

DESCRIPTIONS OF PARASITIC COPEPODA BELONGING TO THE
GENERA PANDARUS AND CHONDRACANTHUS (WITH SEVEN
PLATES).

By RICHARD RATHBUN.

Genus PANDARUS Leach.

Pandarus sinuatus Say, Journ. Phila. Acad., i, pp. 436-437, 1817.

Pandarus, sp., Smith, Rept. U. S. Comm. Fish and Fisheries, part 1, p. 576
(282), pl. vii, fig. 31, 1873 (1874).

Plate V, fig. 2; plate VI, figs. 1-8; plate VII, figs. 1-8.)

In 1817, Say described, under the above name, a species of parasitic copepod, which he stated to be of common occurrence on the dog-fish, *Squalis canis* ? Mitchell. His description, though brief and unsatisfactory, evidently applies to a species of *Pandarus* which has frequently been taken from specimens of the dog-fish (*Mustelus canis*), sand-shark (*Carcharias americanus*), and Atwood's shark (*Carcharodon Atwoodi*), collected in the vicinity of Wood's Holl, Mass., by the U. S. Fish Commission. The specimens from these several species of sharks differ slightly from one another in certain minor details, but they all undoubtedly belong to a single species. A specimen from Atwood's shark has been figured in general outline by Prof. S. I. Smith (*loc. cit.*).

Following is Say's description :

"*P. sinuatus*. Body dilated, thorax emarginate before, abdomen sinuate behind.

"Inhabits dog fish (*Squalis canis* ? Mitchell). Cabinet of the Academy [of Philadelphia]. Length, one-fifth of an inch.

"Body longitudinally oblong quadrate; thorax transverse quadrate, somewhat narrowed before, emarginate between the antennæ, middle of the base rectilinear and fuscous, angles projected backwards and rounded at tips; antennæ very short; anterior feet formed for suction, at tip oval or subreniform, and placed obliquely; scales, four subequal ones in a transverse line at the base of the abdomen, each transverse and rounded at tip, and two larger ones originating beneath the preceding, slightly dentate at tip, and not concealing half of the abdomen; abdomen quadrate, as wide as the thorax but rather longer, posterior edge with a central sinus and lateral one each side. posterior angles acute; oviducts filiform.

"Very commonly occur on this species of *Squalis*, attaching themselves more particularly about the bases of the fins. They are by no means so active as the *Caligus piscinus*, which also occurs in plenty, on the codfish of our coast."

The following description is drawn up mainly from specimens obtained from the sand-shark, but the principal differences exhibited by specimens from the dog-fish and Atwood's shark are also noted.

➤ This species is rather below the average size for the genus, and in shape and general appearance more closely resembles *Pandarus bicolor*, of Europe, than any other described species. It may readily be distinguished from *P. bicolor*, however, by its smaller size, narrower frontal plates, the much smaller dorsal lobe of the third cephalo-thoracic segment, and the smaller terminal caudal plate. The swimming feet, and especially those of the fourth pair, also present considerable differences.

In dorsal view, the body is elongate-oval in outline, with the length equal to about twice the greatest width, which is near the hinder end of the anterior segment, or across the dorsal appendages of the second segment. The anterior segment is moderately convex, quite regularly semi-elliptical in outline, and about three-sevenths as long as the entire body; length to width about as 3 to 4; or 5 to 6; anterior margin regularly rounded; postero-lateral angles more or less acute or slightly rounded, moderately produced and frequently directed slightly inward. The posterior margin, when perfect, bears three or four short, broad, and sharply pointed teeth-like projections on each side of, and near to, a rounded median one. More often all the projections are blunt and rounded, and frequently the margin is more or less irregular and jagged, with a slight irregular notch near the middle, and has but few small, ill-defined teeth, which are seldom regularly placed, there being often but one or two on each side of the center. The frontal shields are of medium width, with the anterior margin generally but slightly curved along the middle, and the median notch of moderate size. They broaden gradually to the point where they become free, beyond which they retain a nearly uniform width, the outer extremities being more or less regularly rounded. Sometimes they are broader and more curved on the outer side, but in no case do they attain so great a width as in *Pandarus bicolor*.

The lateral dorsal lobes of the second segment are oval in dorsal view, and placed somewhat obliquely. The inner posterior margin generally presents an outward curve, but is sometimes nearly straight or slightly concave; the posterior extremity is well rounded. These lobes are rather widely separated and overlap the appendage of the succeeding segment but slightly, though projecting a short distance back of it, and reaching about half way from the posterior margin of the first segment to the posterior margin of the fourth segment.

Dorsal appendage of the third segment comparatively small, about twice as wide as long, and with a deep sinus in the middle, which reaches about one-half its length, and partly separates it into two equal and very regular lobes. At the margin the sinus opens broadly with concave sides, but farther in its edges approach more or less closely together, and are nearly parallel. In advance of the sinus there is a circular translucent area, which, under a low-power lens, appears to be an extension of it, and to greatly increase its length and width as shown on plate VI, fig. 1.

Dorsal appendage of the fourth segment very large in proportion to the preceding, and equalling or slightly exceeding the fifth segment in width. It is broadly emarginate posteriorly, or with a short, wide sinus, which partly divides it into two well-rounded lobes. The exposed portion of the fifth segment is between one-fourth and one-third the length of the entire body, and about one-third broader than long; its greatest width is just back of the appendage of the preceding segment, which is but slightly, if any, wider. It narrows gradually backward, the posterior extremities on each side being rather broad and rounded, or in some cases obtusely subangular. The posterior median sinus is large, and regularly rounded at the inner end.

The caudal plate is small, its free margin forming an arc, equal to about four-fifths the circumference of a comparatively perfect circle, and from one-half to two-thirds its entire length projects back of the posterior lateral extremities of the fifth segment. The caudal stylets are of medium size, and very thick vertically, being thickest toward the outer margin; they narrow gradually, the outer margin being nearly straight and the inner margin slightly curved, or more or less irregular. The width of the stylets near the tip varies somewhat in different specimens; in some cases the stylets taper regularly to a sharp point; in others, the width near the tip is fully half the width at the inner end. They terminate in three stout, pointed spines, arranged vertically and serially, as shown on pl. VI, fig. 2, the lower spine being also the outermost. A smaller spine projects backward from the lower inner margin, about one-third or two-fifths the length of the stylet from the tip, and slightly in advance of this spine there is usually a single small seta. The antero-lateral angles of the stylets are obtuse, and not produced as in most species. In alcoholic preparations, two-thirds or more in length of the stylets are visible from above. The ovigerous tubes are nearly twice the length of the entire body.

Specimens from the dog-fish and Atwood's shark do not differ much from those above described in the characters of the dorsal surface. The frontal plates are often broader, with a more strongly curved outer margin, in specimens from the dog-fish, while in those from Atwood's shark they are, if anything, a trifle narrower. The posterior margin of the first segment is generally more regular and the spines more constant. In the specimens from Atwood's shark the lobes of the second segment are proportionally longer, and that of the third segment is shorter, with a broader median sinus.

