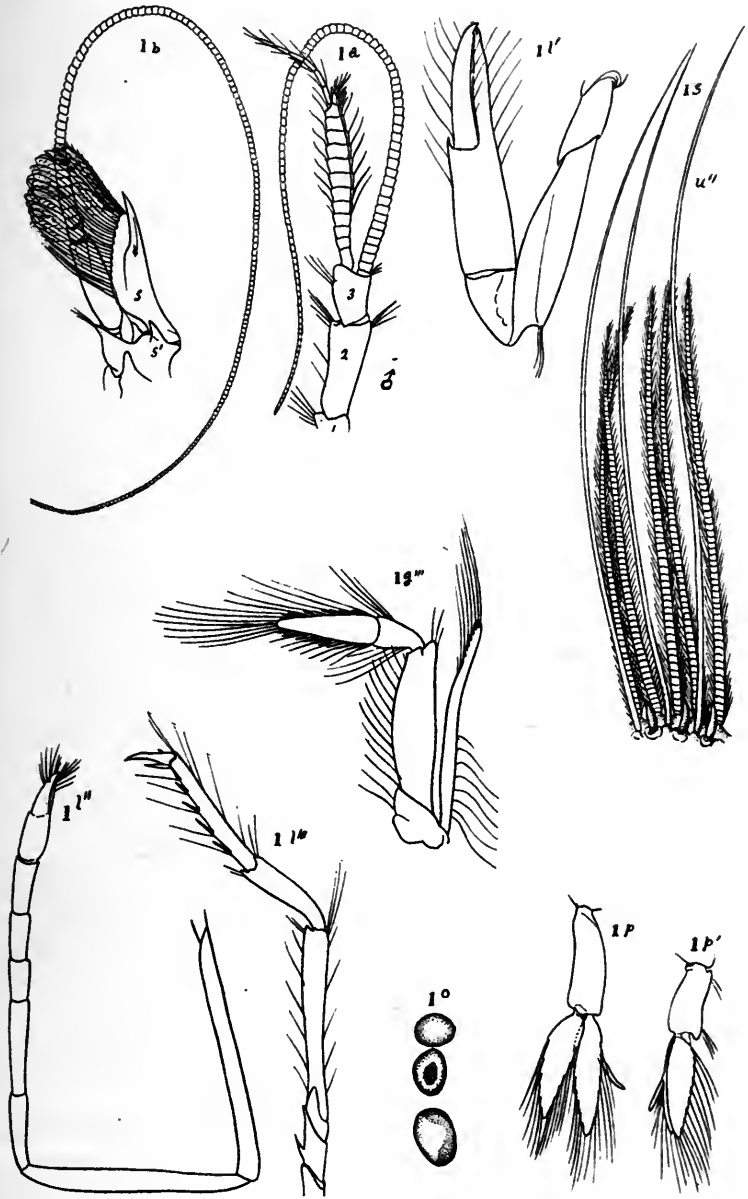


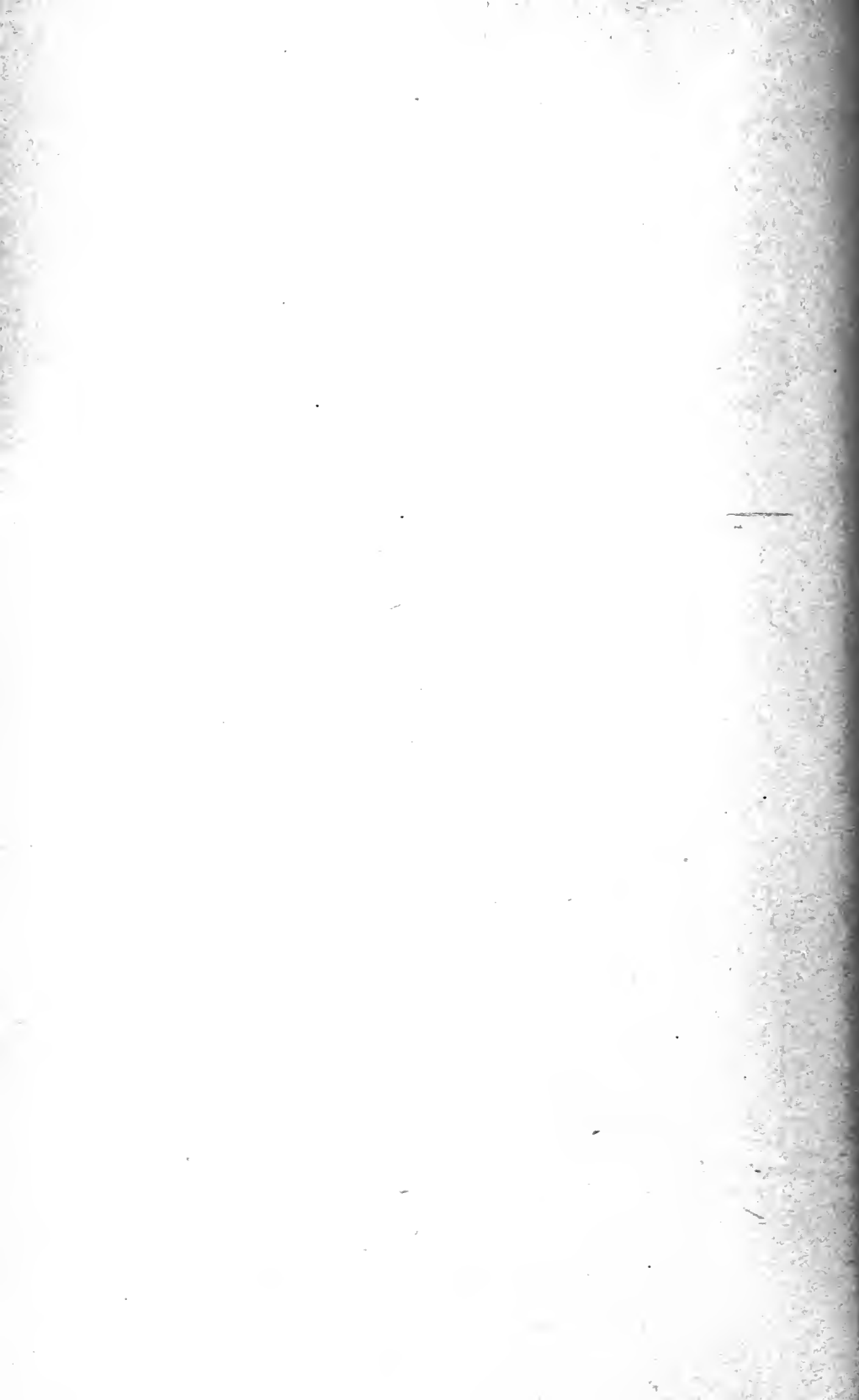


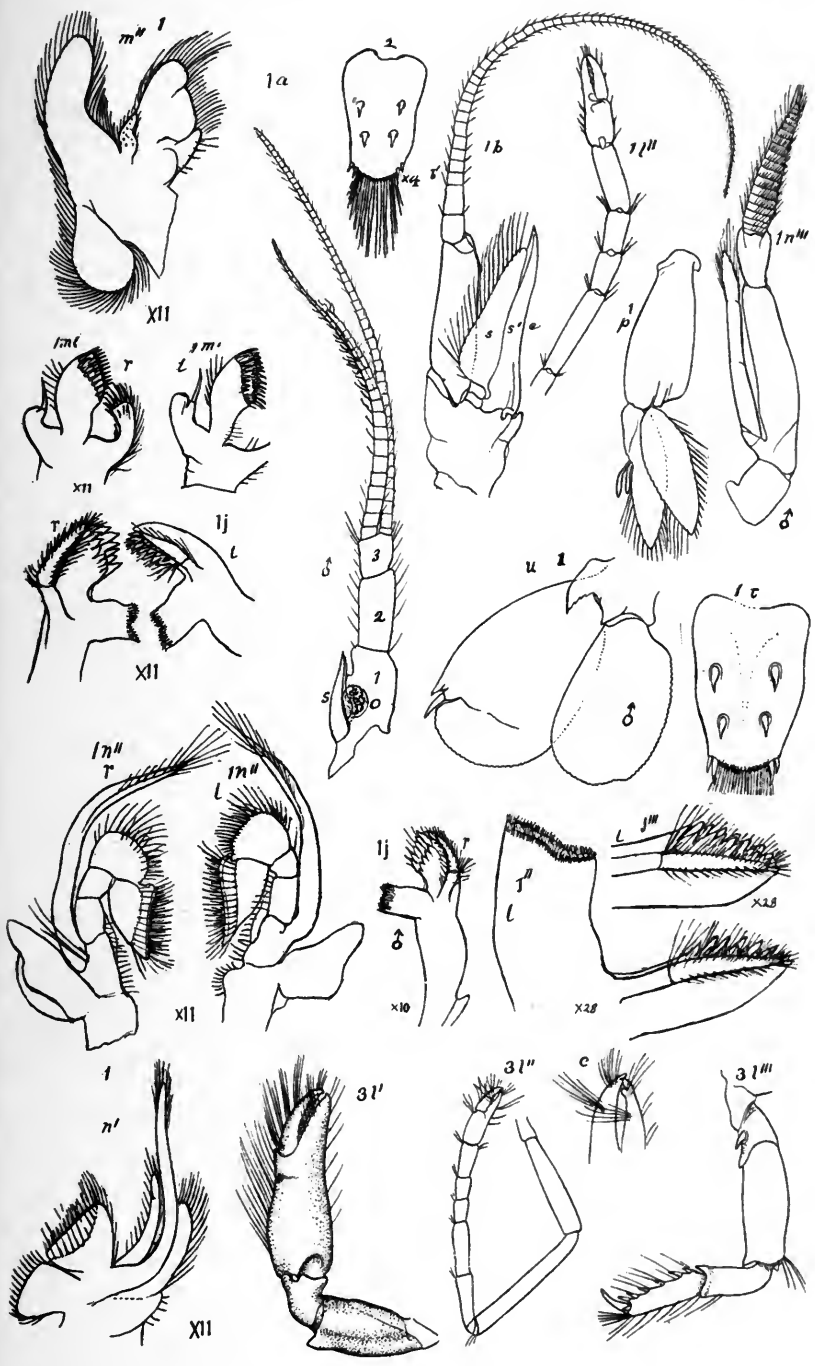


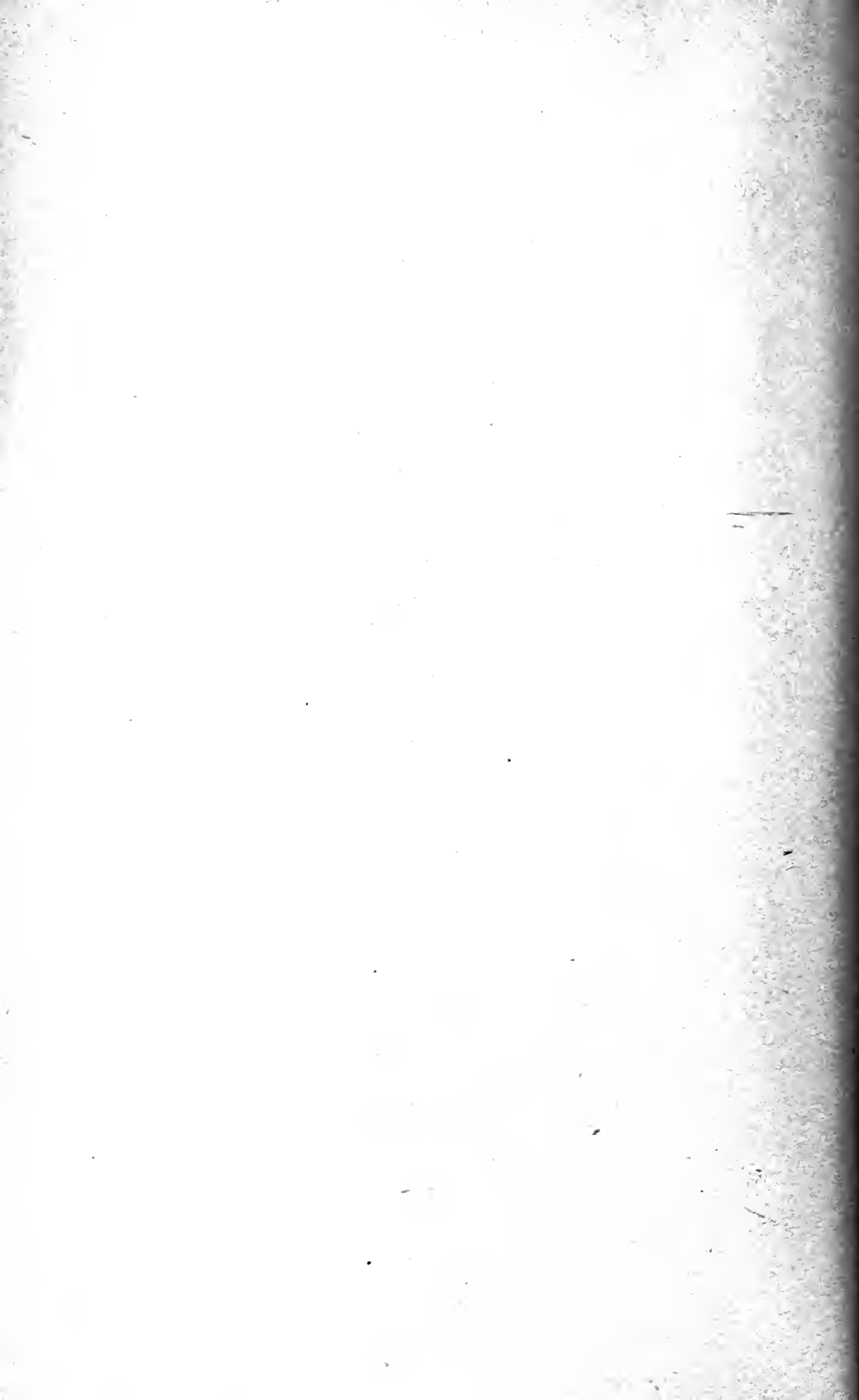


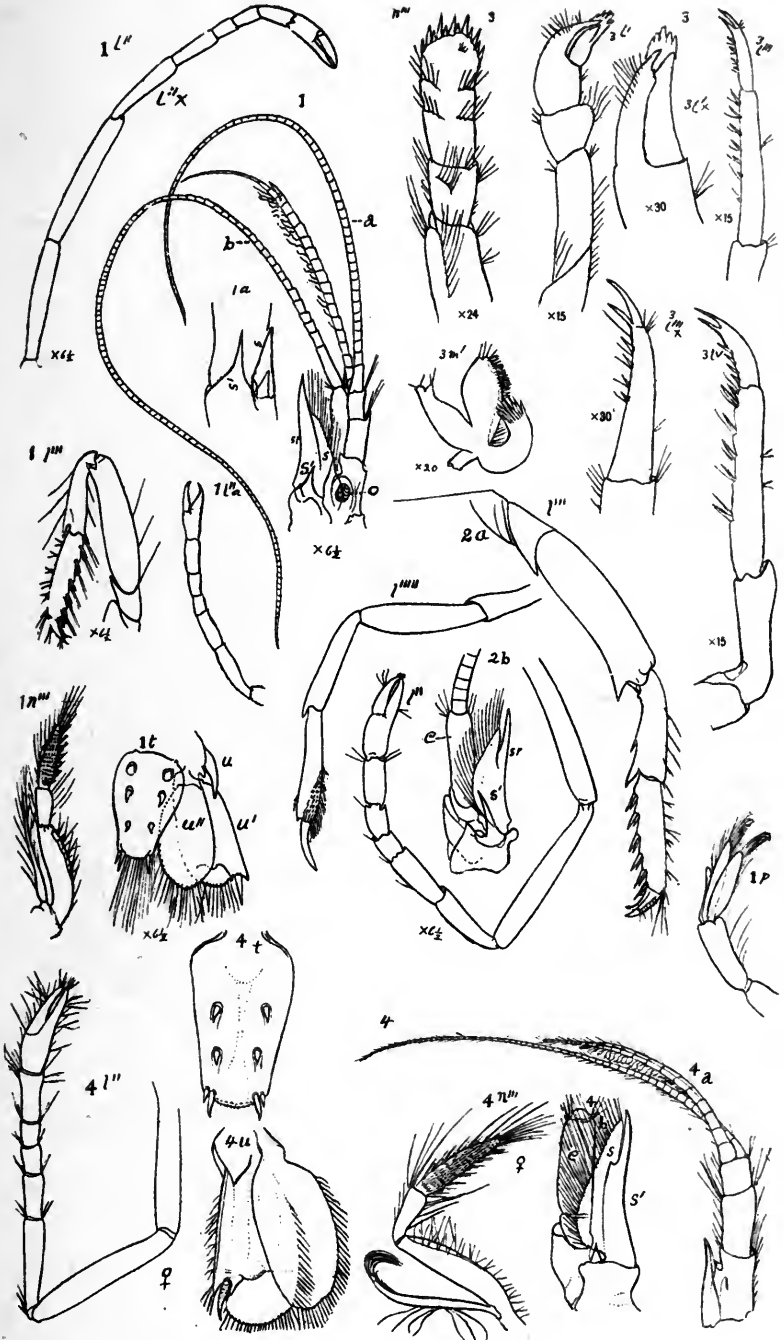




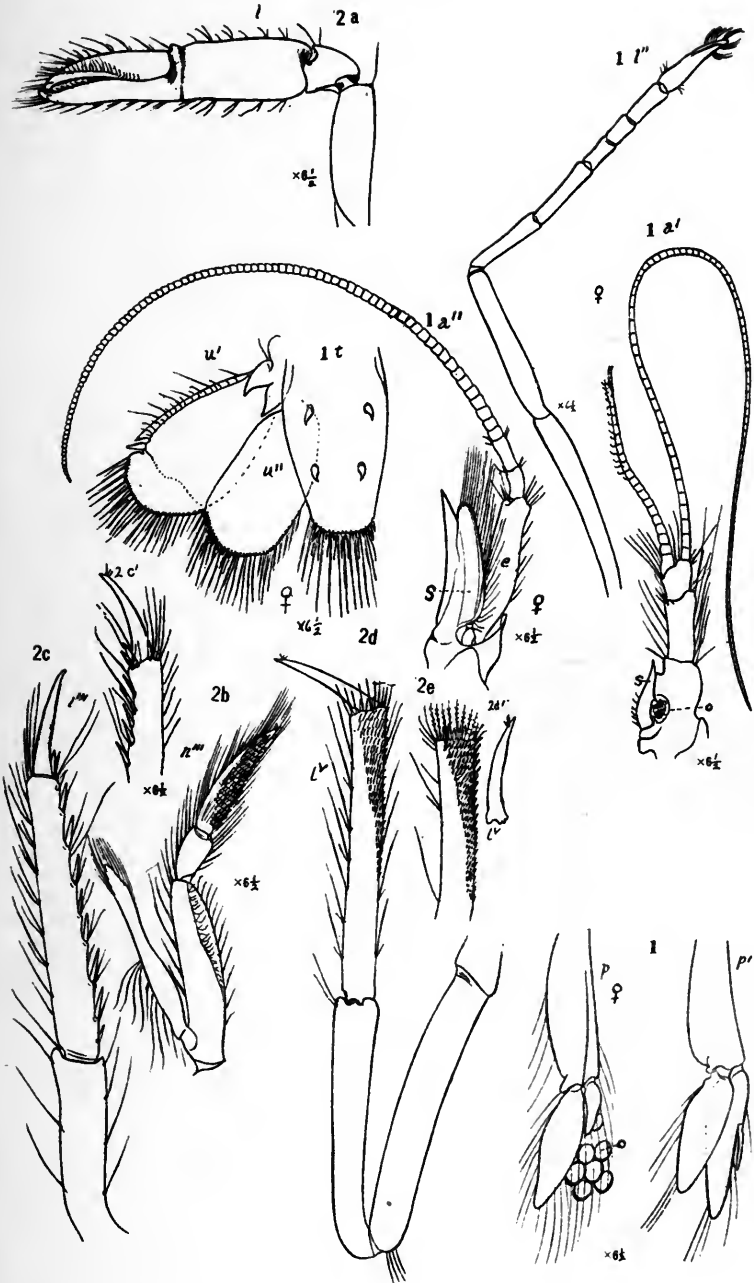


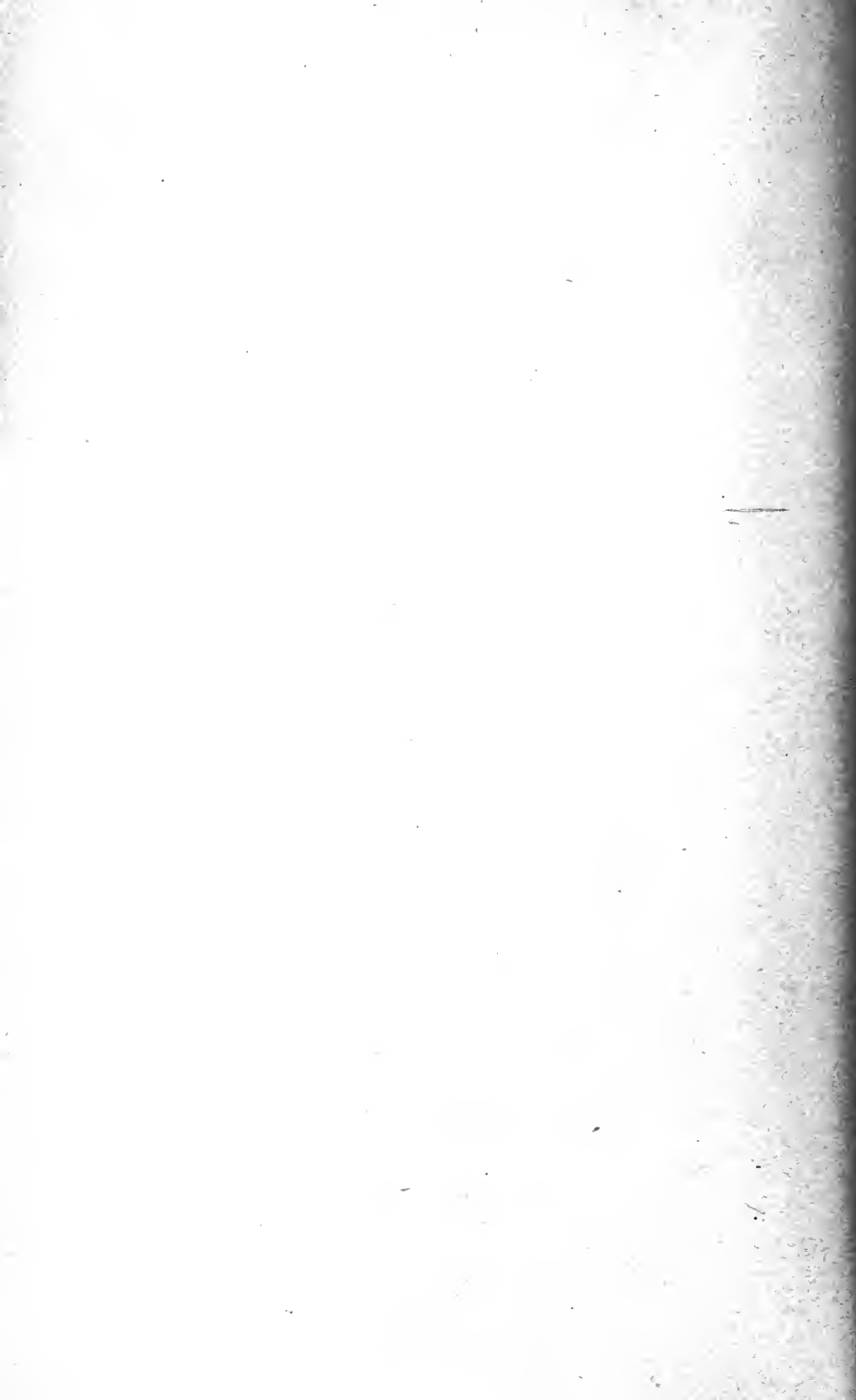


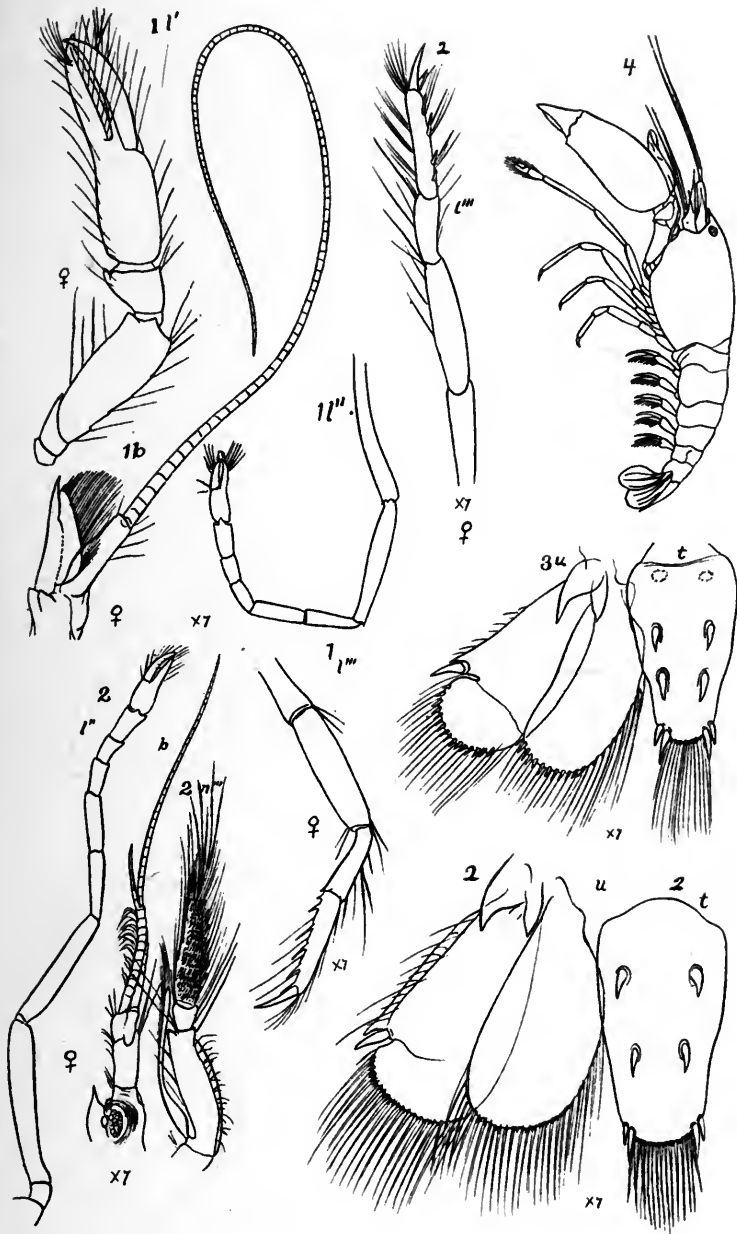


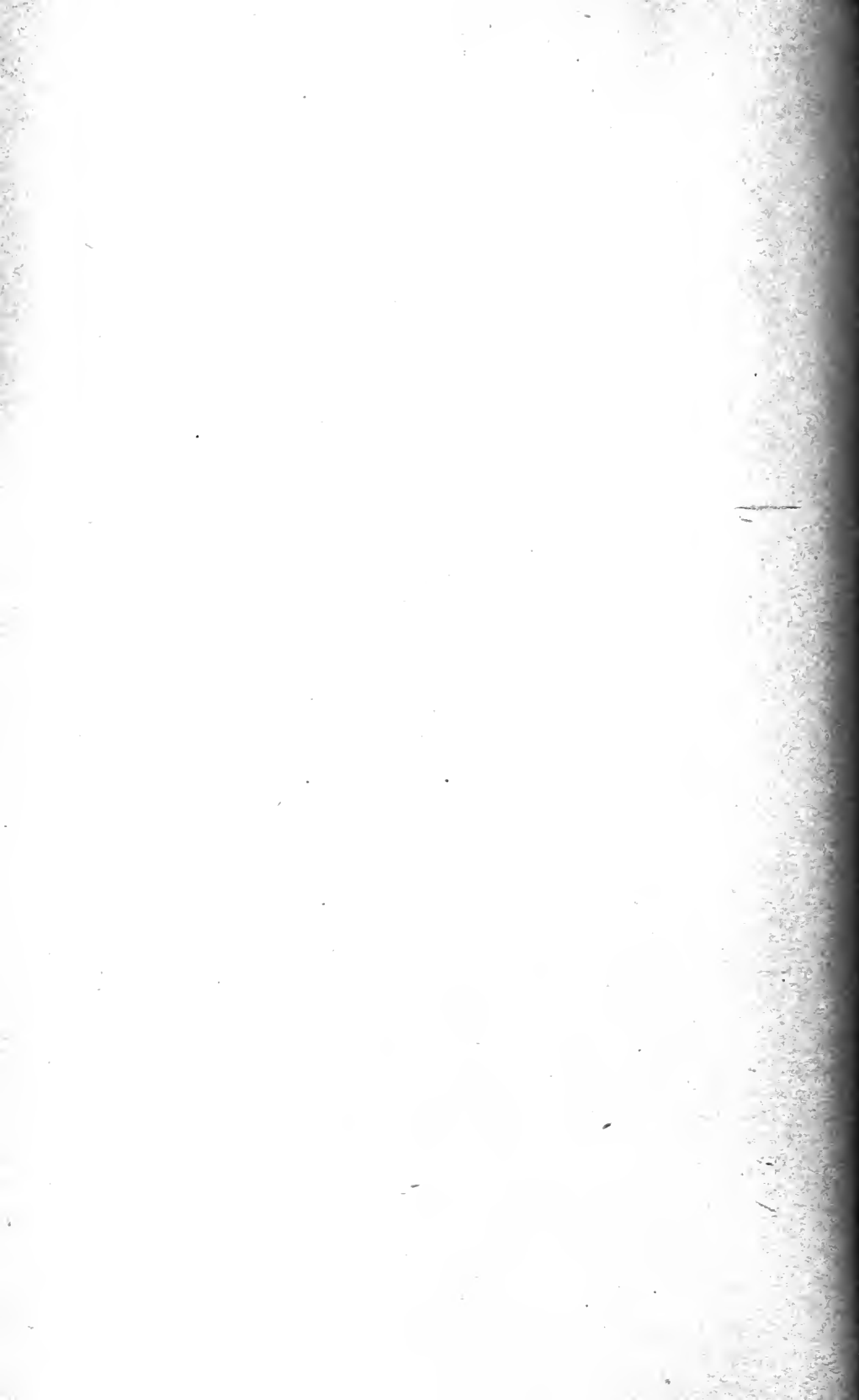