Few of the appendages of the ventral surface present features that are distinctively characteristic of the species, and as they are all figured on plates VI and VII, but brief mention will be made of them.

The so-called "sucking disks" of the two anterior pairs, at the bases of the two pairs of antennæ, are rather large, placed near together and in parallel positions; the inner ones are somewhat smaller than the outer, the former being oval, the latter more elliptical, in outline. The

inner joint of the anterior antennæ is nearly three times as long as broad, broadest near the outer end, and strongly and regularly curved from the outer edge of the anterior emargination to the postero-lateral angle, this entire curved margin bearing numerous long and rather stout papillæ. The outer joint is a little more than one-third the length of the basal, and about twice as long as broad, its distal end with a cluster of small setæ; two similar setæ project from the posterior margin near the outer end. The terminal joint of the second antennæ bears two small, slender spines on the basal portion, the distal portion being stout and slightly curved.

The swimming feet of the first pair vary somewhat in shape in different specimens, but the long flexible spines are the same in number and similarly placed in all the specimens that have been examined. In the specimen represented on plate VII, fig. 1, there is on the middle portion of the outer side of the outer ramus a prominent raised area projecting laterally, and with convex surface, not existing in the other specimen figured (fig. 2). The same character occurs, however, on specimens from all three species of sharks. The two rami of the second pair of feet are of subequal length, the outer being slightly shorter than the inner. The terminal joint of the outer ramus is about two-thirds as long as that of the inner, quite regularly oval in outline and with nine marginal spines, arranged mainly along the end and the inner margin, the four outermost being much the largest. The terminal joint of the inner ramus is about twice as long as broad, and broadens gradually from the base to near the end; it bears five slender spines on the inner margin at the tip, and immediately in advance of them, on the inner margin, there is occasionally an additional minute spine. The four outermost spines are subequal in size and curve outwards; the fifth is smaller and curves inward.

Of the third pair of feet, both rami are about equal in length, the terminal joint of the outer ramus being but slightly shorter than that of the inner. The spines of the terminal joint of the outer ramus, in specimens from the sand-shark, are eight in number and vary somewhat in size, as shown in the drawing, and all but one curve outward; on the corresponding joint of the inner ramus, the two outermost spines only curve in the same way. In specimens from the dog-fish and Atwood's shark, both rami are somewhat smaller than in those from the sand-shark, and the innermost terminal spine of the inner ramus is wanting, leaving only the two curved spines; on the terminal joint of the outer ramus, the innermost spine is lacking in the dog-fish specimens and occasionally in those from the sand-shark, and this and the next succeeding one are not found in the specimens from Atwood's shark. Inside of the rami there is a large, well-rounded, lobe-like extension of the basal joint, which is often much larger than represented in the figure.

The fourth pair of feet vary considerably in size and shape, but are

essentially alike in all the specimens examined. Four figures are given, two from sand-shark specimens, and one each from the dog-fish and Atwood's shark; these serve to represent the principal differences observed. The basal joint is very large, with a notch of variable size on the outer margin. The rami are larger in the sand-shark specimens than in those from the other species, and there is considerable variation in their outline; the outer ramus has four spines at the outer end, with sometimes a smaller one on the outer margin, slightly in advance of the latter; a small curved spine also projects from the same margin near the middle. The inner ramus is without spines. In *Pandarus bicolor*, the fourth pair of feet are quite unlike those of this species, the rami being much longer, more slender, and of an entirely different shape.

The ventral caudal plate is shorter than the dorsal, and slightly concave along the middle of the posterior margin.

There is considerable variation in the color of this species. In alcoholic specimens the prevailing color of the dorsal surface of the first four segments is a dull yellow, or yellowish white; the fifth segment is sometimes of the same color, but generally darker, and with a grayish or brownish tinge; the caudal plate is nearly white, or slightly yellowish. In most specimens there are two bright-brown or brownish-black spots close to the front margin, one on each side. These often extend backward a variable distance, and sometimes unite in front to form a horseshoe-shaped figure, which may cover a greater or less extent of surface. The dorsal lobe of the fourth segment is generally marked with the same color, which may form a central dot, nearer the posterior than the anterior margin, or a broad blotch covering the greater part of the lobe. Specimens from the dog-fish are usually darker than those from the sand-shark or Atwood's shark, and the brown or blackish marking often covers most of the first segment, leaving only an elongate median light space of variable width. The same markings frequently extend to the lobes of the second and third segments, and that of the fourth segment is generally entirely dark.

The length of the body, exclusive of the ovigerous tubes, is between 7^{mm} and 8^{mm}, nearly all the specimens collected coming within those dimensions. The drawings of appendages representing this species on plates VI and VII have been made from alcoholic preparations, mostly treated with a dilute solution of caustic potash, and examined under very slight pressure.

This species is found attached to the surface of the body and to the fins. It has been most commonly taken from the sand shark, which is abundant in Vineyard Sound, Massachusetts, but is frequently found on the dog-fish in the same region. It has been collected only once from Atwood's shark, but this species of shark has not been observed since 1875. The specimens recorded in the following list were all obtained by the U. S. Fish Commission.

RECORD OF SPECIMENS EXAMINED.

From the Sand-shark, *Carcharias americanus* :

Vineyard Sound, Mass., 1875, 10 specimens, ♀ (6202, 6208*); 1880, 30 ♀ (6021);
1882, 14 ♀ (6028, 6030); 1883, 25 ♀ (6034, 6041); 1884, 10 ♀ (8121); 1885, 20
♀ (10744).

From Atwood's Shark, *Carcharodon Atwoodi* :

Vineyard Sound, Mass., 1871, 25 ♀ (6172).

From the Dog-Fish, *Mustelus canis* :

Vineyard Sound, Mass., 1875, 14 ♀ (6199, 6203); 1883, 7 ♀ (6046); 1884, 3 ♀
(8124, 8126); 1885, 3 ♀ (10745).

Long Island Sound, off Noank, Conn., 1874, 1 ♀ (6207).

Pandarus Smithii, sp. nov.

(Plate V, fig. 3; plate VII, fig. 9.)

This is a large species, differing considerably from both *P. Cranchii* and *P. sinuatus*, though resembling the former more closely than the latter in general appearance. From *P. Cranchii* it may be readily distinguished by the shape of the frontal plates and of the anterior body segment. The median dorsal portion of the second segment, between the lateral lobes, is extended some distance backward, in the shape of a transverse, chitinous plate, and the appendage of the third segment is divided into two separate lobes. The fourth segment is exceedingly large, while comparatively little of the fifth segment is visible from above. In the characters of the second and third segments this species bears some resemblance to *P. lugubris* Heller,† but otherwise the two are very unlike.

Frontal plates broad, with the anterior margins strongly and regularly curved, increasing rapidly in width from the median line of the body to the point where they become free; posterior free margin entirely adjacent to the margin of the first segment; outer extremities broadly and regularly rounded. In alcoholic specimens but a very small portion of the basal joint of the first antennæ is usually exposed in dorsal view.