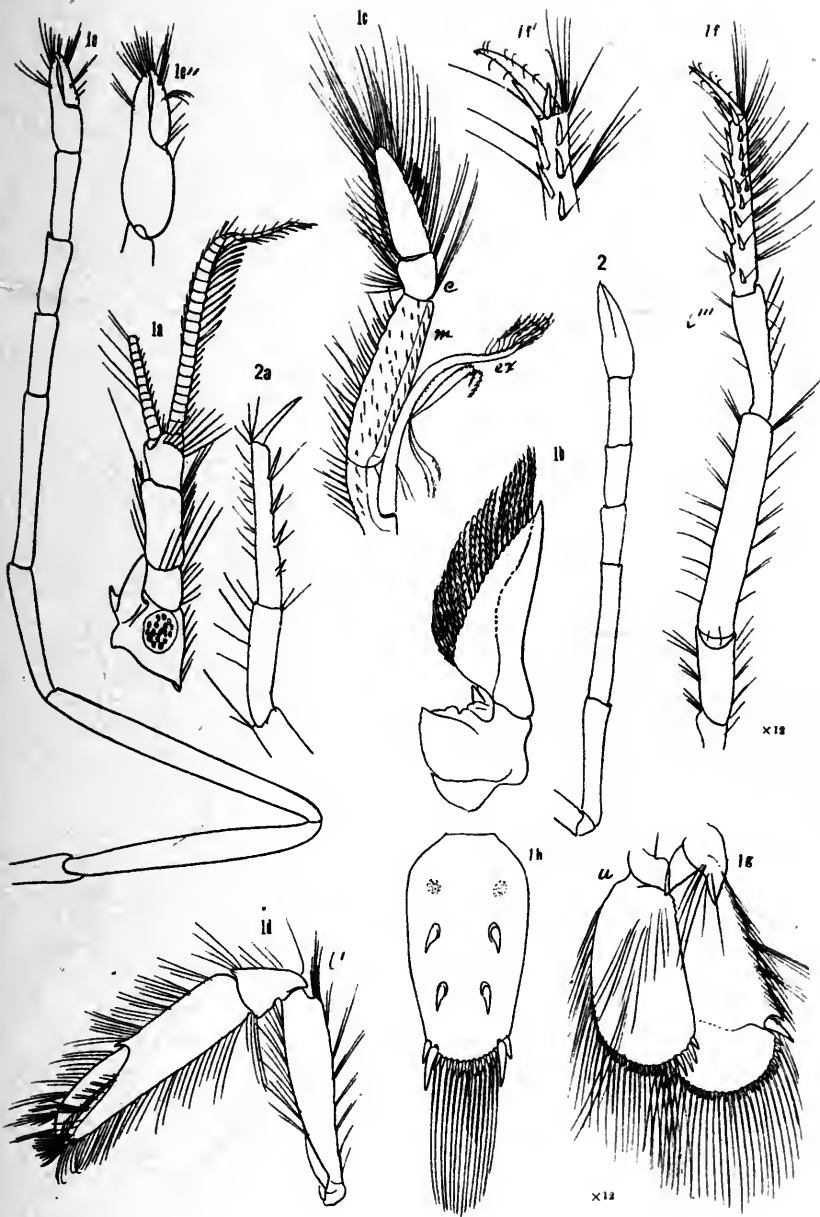


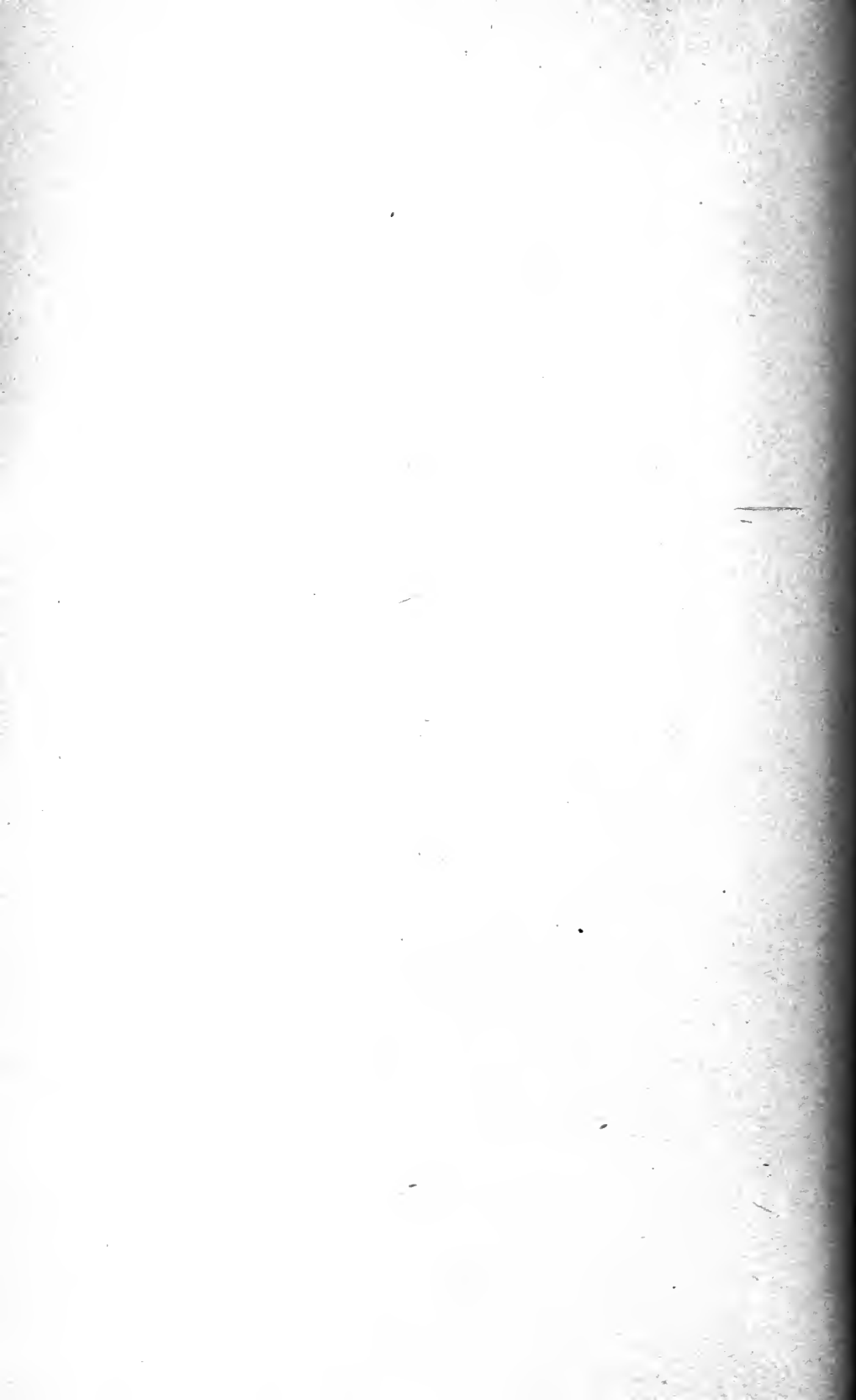


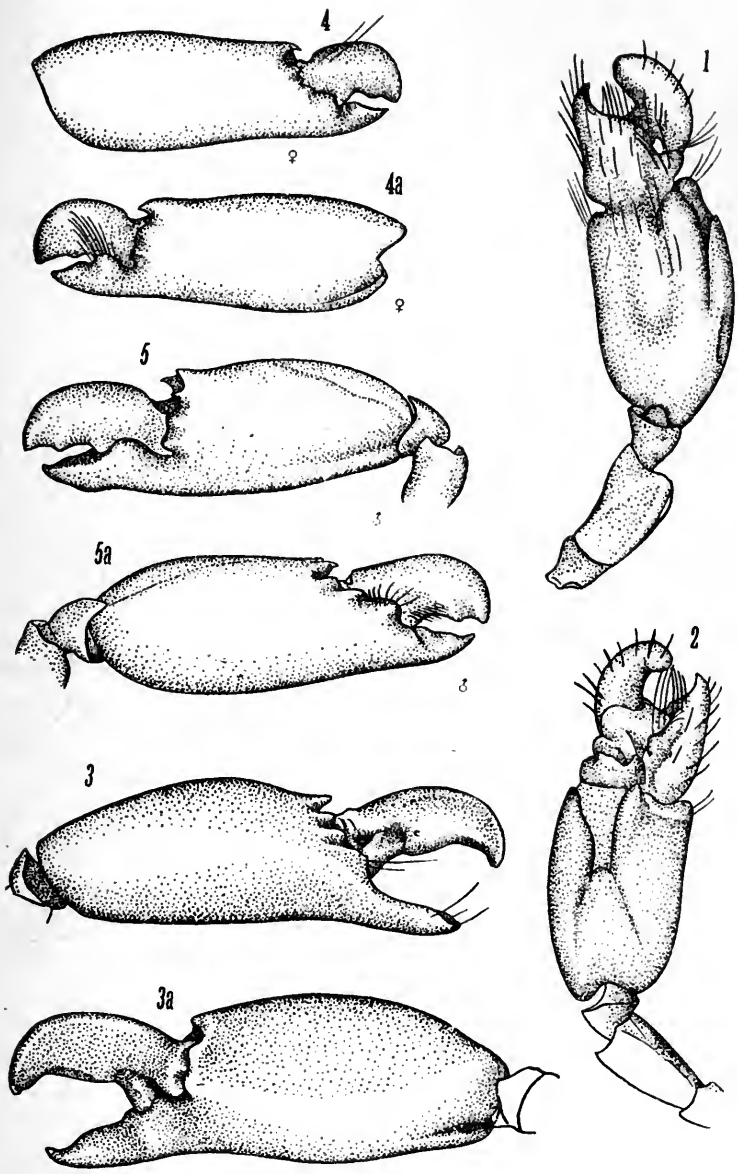


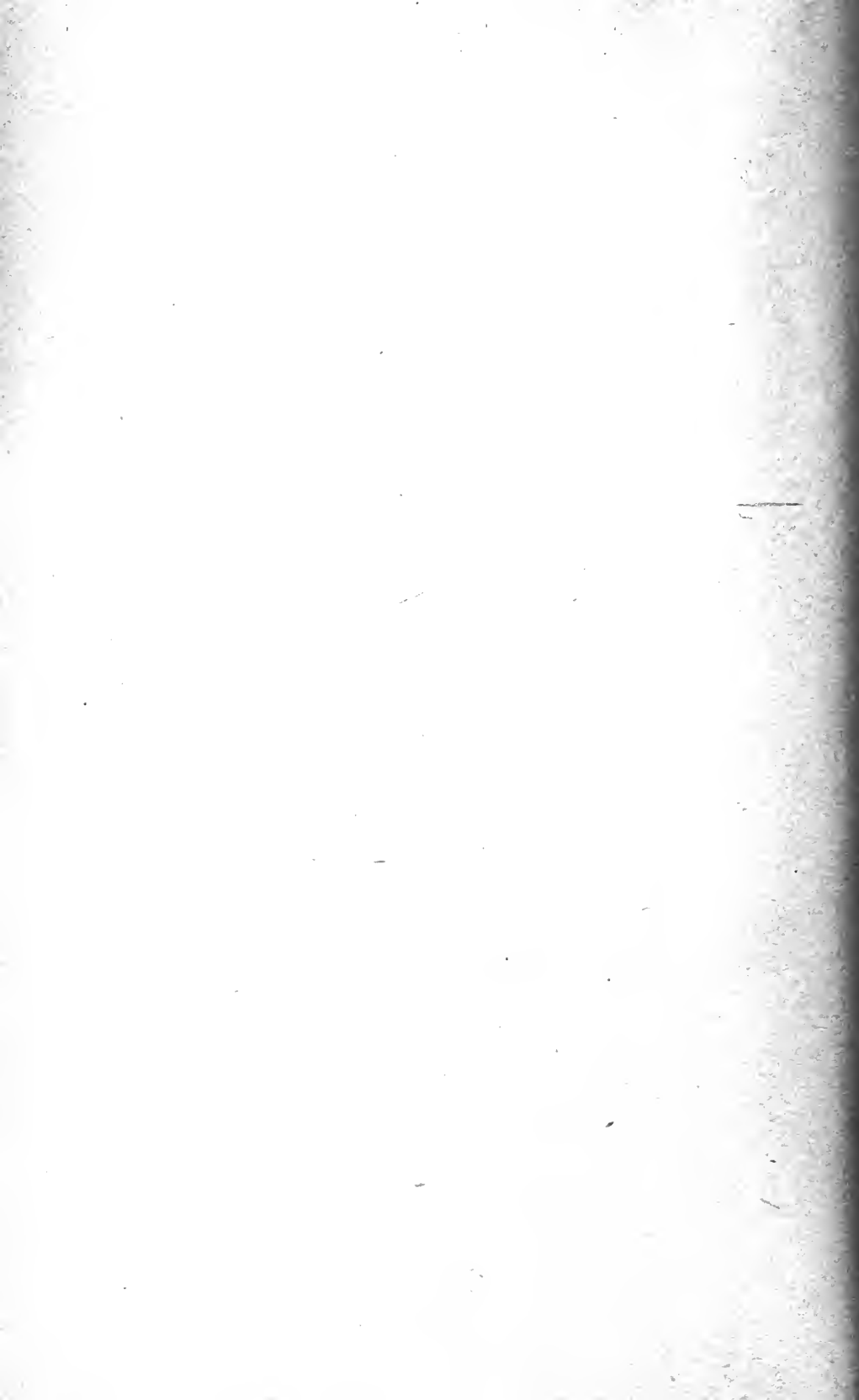


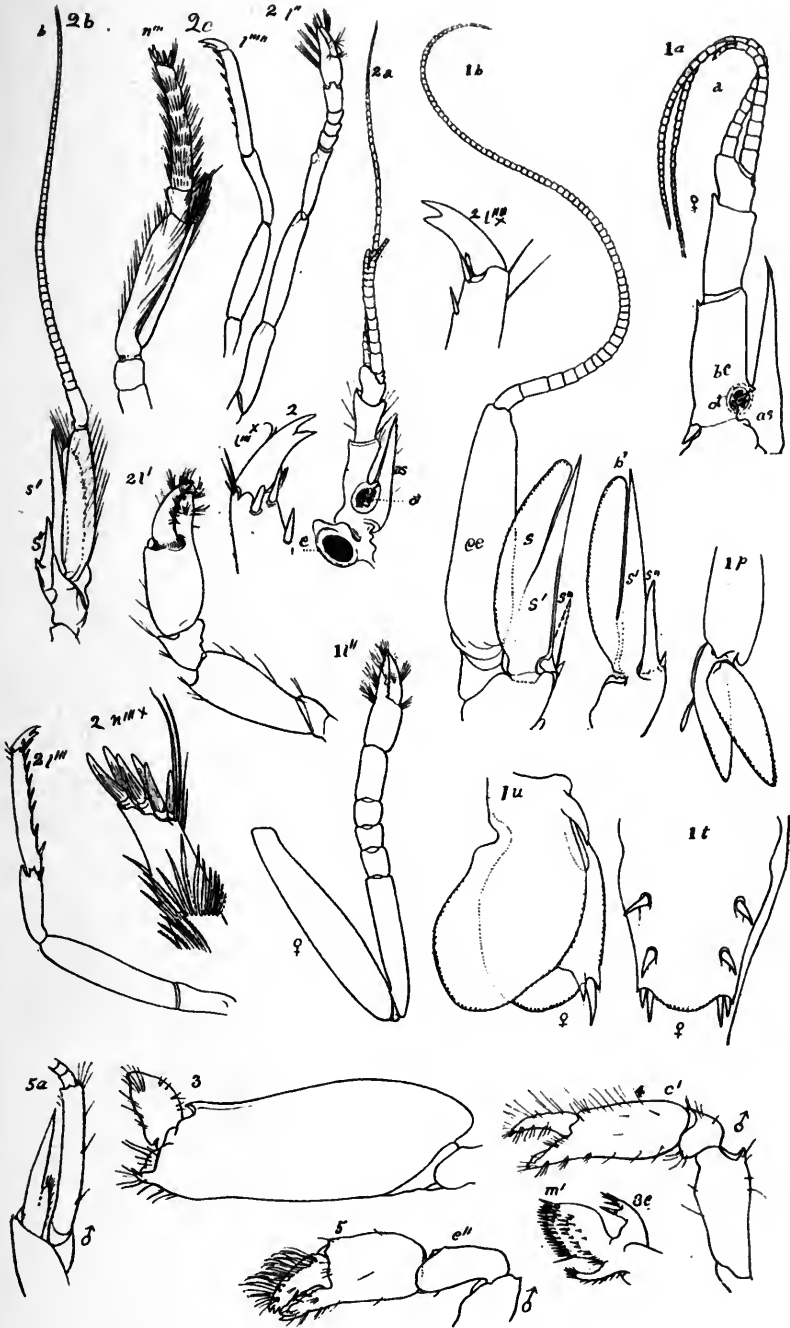


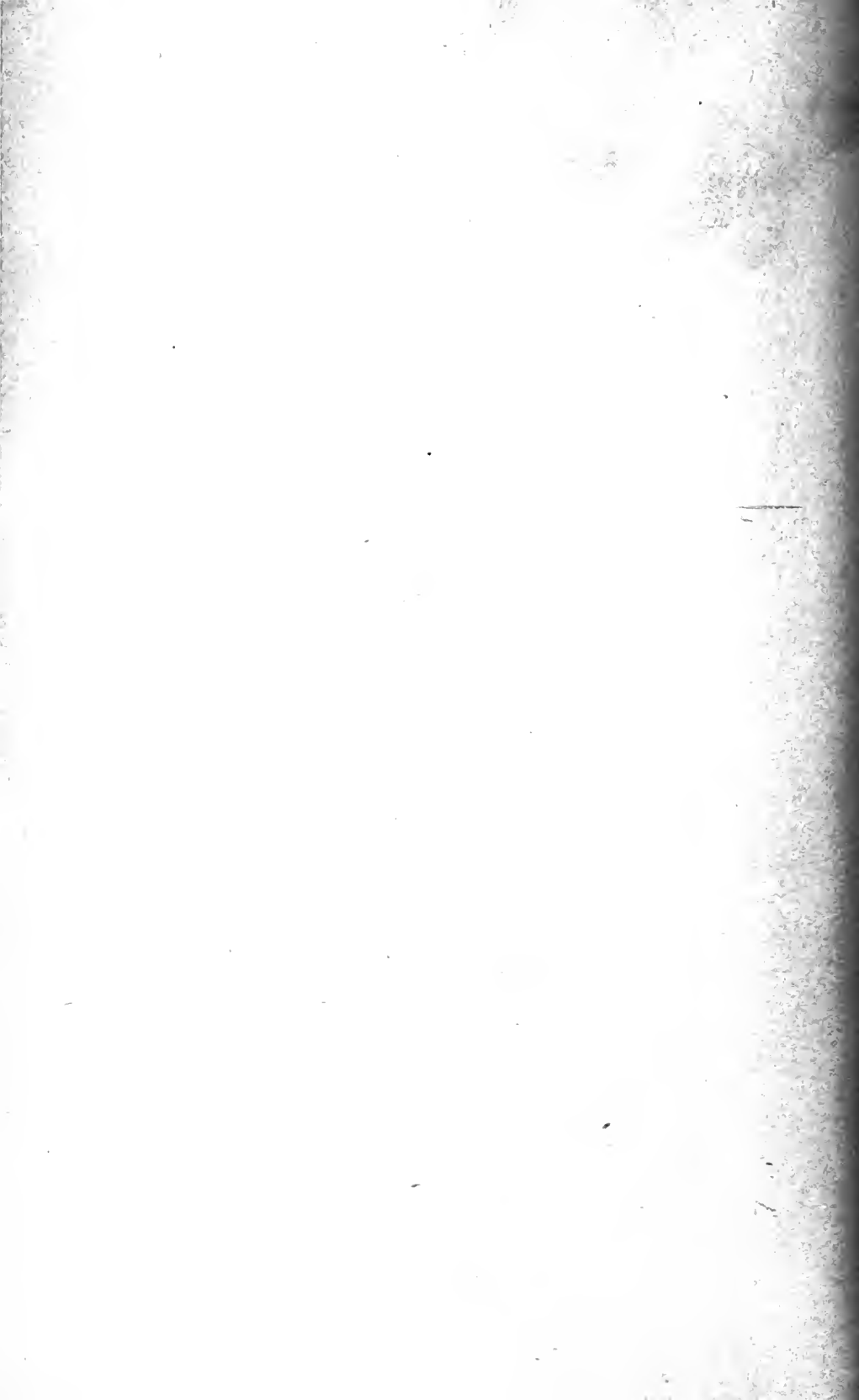


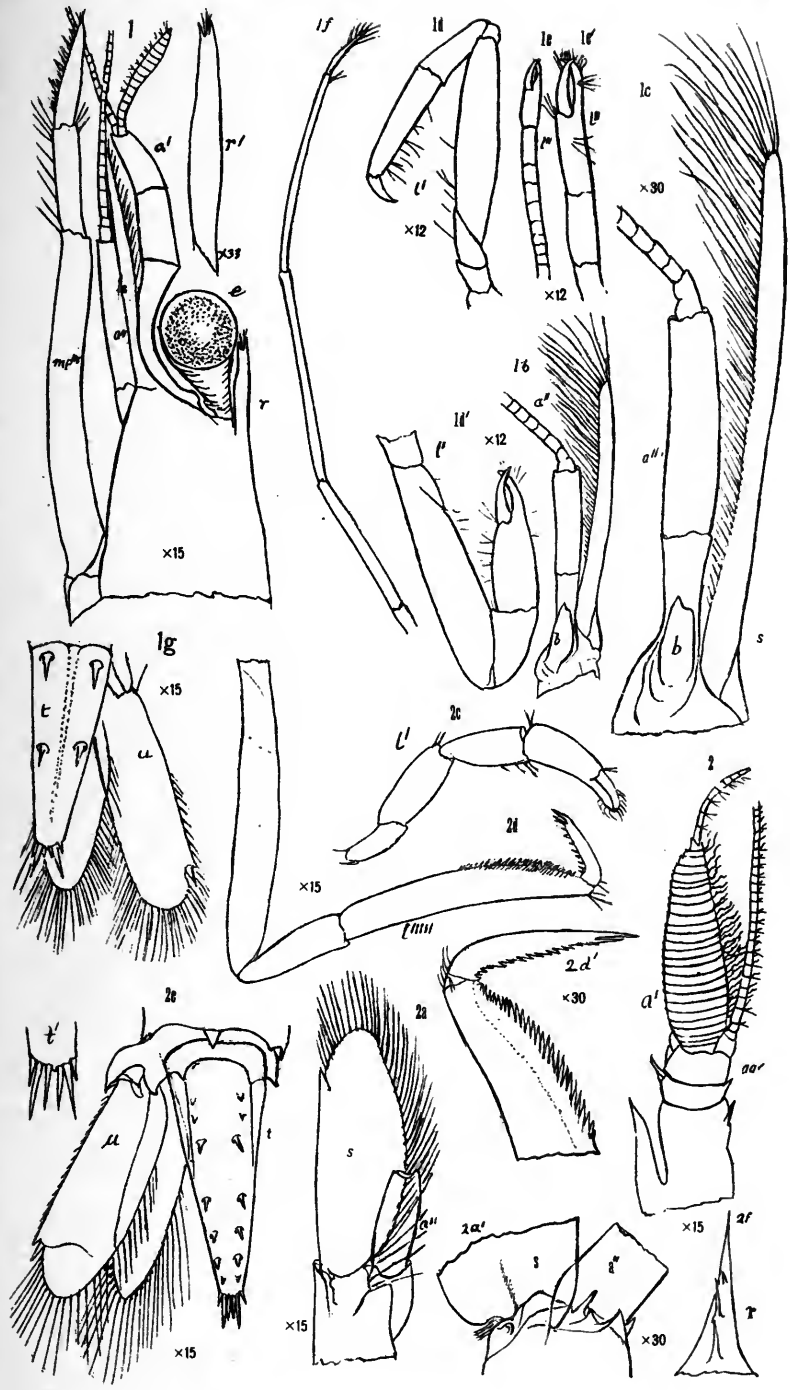


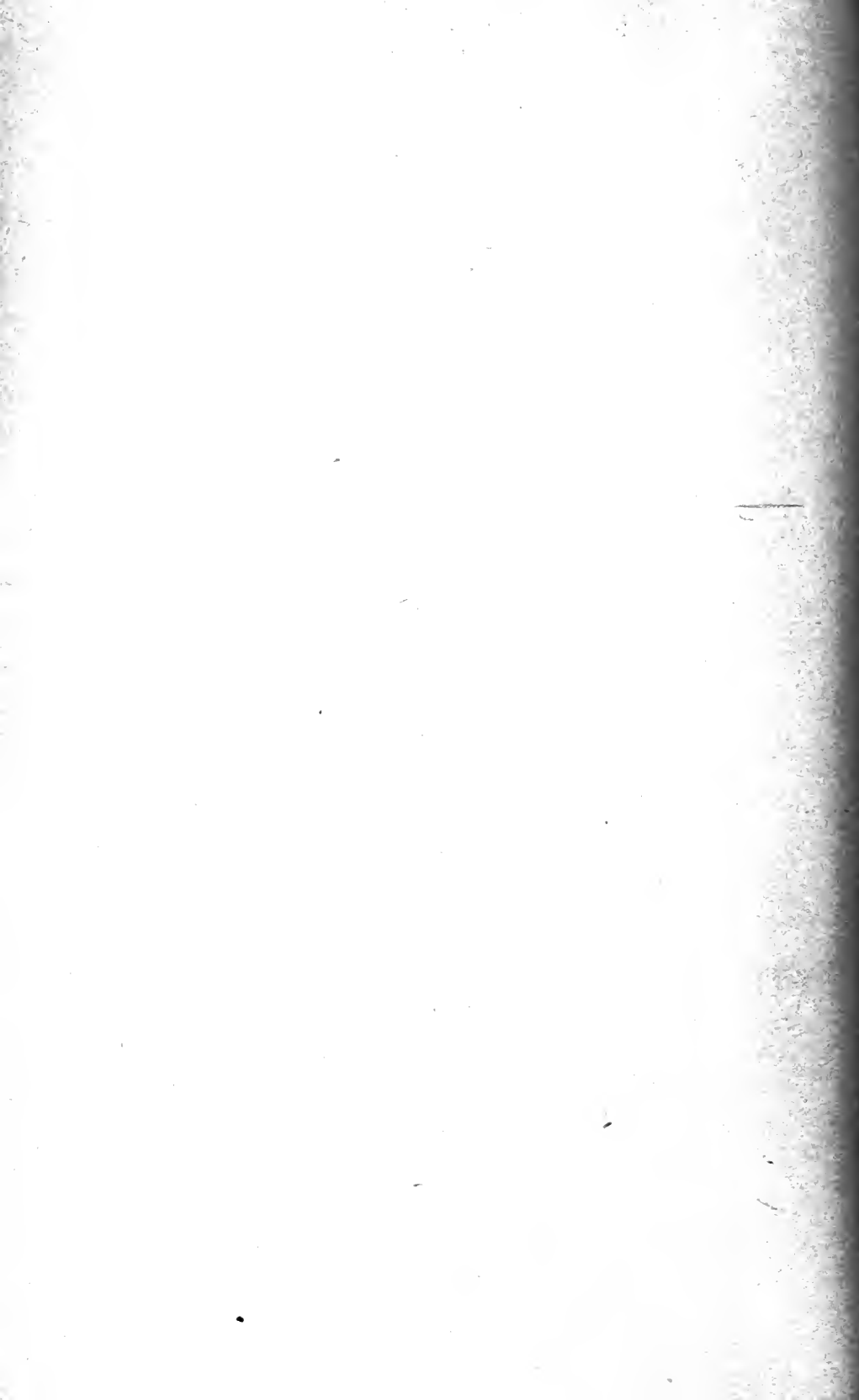


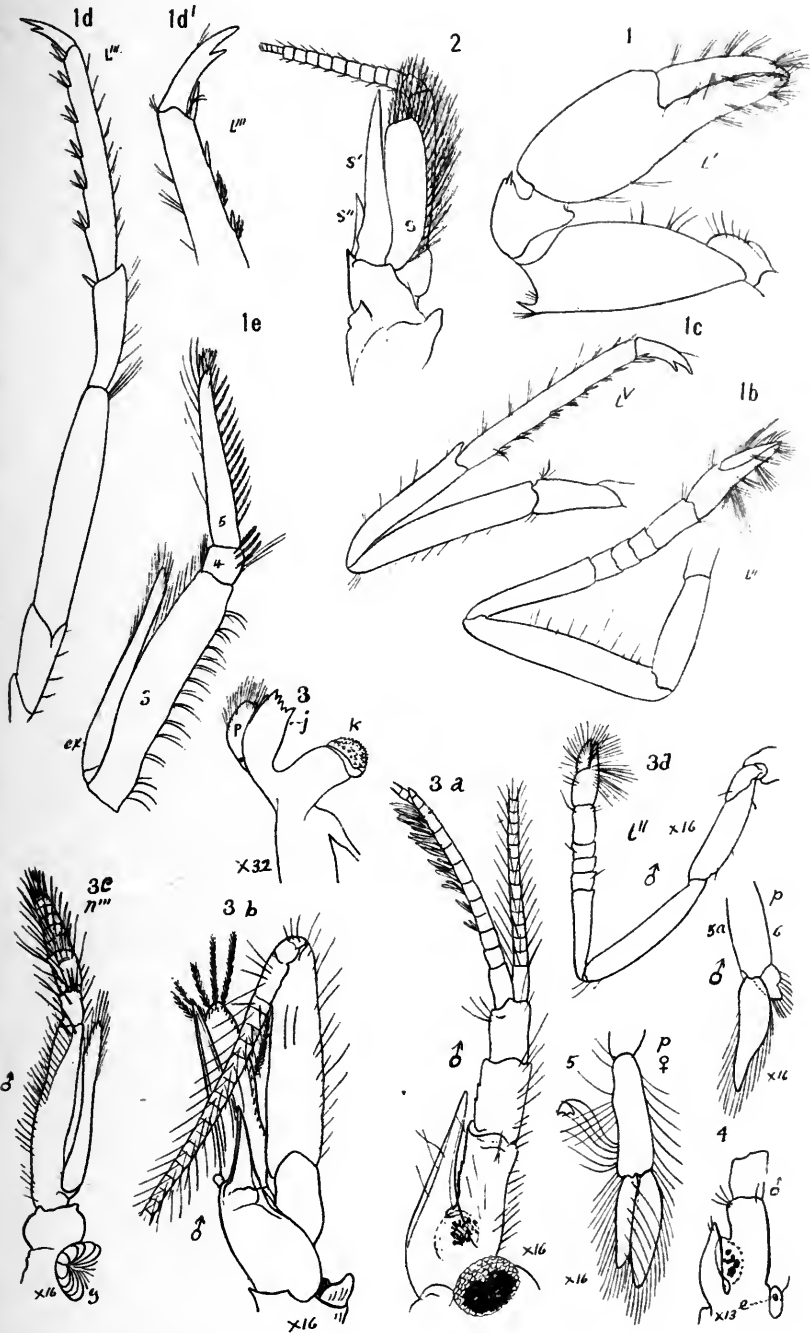


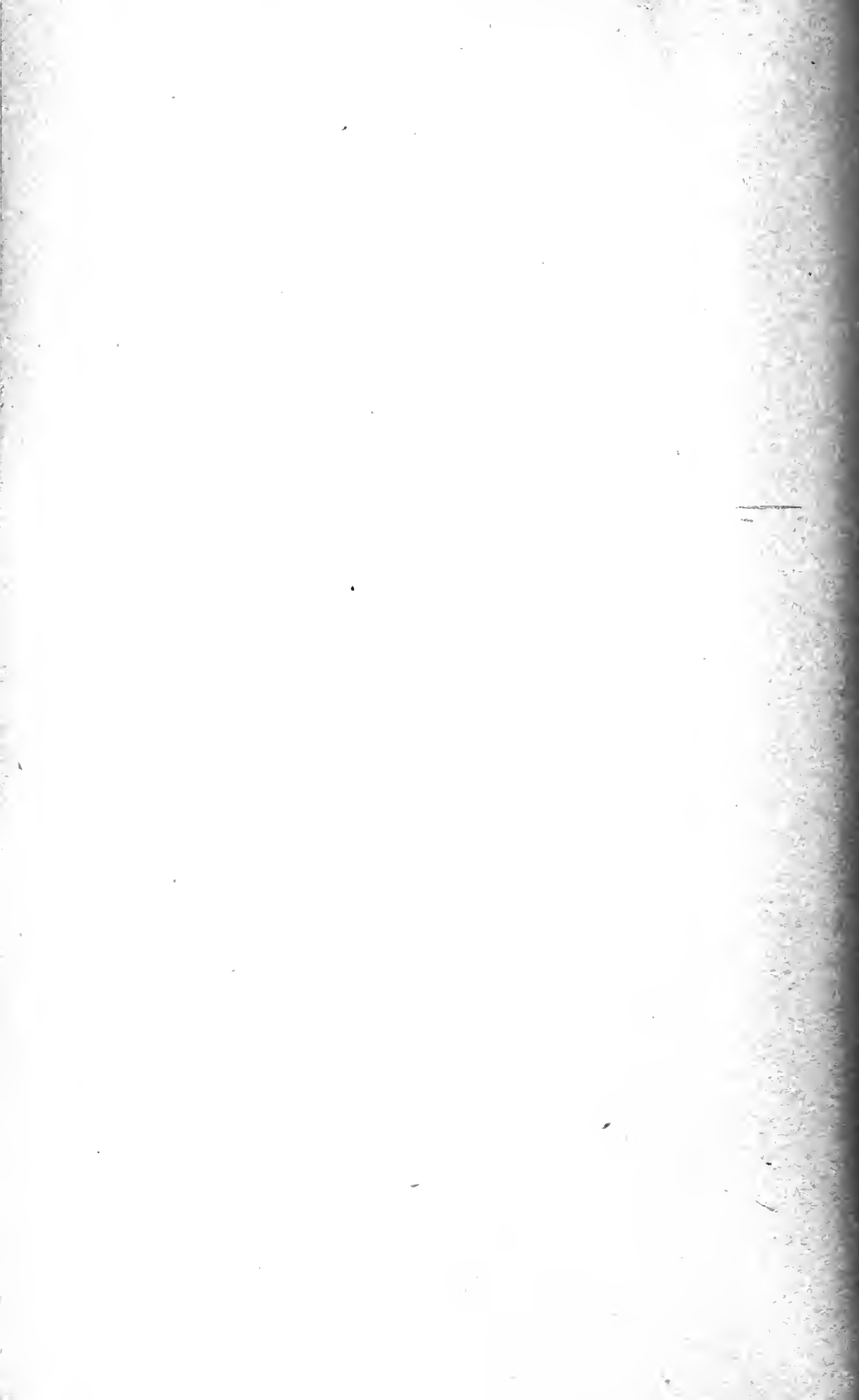