First body segment large, slightly broader than long; front margin well rounded; lateral margins convex, diverging somewhat rapidly for about three-fourths the length of the segment, thence bending inward toward the postero-lateral angles, which are rounded, and extend a moderate distance back of the median portion of the posterior margin; posterior margin with four sharply-pointed, spine-like teeth on each side of a median one, which is shorter than those adjoining it. Lateral

* The numbers inclosed in parentheses refer to the Crustacean record-books of the U. S. National Museum, in which the specimens are catalogued.

† Reise der Österr. Fregatte Novara; Zool. Theil, Band II, p. 205, pl. XX, figs. 1, 2, 1868.

dorsal lobes of the second segment elongate-oval, about twice as long as broad; median portion with a transverse, subtriangular, lobed plate, as shown in the figure. Dorsal appendage of the third segment divided into two small, equal, and regularly curved lobes, the margins of which meet, but do not coalesce, at the posterior extremity of the preceding segment. Dorsal appendage of the fourth segment very large and concealing the greater part of the fifth segment; width slightly greater than twice the length; median sinus subtriangular in outline, the lateral lobes formed by it semicircular in outline. Fifth segment very short, as seen from above, and much narrower than the preceding segment; sides strongly and regularly curved, and terminating posteriorly in a small but prominent knob on each side of the median sinus, which is broad, rounded, and of moderate depth.

Caudal plate rather large, subcircular in outline, narrowing abruptly anteriorly, about two-thirds in length projecting back of the fifth segment. Caudal stylets mostly uncovered from above, moderately long and narrow, thick vertically, and terminating in three spines arranged vertically and serially, as in *P. sinuatus*. A wing-like projection extends inward from the anterior half of each stylet, and overlaps the ventral caudal plate on the lower side.

The sucking disks of the two anterior pairs, on the ventral side of the first segment, are of about the same width and parallel; outer ones elongate-suboval in outline, inner about half as long as the outer, and cut off squarely at the front end. Rami of the posterior pair of feet much longer and more slender than in *P. Cranchii*, and also somewhat more elongate than in even extreme cases of *P. sinuatus*; outer ramus with five terminal spines and one median spine on the outer margin, situated in the middle of a rounded notch.

The dorsal surface of the body is smooth and almost entirely of a rich brownish black, the margins of the segments and the frontal plates being lighter and of an amber or horn color. On the anterior portion of the first segment there is also a transverse curved area of the same light color. The fifth segment is blackish about the posterior knobs and lighter anteriorly; the caudal plate is a deep rich brown, almost black.

The above description is made up from two specimens taken from a dusky shark, *Carcharinus obscurus* (Lesueur) Jor. & Gilb., caught off Noank, Conn., in 1874, by the U. S. Fish Commission (6198), and the drawings are from one of the same. The same species has also been found on a specimen of sand-shark, *Odontaspis littoralis* (Mitch.) Jor. & Gilb., taken in Vineyard Sound, Mass., by the Fish Commission, in 1880 (6022), and on an undetermined species of shark from about the same region (8119). There is only a single specimen in the lot numbered 8119. It measures 8^{mm} in length, and differs but slightly from the types described above. The terminal knobs of the fifth segment are each armed with a minute spine; the caudal plate is more elongate, being oval in outline; and the shaft of the caudal stylets is relatively broader,

with the three terminal spines arranged in an oblique series, trending inward from the tip.

There are four specimens from the sand-shark, and they resemble No. 8119 more than they do the types, though differing somewhat from the former. They are lighter in color, and the transverse light area on the front part of the first segment is larger and less well-defined; the five median spines of the posterior margin of the same segment are carried on a slight backward projection of the margin, and the two additional spines on each side are very small. The dorsal lobes of the third segment are widely separated throughout, and the appendage of the fourth segment is smaller than in the types, leaving much more of the fifth segment exposed above. The caudal plate and stylets are similar to those of 8119; the ovigerous tubes are slightly longer than the body. The largest of the specimens measures 9^{mm} in length of body, and the others are not much smaller.

Pandarus Cranchii Leach.

(Plate V, fig. 1.)

A number of specimens of this species were obtained from a large, undetermined species of shark, taken by the U. S. Fish Commission steamer Albatross off the Capes of Virginia, at station 2422, lat. 37° 08' 30" N., long. 74° 33' 30" W., June, 1885. Other American localities for the species have already been recorded by the writer.*

Genus **CHONDRACANTHUS** De la Roche.

Chondracanthus galeritus, sp. nov.

(Plate VIII, figs. 1-7; plate X, figs. 1-7.)

Rather below the medium size, elongate, but exceedingly variable shape, according to the amount of contraction or method of preservation. When most extended, the total length of the body is three or more times the greatest width, which is across the abdomen. In much contracted specimens, the width is sometimes nearly equal to the length. In the former case, with alcoholic specimens, the head is generally thrown back, the thorax and abdomen straight, smooth, and much inflated, as on plate VIII, figs. 1, 2; in the latter, the body is more or less compressed, and curved or twisted, the thoracic and abdominal portions with thickened margins and more or less pronounced foldings on the dorsal surface. Considering the former as the more normal shape, we have confined our description mainly to it.

The head is slightly elongate, broadest near the front, and narrows gradually backward. The dorsal portion is inflated and projects to a greater or less extent over the ventral and basal portions, like a hood or cap. The front margin is broad, approximately straight, the antero-

* Proc. U. S. Nat. Mus., vol. vii, 1884, p. 488.

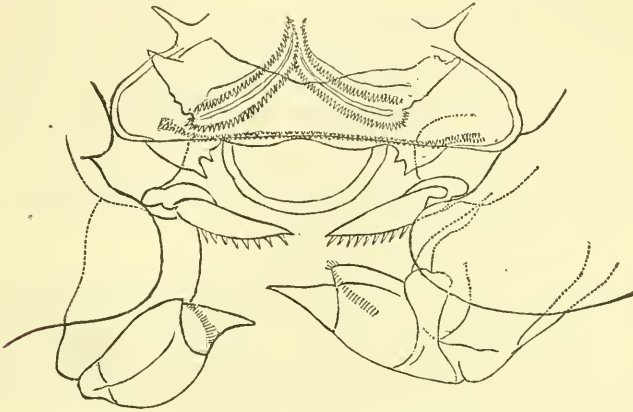
lateral corners well rounded, the front dorsal surface divided off as shown in fig. 1, and the dorsal groove reaching to near the hinder end of the hood. The thickness through the hood is nearly equal to its width, the region about the mouth being much exsert, and the base of the head somewhat constricted near where it joins the thorax.

In dorsal view, the thorax is rather narrow in front and bilobed on each side, the front lobes being very small, sometimes but faintly indicated, and the posterior, which immediately follow them, quite large and regularly rounded, the width of the thorax at this point being not very much less than that of the abdomen. The larger lobes give origin to the second pair of thoracic appendages. The abdomen is also divided near the middle into two segments by a rather broad and shallow constriction, deepest and best defined at the sides, and indicated on the dorsal surface by a very slight transverse depression. In contracted specimens this division is frequently more marked. The posterior segment is generally slightly longer and broader than the anterior, and its length is about equal to the thickness through the abdomen. The postero-lateral prolongations of the hinder segment are rather short (a little more than one-third the length of the segment), stout, and well rounded at the extremities. In some cases they taper rapidly, while in others they retain a more uniform width. The genital segment is small; the tail very small, elongate, rounded at the end, and with two minute appendages on the ventral side near the front, each tipped with a single stout seta.