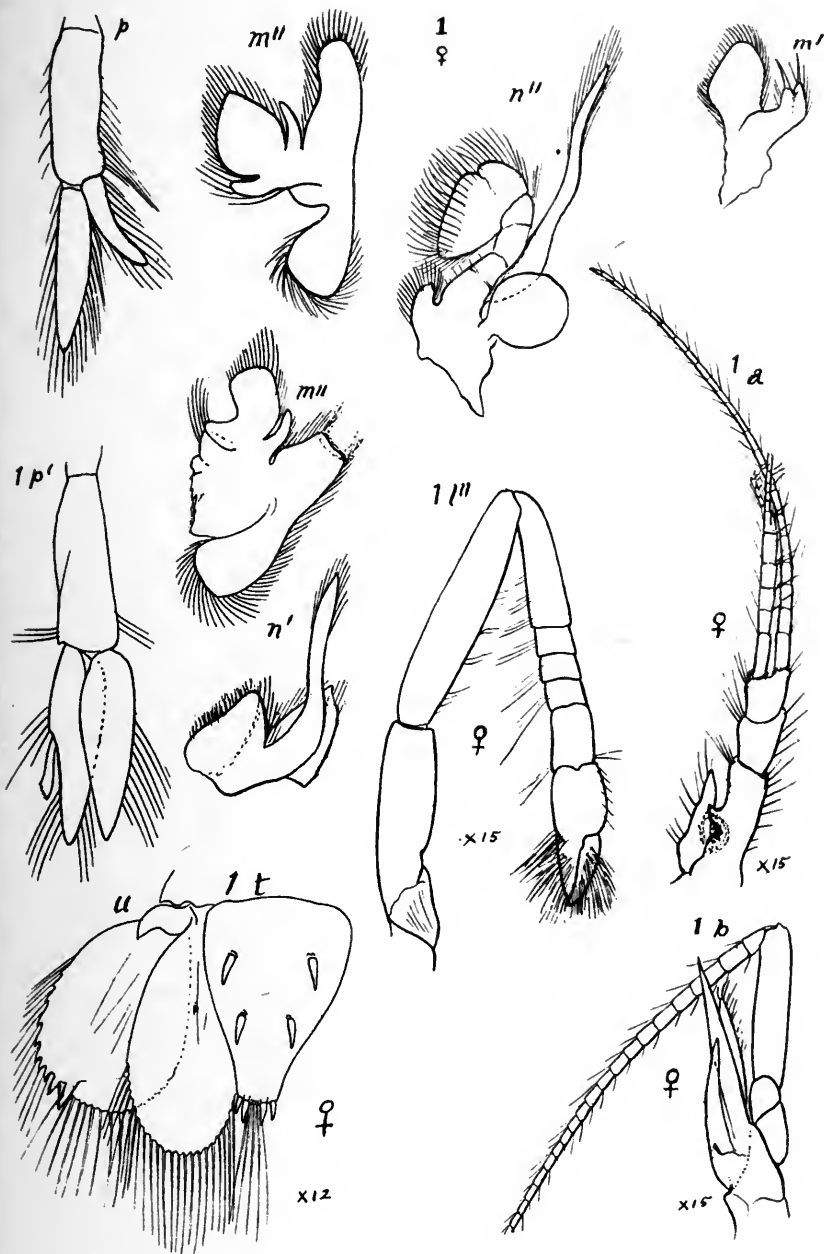


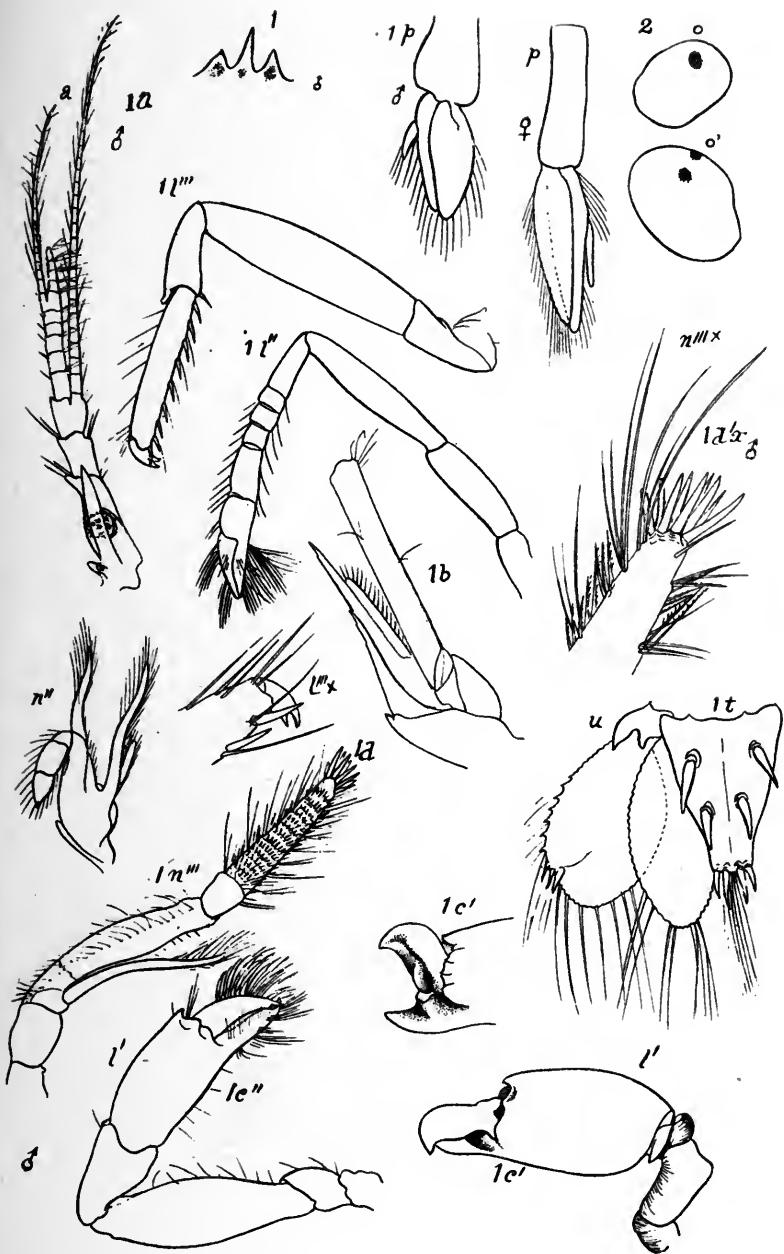


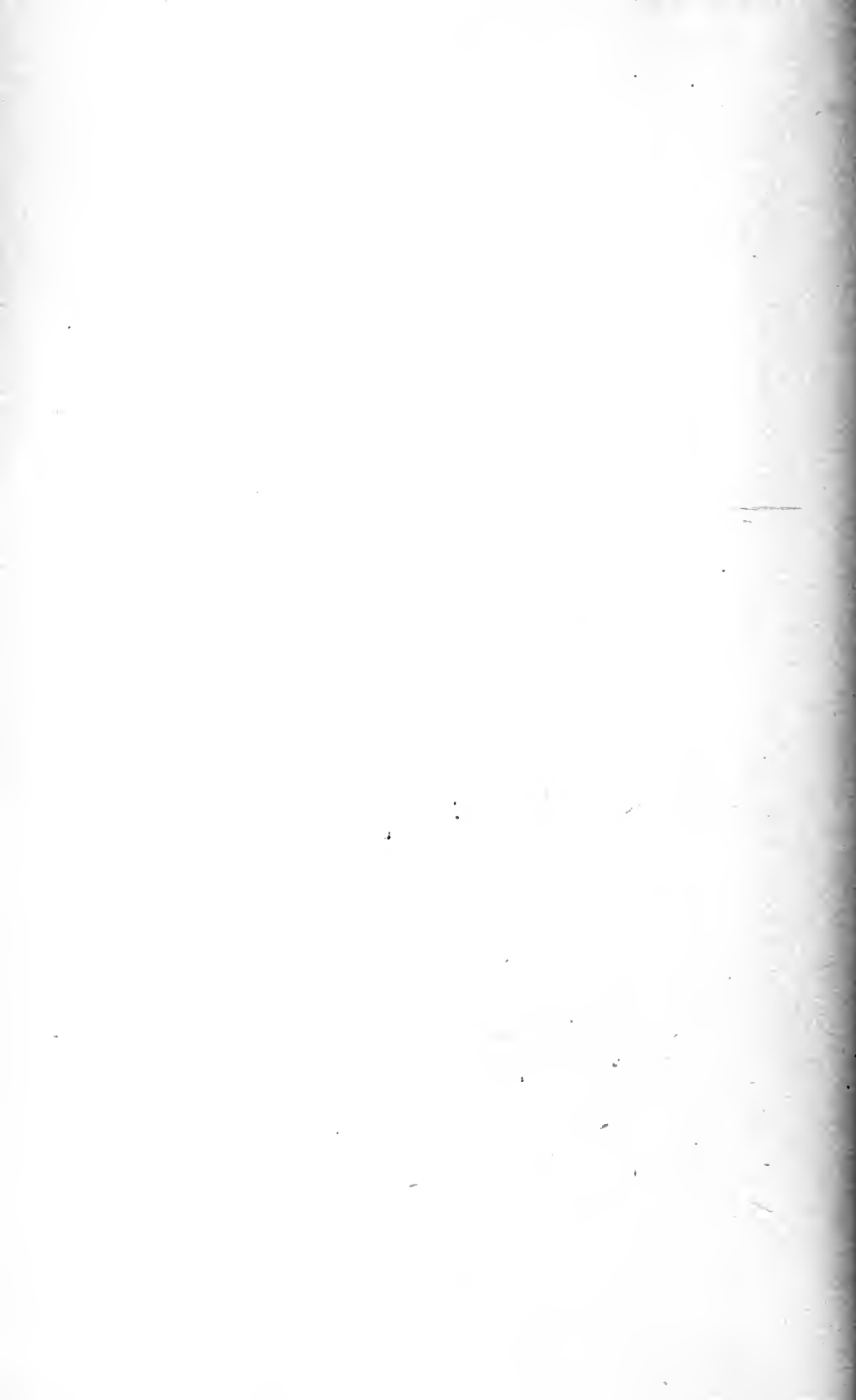


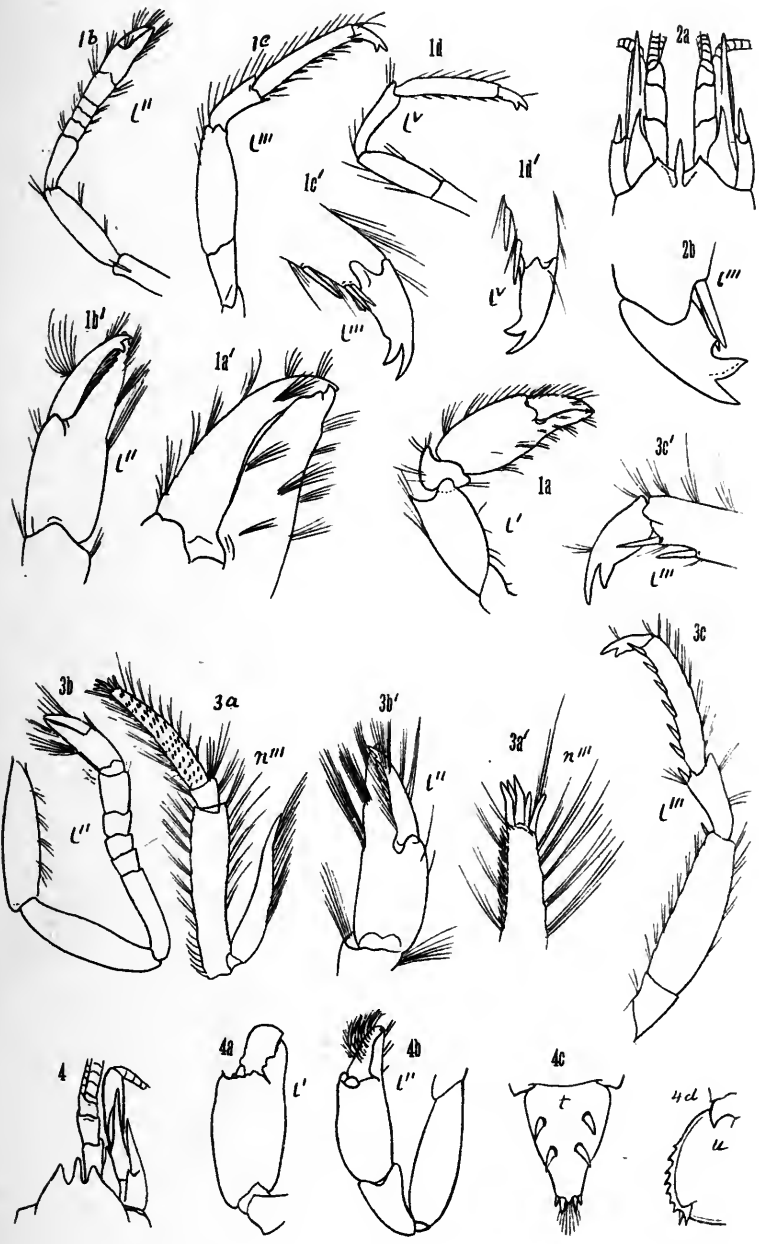


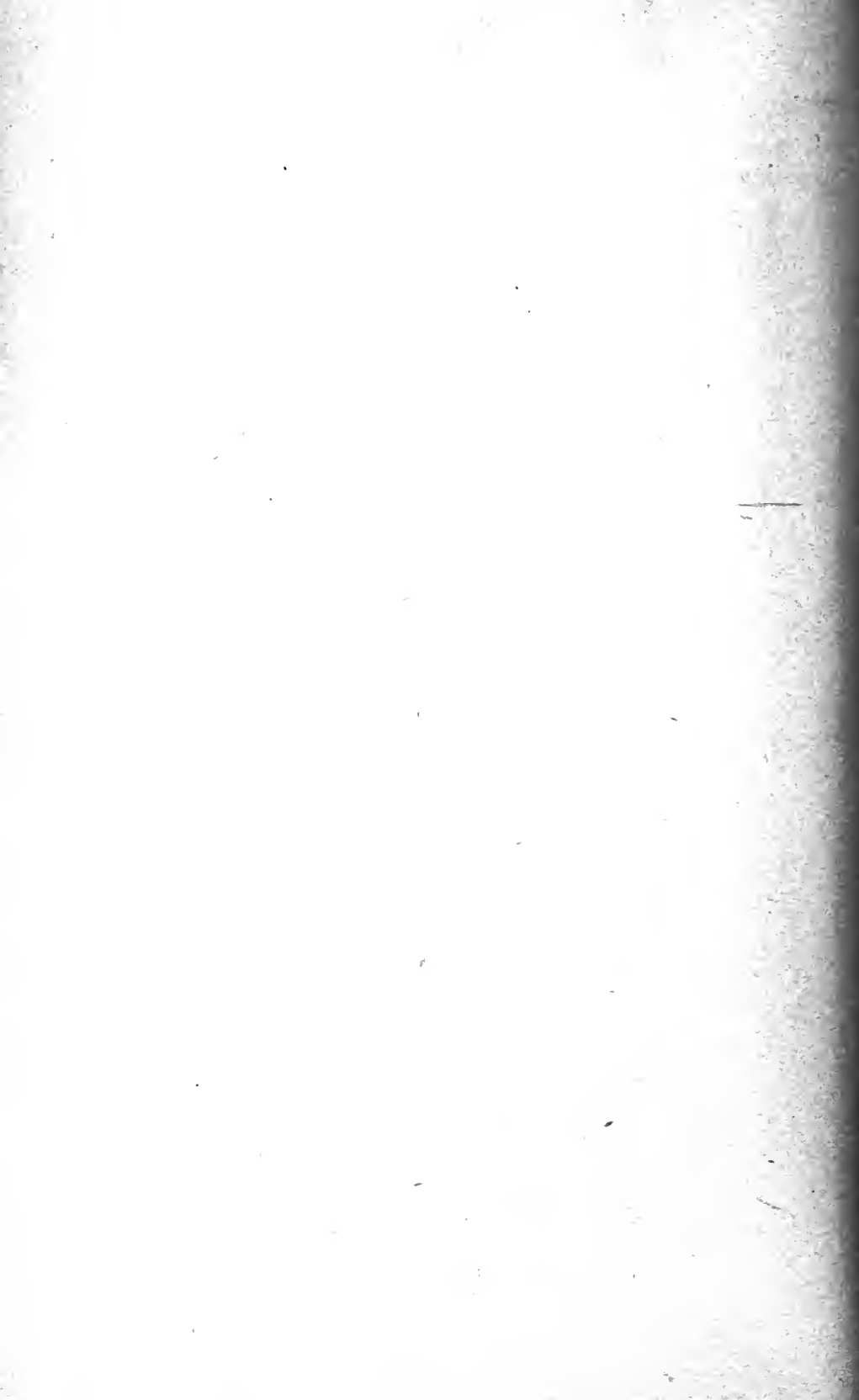