The anterior antennæ are large, broad, flattened, but not as conspicuous as in *Chondracanthus cottunculi*, and consist of only a single joint, although the setæ at the outer end are borne upon a small, overlapping and elongate fold or lobe, as shown on pl. X, figs. 2, 3. In specimens normally preserved they stand almost entirely in advance of the head, and reach nearly or quite to the lateral margins of the head; greatest length about twice the greatest width; the adjacent margins slightly overlapping. The front and inner margins are strongly convex; posterior margin straight or slightly concave, with a small, rounded prominence or lobe near the inner end; outer end abruptly narrowed, rounded, and with several small setæ. In contracted specimens these antennæ are often drawn down to a greater or less extent over the ventral surface of the head, thus appearing much less conspicuous dorsally. (See plate VIII, figs. 4 and 5.)

The second antennæ or prehensile hooks are rigid, of a light horn color, and arise from a rather complicated frame-work of the same consistency, imbedded in the soft ventral surface of the head, close to the front margin. They are strongly incurved near the end, and terminate in a sharp point, but the lower two-thirds to three-fourths is nearly straight. Their length, not including the incurved portion, is about equal to the greatest width of the anterior antennæ.

Of the three principal pairs of mouth organs, one pair is in advance of the mouth opening and two pairs back of it, while on each side there is a small palpus, terminating posteriorly in two sharp spines. The organs of the first pair are rather slender, curved, and serrated on both margins. Of the second pair, the terminal joint is slender, very slightly curved, and tapers gradually to a sharp point. The posterior margin is armed with about ten acute spines, arranged in a single regular series, extending from the tip to beyond the middle. The hinder pair are comparatively very large, and capable of considerable extension backward. The basal joint is very broad, the median joint of moderate size, the terminal joint small, broad at the base, and rapidly narrowing to a slender distal end, terminating in a rather acute point.



Arrangement of mouth parts in *Chondracanthus galeritus*.

The thoracic appendages are comparatively small and divided at the outer ends, for slightly more than half their length, into two subequal portions, which are stout at the base and taper rapidly to sharp or slightly rounded tips. The first pair originate just back of the head, and are much smaller than the second, when compressed against the ventral surface, scarcely reaching to the bases of the latter. The second pair, which arises from the posterior thoracic lobes, when compressed in the same manner, do not reach much, if any, beyond the middle of the first abdominal segment. In distended specimens the thoracic appendages project ventrally at an angle of more than 45 degrees, but in distorted ones they may lie more or less flat against the surface, the posterior pair often reaching to or slightly overlapping the second abdominal segment.

The ovigerous tubes are nearly as long as the body, sometimes longer, large, and slightly tapering; rounded at the ends.

By contraction, or by distortion in alcohol, this species assumes very odd and irregular shapes, which it is impossible to describe in detail; but it is always readily distinguished from the other species of the genus

described in this paper, by the shape of the anterior antennæ and of the thoracic appendages. By contraction the head often becomes nearly circular in dorsal view, with the antero-lateral corners extended forward beyond the median anterior margin, and with the thorax immediately following the hood-like dorsal expansion. In such cases, the thorax is also very short.

The average length of the body, in females, is about 6 or 7^{mm}. The color of living specimens is whitish, the head and most of the thorax with its appendages being translucent; remainder of the body mostly opaque; ovigerous tubes slightly yellowish. In alcohol the body becomes yellowish-white and the ovigerous tubes much darker. Just before hatching, the latter become pinkish, due to the color of the embryos in the eggs.

This species is of very frequent occurrence in the mouth of the common flounder, *Paralichthys dentatus* (L.) Jord. & Gilb., at Wood's Holl, Mass., and vicinity, many specimens having been collected by the U. S. Fish Commission in 1883 (6036, 6037, 6049, 6077, 6082). It generally attaches itself in the front part of the mouth, holding on tightly by means of its hooked antennæ, its head often partly buried in the soft skin. Males are often found attached to the females, and a side view of a male is represented on plate VIII, fig. 7.

Chondracanthus galeritus appears to correspond more nearly, in its general shape and characters, with *Chondracanthus cornutus* of Europe, than with any other described species. I have not been able to examine specimens of the latter species, but a comparison with published figures indicates that the anterior antennæ and mouth parts, at least, furnish good distinguishing characters.

***Chondracanthus phycidis*, sp. nov.**

(Plate IX, figs. 1-6; plate X, figs. 8-13.)

This species is of about the same length as *Chondracanthus galeritus*, but generally rather stouter, when most extended about twice as long as broad, when much contracted in alcohol fully two-thirds as broad as long; ovigerous tubes large, straight, or slightly curved, usually about three-fourths as long as the body, but sometimes of about the same length.

Head large, about one-third the length of the entire body, broadly suboval in outline, as viewed from above, the greatest width being nearly equal to or even slightly exceeding the length. It is more or less abruptly narrowed toward the front, generally more so than in the figure given, with the anterior margin straight or slightly convex in the middle. The lateral margins diverge rapidly from the front, and are at first slightly concave, but soon round outwardly, the posterior two-thirds of the head in length being quite broad and with strongly convex sides. In side view the dorsal contour is strongly arched, the

ventral concave anteriorly and strongly convex posteriorly, giving a much greater depth to the head in the region of the mouth than at the front, the greatest thickness being nearly equal to the greatest width.

The thorax is short and broad, not more than half as long as, and somewhat narrower than the head. Viewed from above it presents two rounded lobes on each side, produced by a constriction near the front; the anterior lobes merge into the head, the posterior are larger and better defined.

The abdomen enlarges abruptly from the thorax and is very broad, especially toward the front, its greatest width being nearly equal to its length, or even exceeding it in specimens that are much contracted. A slight, narrow constriction at the sides partly divides it into two segments, of which the anterior is slightly longer than the posterior in specimens in normal condition, but often very much larger in the young or contracted ones. The greatest width of the body is across the anterior segment, and its thickness at the same place is considerably more than half the width, the median ventral surface being more or less raised and the margins broadly thickened. The postero-lateral prolongations of the abdomen are large and stout, rounded at the ends, and generally extend obliquely downwards and backwards, though sometimes nearly at right angles to the rest of the abdomen.

The genital segment is relatively small, the tail nearly as large, globular, and reaching back nearly as far as the hinder prolongations of the abdomen; in young specimens it projects back of the latter. The ovigerous tubes are of nearly uniform size throughout, or taper slightly.

The anterior antennæ are very small, slender, rounded, two-jointed, and do not reach quite to the sides of the front margin; they originate at the extreme end of the ventral surface of the head, very near the median line. The basal joint is elongate, and slightly constricted at the inner end; the terminal joint is short, about one-third as long as, and narrower than, the basal, and is rounded at the outer end, where it is armed with several small elongate papillæ; there is also one similar papilla near the middle of the posterior margin. The posterior antennæ or prehensile hooks are rather large; the principal joint stout, strongly curved throughout, and sharply pointed; the basal short and broad. The mouth parts do not differ greatly from those of *C. galeritus*; the three principal pairs of organs are represented on plate X, figs. 10-12.

The thoracic appendages are of moderate size, relatively stout, and notched or slightly bilobed at the ends; those of the anterior pair are not much more than half as long as the posterior, the latter reaching to about the middle of the first abdominal segment. The anterior pair originate close to the head, and in side view appear subcircular or subovate in section, while the posterior are oblong or short clavate, and about twice as long as broad. The former are but slightly indented at the ends, each terminating in two rounded knobs, the outer somewhat larger than the inner, and often presenting, when viewed from the ends,

a subreniform shape, as represented on plate IX, fig. 2. The latter, in ventral view, are convex on the outer margin and concave on the inner, the outer terminal knob or lobe being the largest, and projecting further back than the inner.

The average length of adult specimens is about 5 or 5.5^{mm}. The color in alcohol is a yellowish or dingy white, the ovigerous tubes being of a light yellow or yellowish buff.

This species is readily distinguished from the other species described in this paper by the shape of the head, the small size of the anterior antennæ, the stoutness of the thoracic appendages, and the shape of the posterior part of the body, including the genital segment and tail. It has been collected only once, about 15 specimens having been taken from nearly as many specimens of the common hake, *Phycis tenuis*, collected off Martha's Vineyard, Mass., in 1883, by the U. S. Fish Commission (6066). They were attached to the gills. Many of the specimens are immature females, and nearly all were accompanied by a single male each.

***Chondracanthus cottunculi*, sp. nov.**

(Plate XI, figs. 1-7.)

Of about the same size as *Chondracanthus phycidis*, but readily distinguished from both that species and *C. galeritus* by the size and shape of the anterior antennæ, and by other prominent characters.

The greatest width of the body is equal to about one-half the length, or slightly less. The head is considerably shorter than broad, about one-fifth as long as the entire body, narrowed and rounded in front, the lateral margins diverging rapidly and very convex and well rounded posteriorly; the greatest width is just in advance of the hinder end. The front margin is extended laterally in the shape of two rather prominent rounded knobs; the dorsal surface arches strongly and terminates posteriorly in a raised margin or collar; on the ventral side, the lateral margins are bordered by two broad, convex, smooth patches or cheeks. The thorax is much constricted immediately back of the head, forming a very short neck, from which the margins diverge very rapidly again with a convex outline, producing a wing-like expansion on each side, cut off squarely behind or, in some cases, sharply pointed and directed more or less backward at the ends. This portion of the thorax is of about the same width as the abdomen, to which it appears to belong, but it gives origin to the second pair of thoracic appendages.

The abdomen composes about three-fifths of the body in length, its width being nearly three-fourths its length. It is moderately convex dorsally, and consists of two segments with slightly raised margins. The posterior segment is slightly longer than the anterior; the posterolateral prolongations of moderate size, sometimes of nearly uniform width with well-rounded ends, at others tapering and more pointed.

Four divisions of the body back of the head are plainly distinguishable on the dorsal side. These are separated by three shallow but well-defined transverse grooves, having a backward extension, as represented on plate XI, fig. 1. The first is just back of the short neck; the second originates at the hinder ends of the thoracic wings, and extends some distance backward, forming three sides of a rectangular figure; the third starts at the median indentations on the sides of the abdomen, and, though similar in its course to the preceding, is somewhat straighter. The above arrangement of the grooves is well marked on the specimen figured, which is more perfectly preserved than any of the others. In other specimens, they have the same relative position and shape, but from distortion in alcohol present numerous irregularities, and the intervening spaces are often inflated, appearing like large rounded knobs, while the margins may be much thickened.

The genital segment is small; the tail very small, globular, with two moderately long setose processes projecting from the ventral side, and stopping some distance in advance of the posterior extremities of the abdomen.

In lateral view the body presents a grotesque appearance, the dorsal contour being rather strongly and regularly arched, the head and prominent antennæ resembling somewhat a crested helmet, and the thoracic appendages held out rigidly in front.

The anterior antennæ are very large, prominent, flattened, irregularly subtriangular in outline, their lateral extension being somewhat greater than their longitudinal. Being soft and flexible, they exhibit considerable variation in their outline, but the inner margins are generally convex and closely adjacent or slightly overlapping, the posterior and the antero-lateral more or less concave, the former sometimes nearly straight. At the sides they project far beyond the antero-lateral corners of the head, their total spread being about equal to the greatest width of the head. The lateral portions are much narrowed, rounded at the ends, and armed with a few small setæ or papillæ; the anterior extension varies in width, being sometimes broadly rounded, at others more acute. The inner posterior corners are more or less extended. Each antenna appears to consist of only a single joint; in one specimen examined, however (plate XI, fig. 5), there were traces of a division near the middle; but this would probably have disappeared under compression.

The posterior antennæ are small compared with the anterior; they consist of a rather small basal joint, and a stout, moderately curved distal joint, but slightly tapering, though sharply pointed. The horny framework to which they are attached is comparatively large and strong, and continuous from side to side.

Figures are given of the second and third pairs of mouth organs. In the former the terminal joint is very slender, sharply pointed, the basal large; in the latter the terminal joint is curved and also slender, but

abruptly enlarges at the base; the second joint is closely margined with fine hairs along the inner margin.

The thoracic appendages are of moderate size, nearly as thick as wide, rather abruptly expanded and indented at the ends, as shown on plate XI, fig. 2, the terminal projections on each side being rounded. The first pair originate immediately back of the head, and are smaller than the second pair, though not very much shorter. When compressed against the ventral surface, the appendages of the second pair extend but a moderate distance back of the lateral thoracic wings, and those of the first pair overlap the second but slightly. Following these appendages, and in the same line, there is a pair of short, stout, simple abdominal appendages, belonging to the first segment; they are somewhat conical in shape, rounded at the ends, and sometimes more or less compressed vertically; they are located close to the margin.

The total length of the body, including the antennæ, is about 6^{mm}. The ovigerous tubes are slightly shorter than the body, or of about the same length. They are comparatively large, taper but slightly, and are rounded at the ends. The color of the body in alcohol is a sort of yellowish white, or light flesh color; ovigerous tubes dull yellowish. This species has been found on two species of *Cottunculus*, living in the gill cavity. Males were attached to most of the females. The specimens were all collected by the U. S. Fish Commission steamer Albatross.

RECORD OF SPECIMENS EXAMINED.

From *Cottunculus torvus*.

Lat. 41° 11' 30" N., long. 66° 12' 20" W., 449 fath., sta. 2078; 3 specimens (6139).

From *Cottunculus microps*.