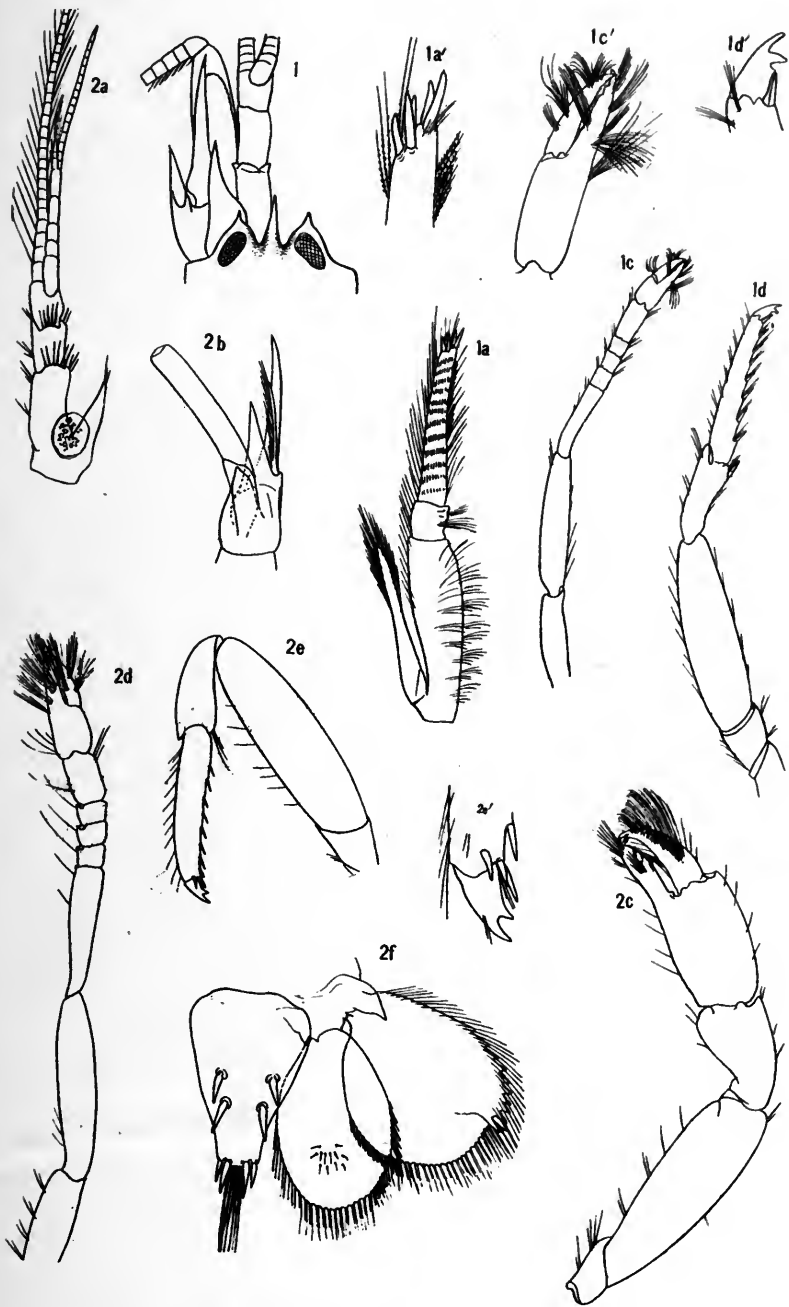




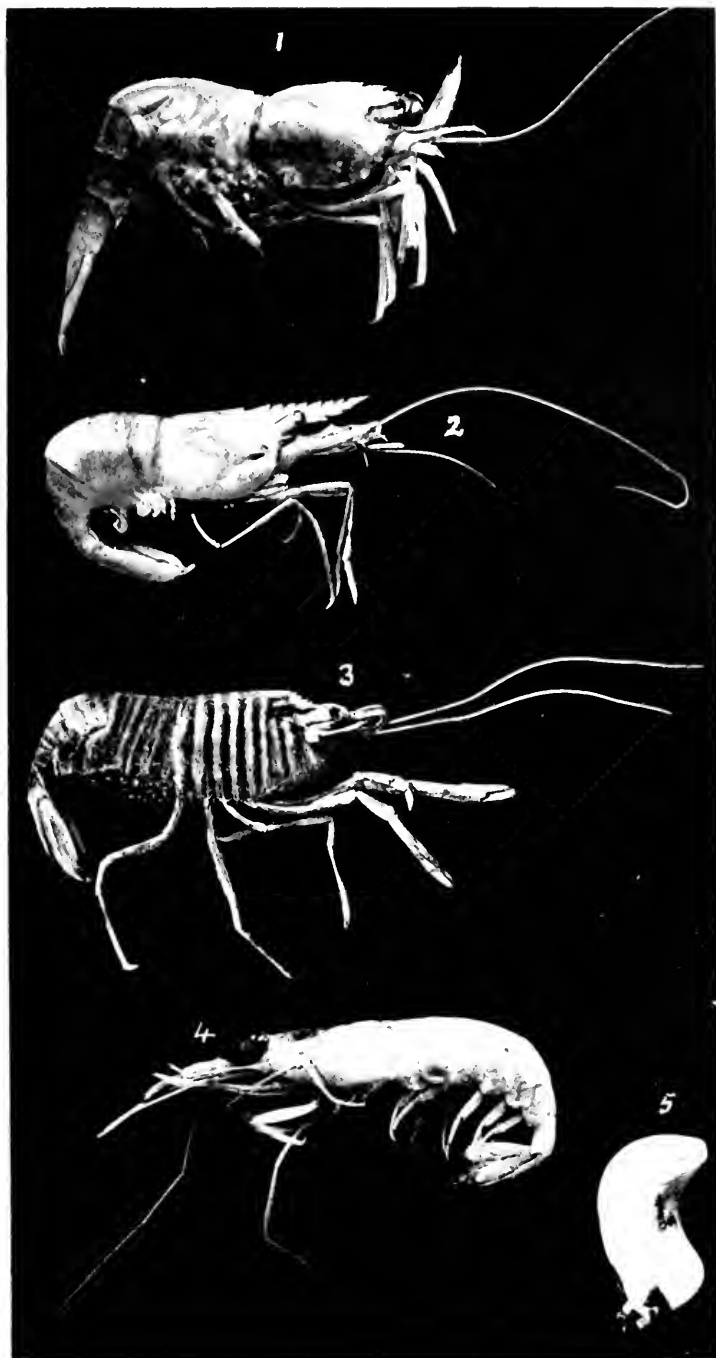


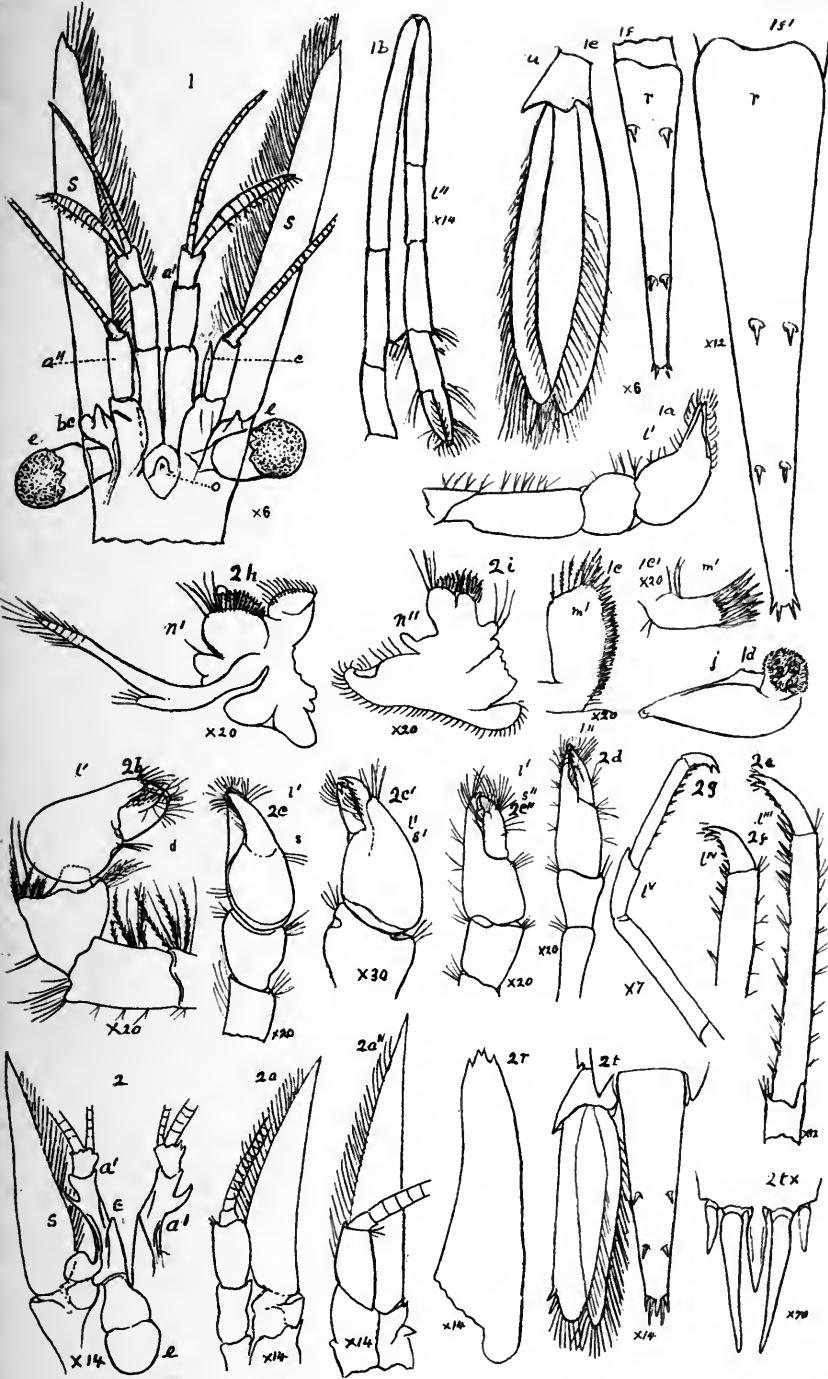




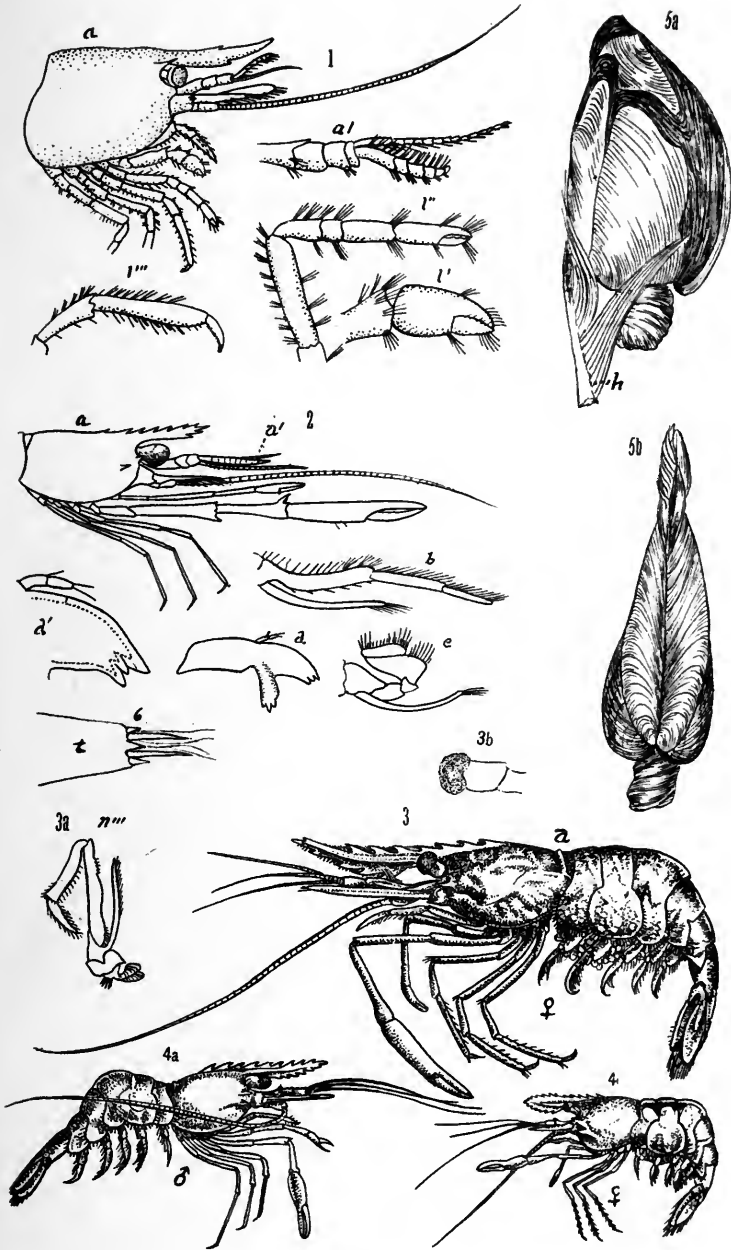