Lat. 39° 55' 35" N., long. 71° 00' 30" W., 197 fath., sta. 2092; 2 specimens (6166).

From *Cottunculus* ?, sp. ?

Lat. 39° 29' N., long. 71° 46' W., 693 fath., sta. 2181; 1 specimen (8454).

REFERENCE TO THE PLATES.

Fig. 1, of Plate V, was drawn by Mr. J. H. Emerton; all the other figures are by the author, and were drawn mainly from alcoholic specimens, with the aid of the camera lucida. Delicate opaque appendages were treated with a dilute solution of caustic potash, and were observed under as slight pressure as possible.

EXPLANATION OF PLATE V.

Pandarus Cranchii Leach (page 317).

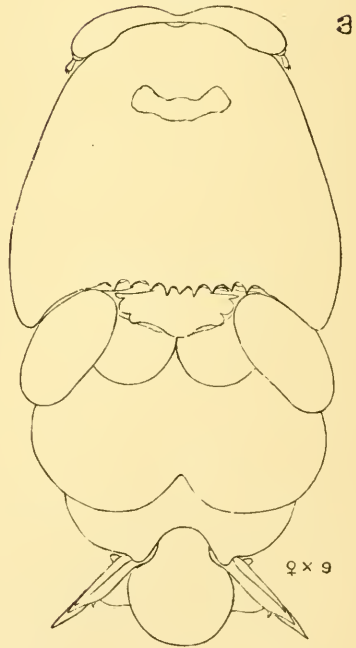
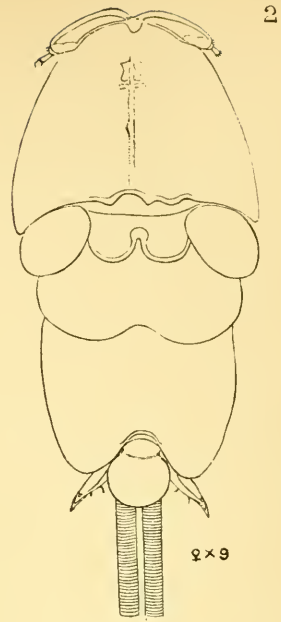
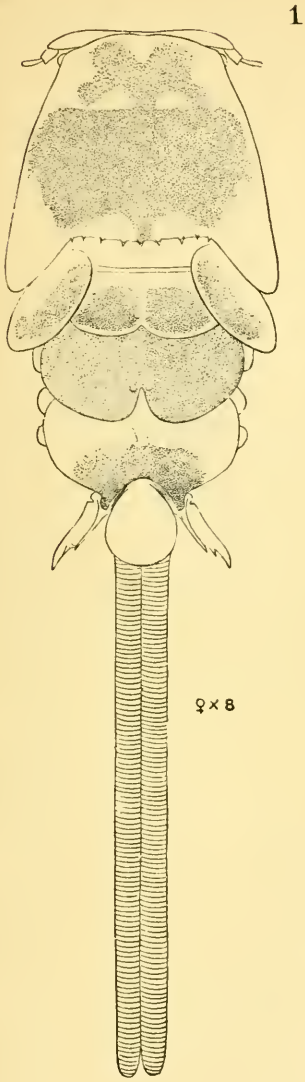
Fig. 1. Female, dorsal view, enlarged 8 diameters. The shaded portions indicate dark color markings.

Pandarus sinuatus Say (page 310).

Fig. 2. Female, dorsal view, enlarged about 9 diameters. Only the basal portions of the egg-sacks are shown.

Pandarus Smithii, sp. n. (page 315).

Fig. 3. Female, dorsal view, enlarged about 9 diameters.

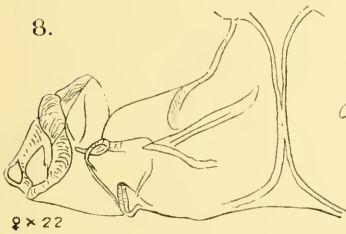
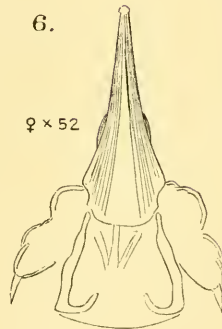
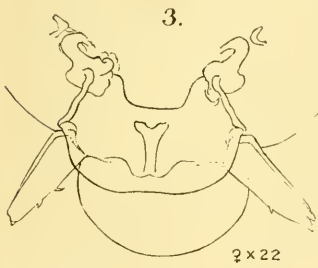
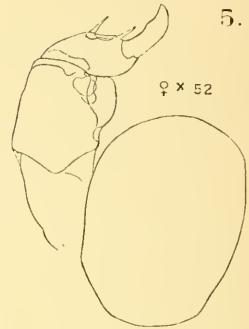
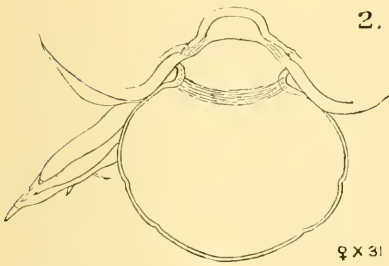
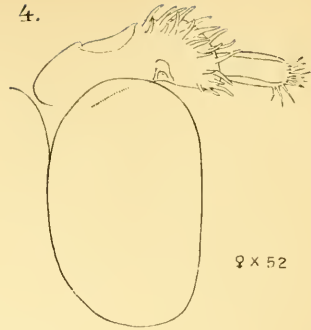
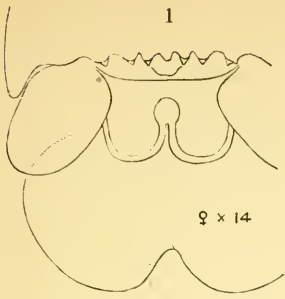


EXPLANATION OF PLATE VI.

Pandarus sinuatus Say ♀ (page 310).

(Unless otherwise stated, all figures on this plate are from sand-shark specimens.)

- Fig. 1. Posterior margin of first segment, and dorsal appendages of second, third, and fourth segments, enlarged 14 diameters; from *Mustelus canis*.
- Fig. 2. Posterior sinus of fifth segment, dorsal caudal plate, and caudal stylet of one side, enlarged 31 diameters; from *Mustelus canis*.
- Fig. 3. Ventral view of ventral caudal plate, and caudal stylets; the posterior margin of the dorsal caudal plate is also indicated; enlarged 22 diameters.
- Fig. 4. Anterior antenna, with the adjacent sucking disk, enlarged 52 diameters.
- Fig. 5. Posterior antenna, with the adjacent sucking disk, enlarged 52 diameters.
- Fig. 6. Rostrum and palpi, enlarged 52 diameters.
- Fig. 7. First pair of foot jaws, enlarged 52 diameters.
- Fig. 8. Second pair of foot jaws, enlarged 22 diameters.



EXPLANATION OF PLATE VII.

Pandarus sinuatus Say ♀ (page 310).

(Unless otherwise stated, all appendages of this species figured on this plate are from sand-shark specimens.)

Fig. 1. Swimming foot of first pair, enlarged 52 diameters; from *Carcharodon Atwoodi*.