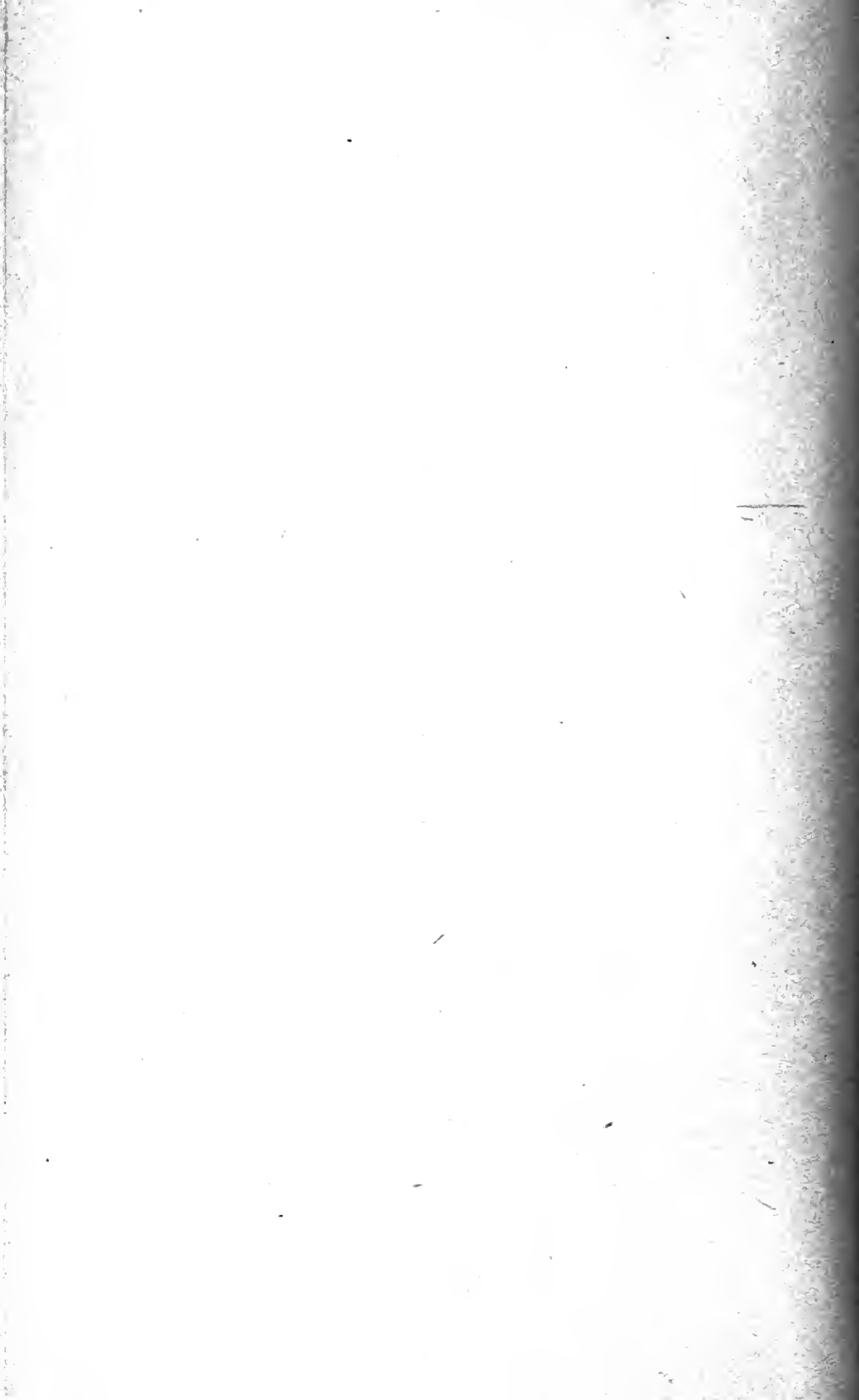


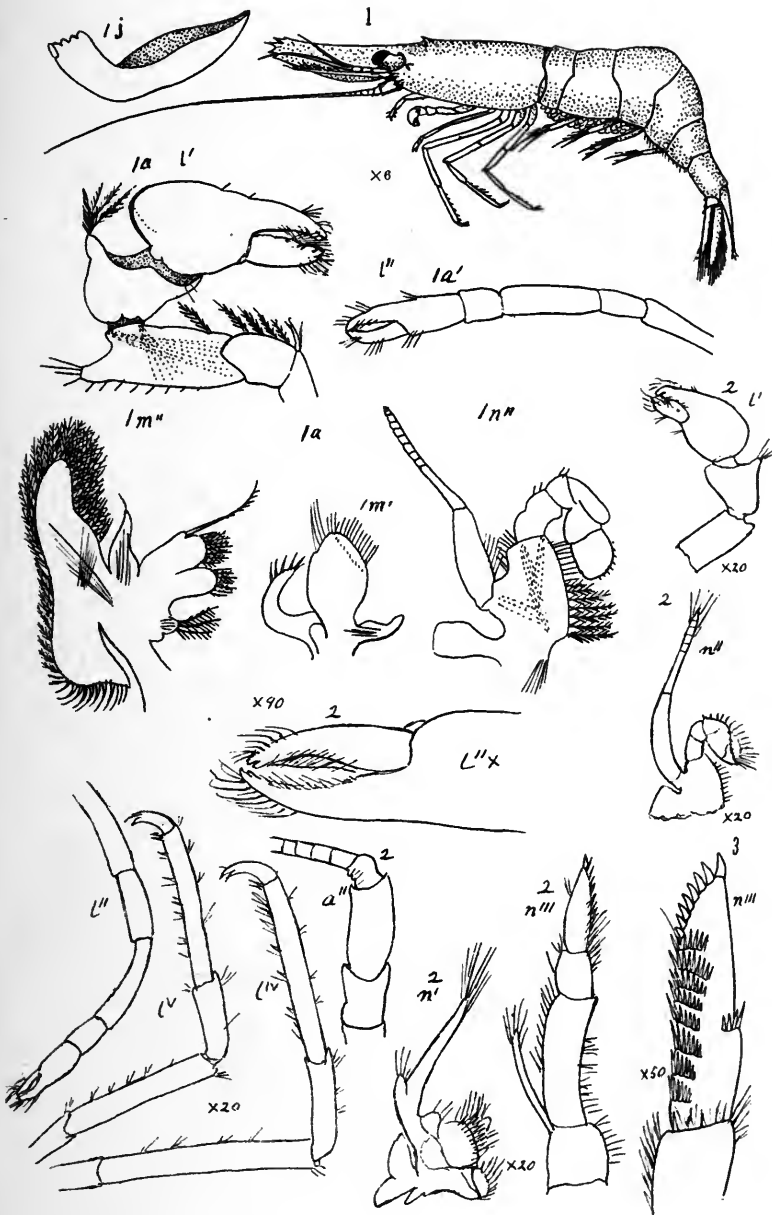




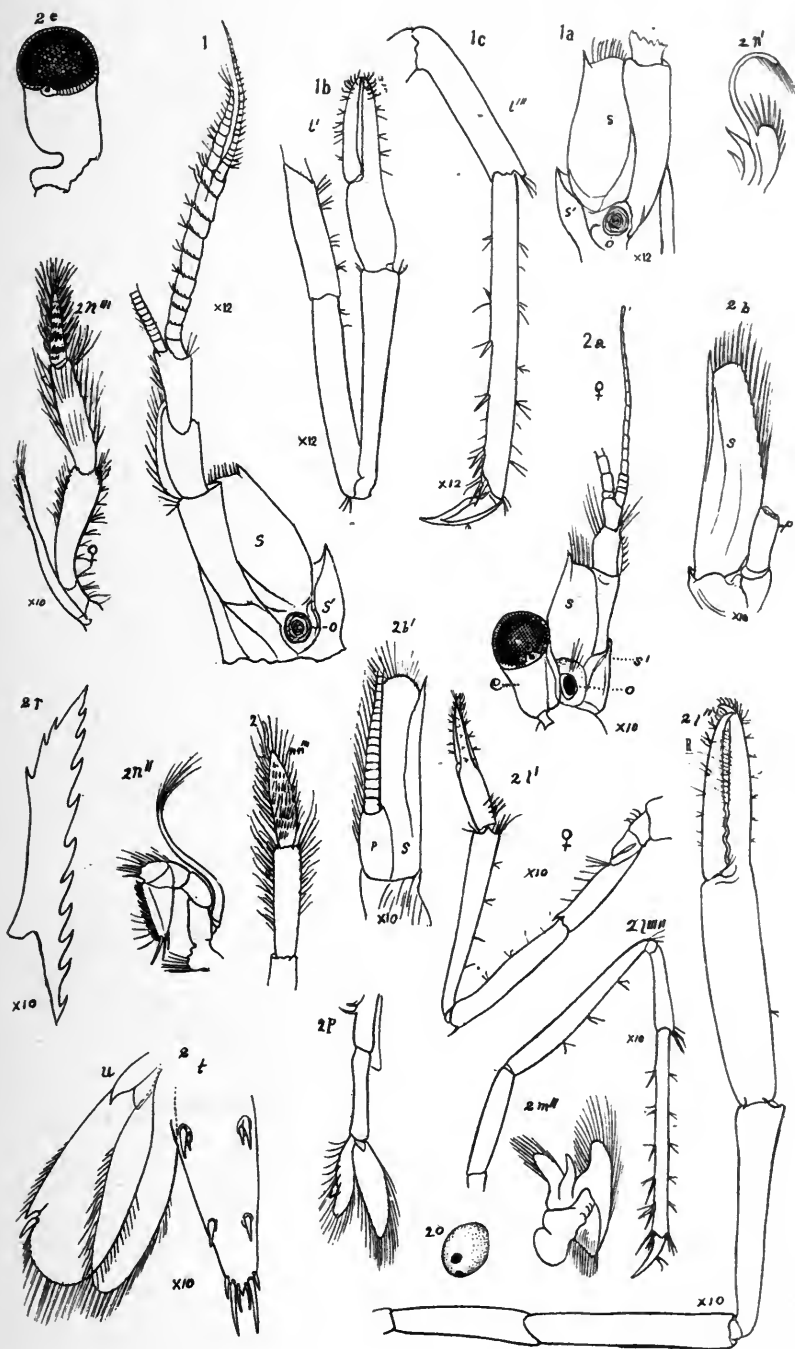


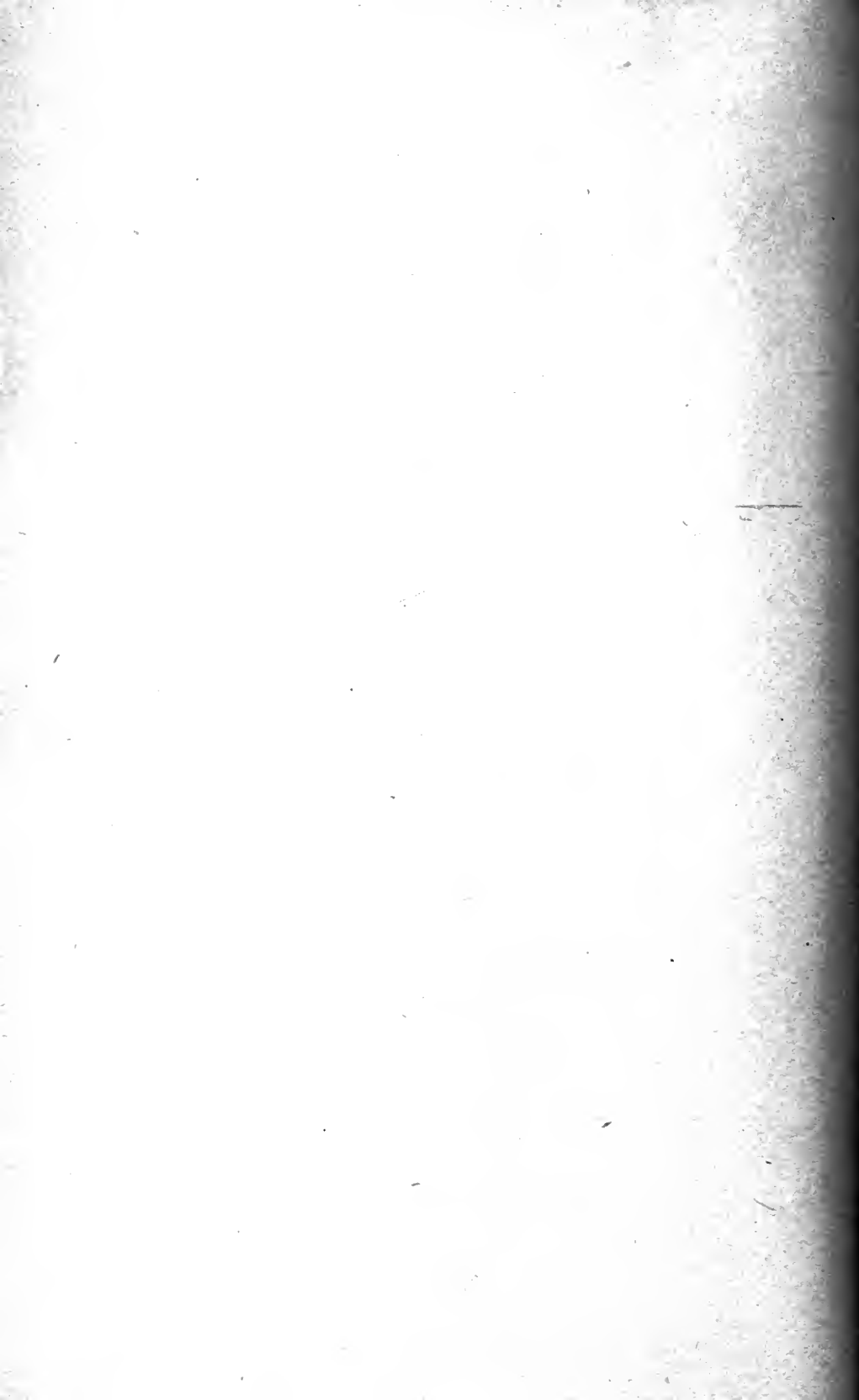


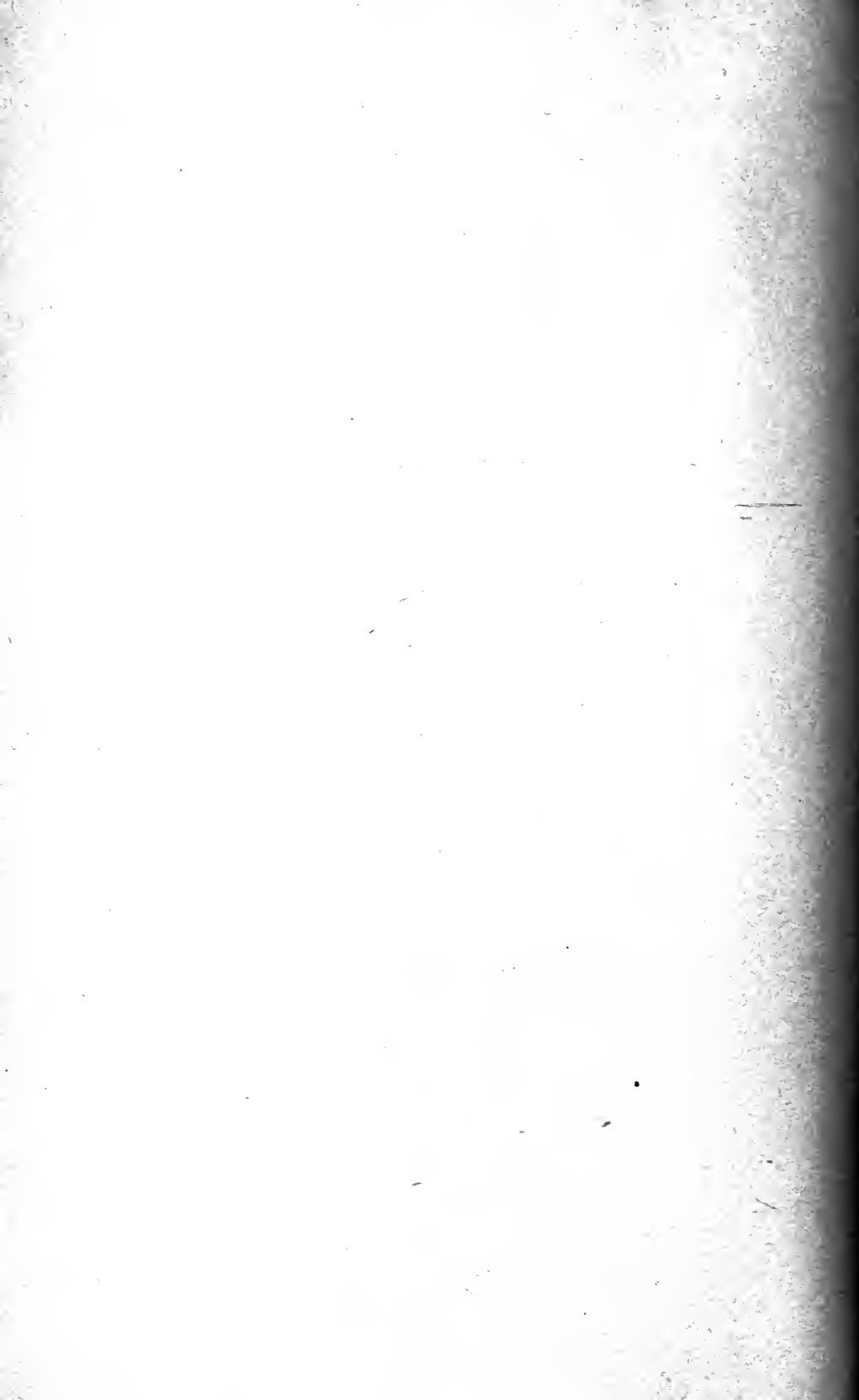