Fig. 2. Swimming foot of first pair, enlarged 29 diameters.

Fig. 3. Swimming foot of second pair, enlarged 22 diameters.

Fig. 4. Swimming foot of third pair, enlarged 22 diameters.

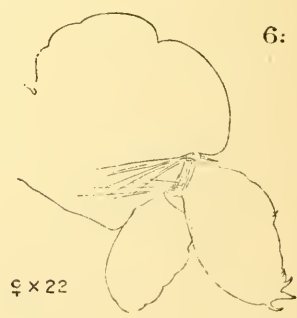
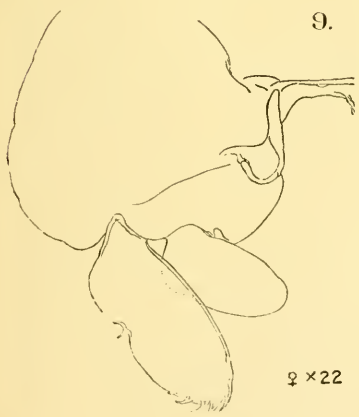
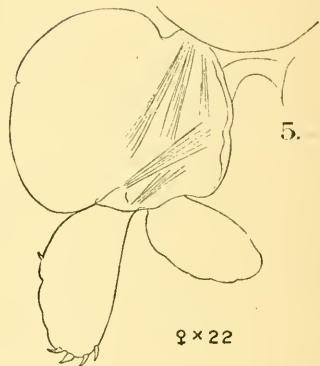
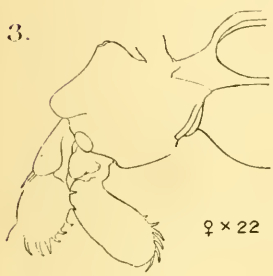
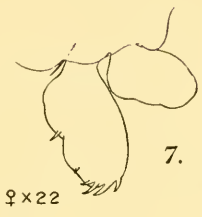
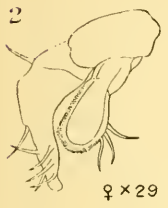
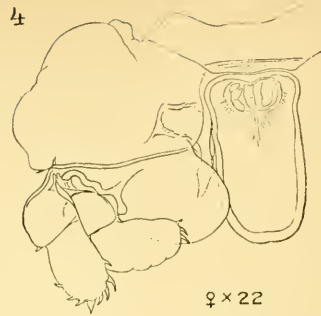
Figs. 5, 6. Swimming feet of fourth pair of two specimens, enlarged 22 diameters.

Fig. 7. Swimming foot of fourth pair, from *Carcharodon Atwoodi*, enlarged 22 diameters.

Fig. 8. Swimming foot of fourth pair, from *Mustelus canis*, enlarged 22 diameters.

Pandarus Smithii, sp. n. ♀ (page 315).

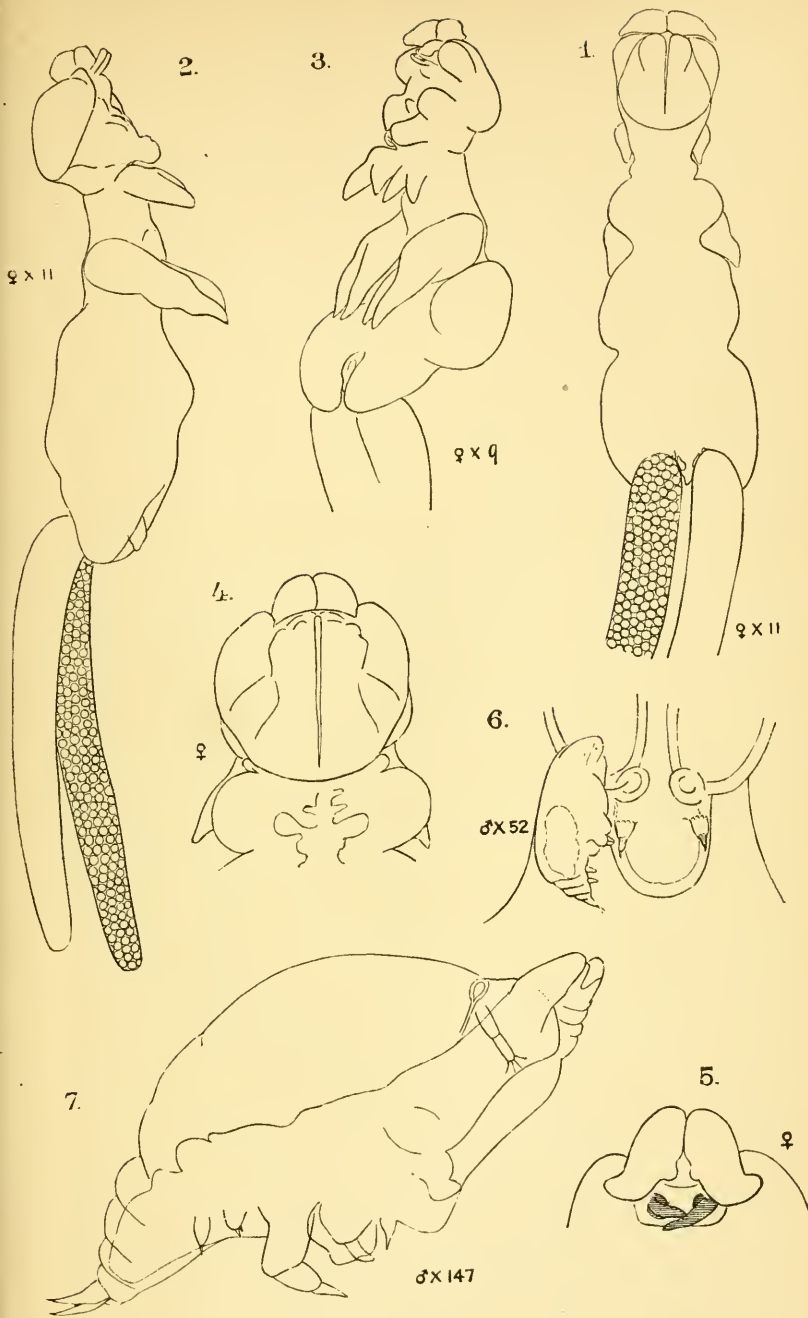
Fig. 9. Swimming foot of fourth pair, enlarged 22 diameters.



EXPLANATION OF PLATE VIII.

Chondracanthus galeritus, sp. n. (page 317).

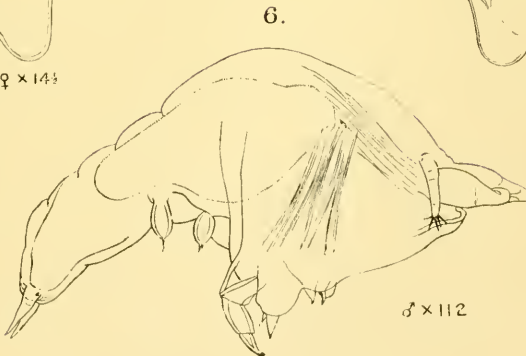
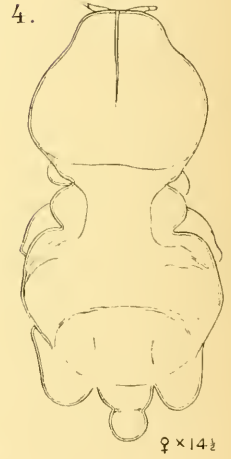
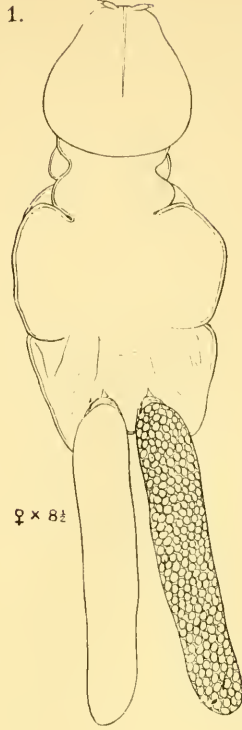
- Fig. 1. Female, dorsal view, and upper half of egg-sacks, enlarged 11 diameters.
Fig. 2. Same specimen, lateral view, with egg-sacks shown in full, enlarged 11 diameters.
Fig. 3. Female, partly contracted specimen, viewed laterally and ventrally, enlarged 9 diameters.
Fig. 4. Dorsal view of head and thorax of contracted specimen, similar to fig. 3, showing the manner in which the anterior antennæ may be partly withdrawn on to the ventral surface; enlarged somewhat more than fig. 3.
Fig. 5. Ventral view of anterior part of head, and of the anterior antennæ of same specimen as fig. 4.
Fig. 6. Male attached to posterior part of body of female, enlarged 52 diameters.
Fig. 7. Male, lateral view, enlarged 147 diameters.



EXPLANATION OF PLATE IX.

Chondracanthus phycidis, sp. n. (page 320).

- Fig. 1. Female, dorsal view, enlarged $8\frac{1}{2}$ diameters.
- Fig. 2. Same specimen, ventral view, enlarged $8\frac{1}{2}$ diameters.
- Fig. 3. Same specimen, lateral view, enlarged $8\frac{1}{2}$ diameters.
- Fig. 4. Female, younger specimen, dorsal view, enlarged $14\frac{1}{2}$ diameters.
- Fig. 5. Same specimen, ventral view, enlarged $14\frac{1}{2}$ diameters.
- Fig. 6. Male, lateral view, enlarged 112 diameters.



EXPLANATION OF PLATE X.

Chondracanthus galeritus, sp. n. ♀ (page 317).

Fig. 1. Posterior antennæ, and anterior antenna of one side, enlarged 35 diameters. The shaded portions represent the horny frame-work at the bases of the posterior antennæ.

Figs. 2, 3. Tips of the anterior antennæ of two specimens, showing the slightly lobed termination; enlarged considerably more than fig. 1.

Fig. 4. Posterior antennæ of a second specimen, enlarged 35 diameters. The shaded portions represent the walls of the antennæ and horny basal frame-work, the latter varying greatly in appearance, according to the treatment of the preparation.

Fig. 5. First pair of mouth organs, enlarged 250 diameters.

Fig. 6. Second pair of mouth organs, enlarged 125 diameters.

Fig. 7. Third pair of mouth organs, enlarged 125 diameters.

Chondracanthus phycidis, sp. n. ♀ (page 320).

Fig. 8. Anterior antenna of one side, enlarged 112 diameters.

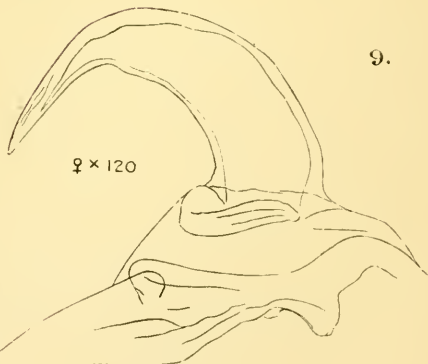
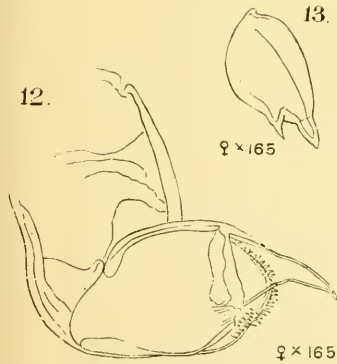
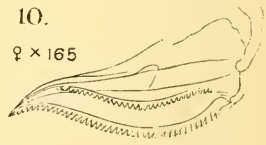
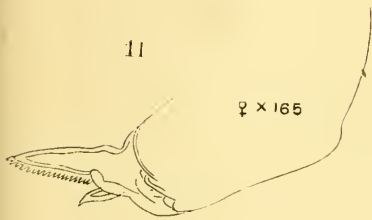
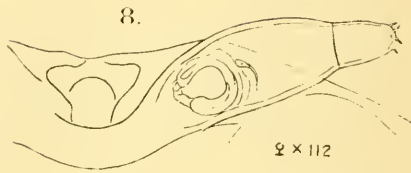
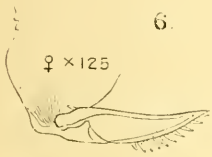
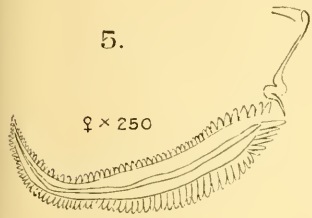
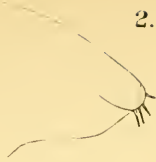
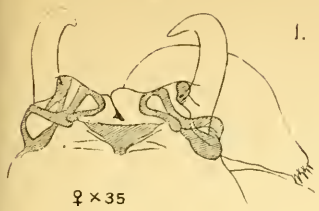
Fig. 9. Posterior antenna of one side, enlarged 120 diameters.

Fig. 10. First pair of mouth organs, enlarged 165 diameters.

Fig. 11. Second pair of mouth organs, enlarged 165 diameters.

Fig. 12. Third pair of mouth organs, enlarged 165 diameters.

Fig. 13. Palpus from side of mouth opening, enlarged 165 diameters.



EXPLANATION OF PLATE XI.

Chondracanthus cottunculi, sp. n. ♀ (page 322).

Fig. 1. Dorsal view, enlarged 11 diameters.

Fig. 2. Ventral view, with male attached to caudal segment, enlarged 11 diameters.

Fig. 3. Lateral view, enlarged 11 diameters.

Fig. 4. Anterior antennæ, basal joints of the second antennæ, and horny basal frame-work of the latter; enlarged 28 diameters.

Fig. 5. Anterior antenna of another specimen, showing an apparent joint near the middle (see page 323), and posterior antenna, roughly drawn; enlarged slightly less than fig. 4.

Fig. 6. Second pair of mouth organs, enlarged 55 diameters.

Fig. 7. Third pair of mouth organs, enlarged 55 diameters.