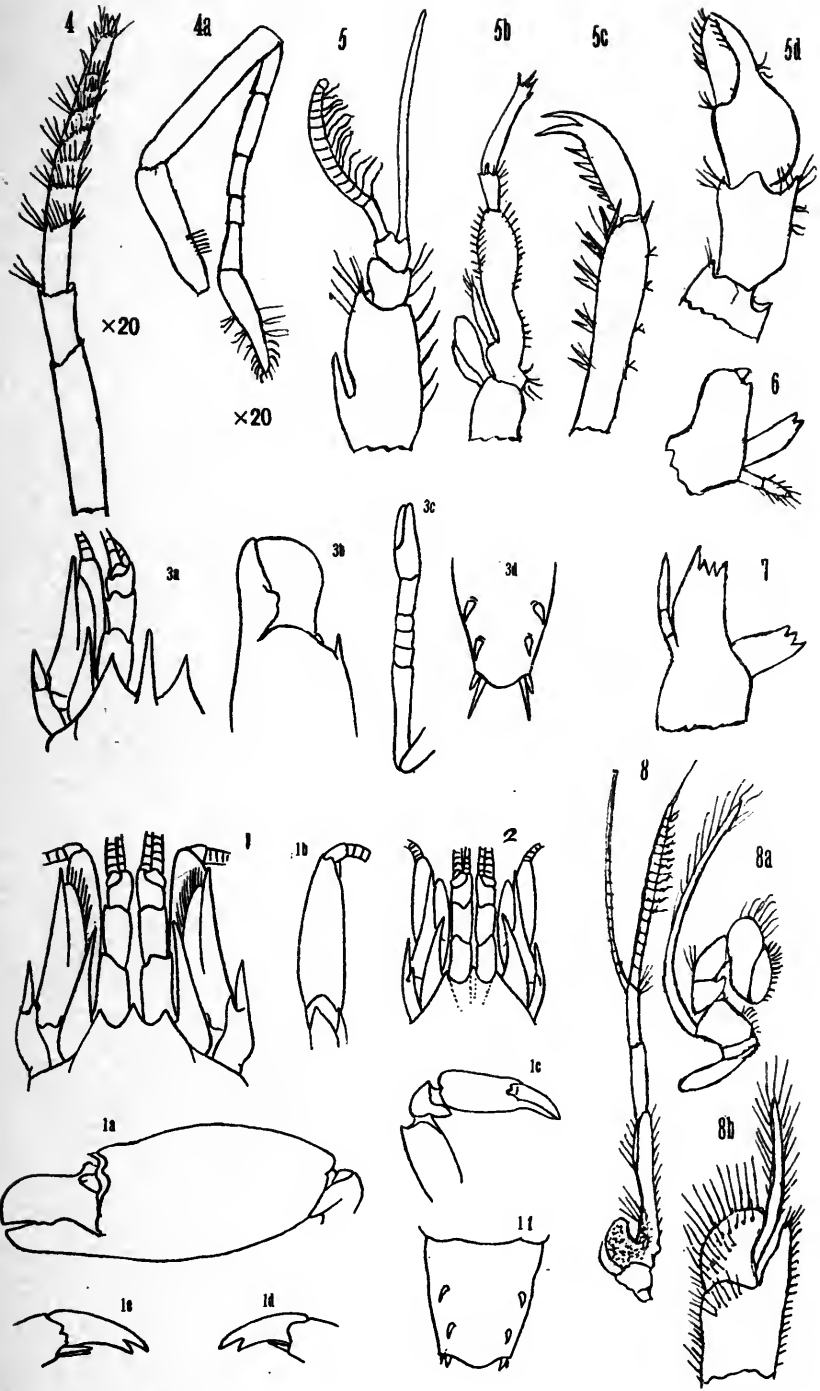


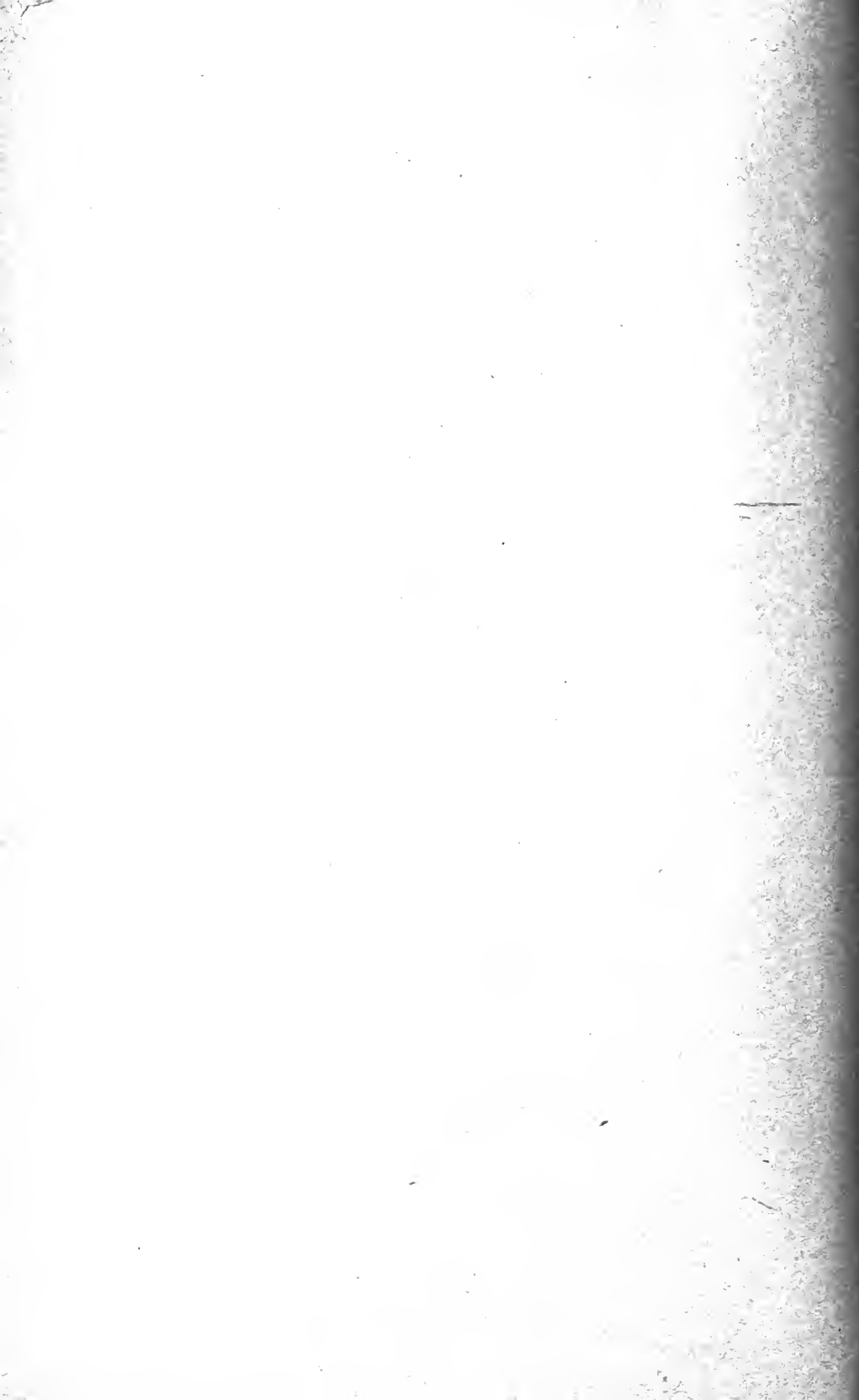


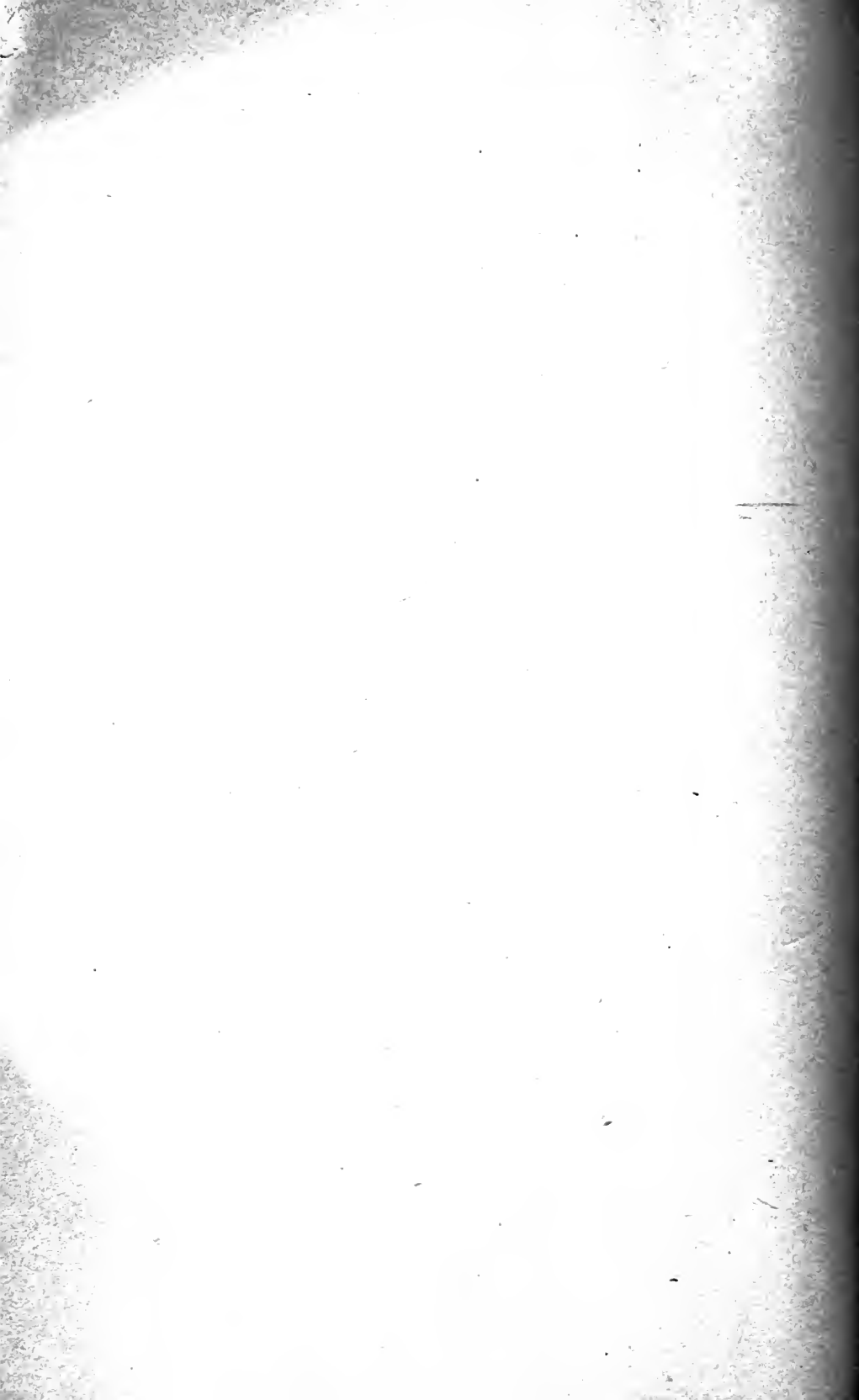
















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