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with the kind regards
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DESCRIPTION

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From the American Journal of Science and Arts, No. 2, Vol. xxxiv.

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Read before the Yale Nat. Hist. Soc., Feb. 20, 1838.

The species of the genus Caligus, and of other allied genera, are commonly called *fish-lice*, in allusion to their parasitic mode of life. The individuals which are the subject of the following remarks, infest the Common Cod* of this part of the American coast.

During the fall of the year, when the shoal fish are brought to the New York market,† the Caligi are exceedingly abundant. Occasionally, forty or more individuals may be taken from a single fish. As the season advances, the fish are taken in fewer numbers off Sandy Hook and Long Island, and afford a much smaller proportion of parasites. The Caligi are most numerous on the half-grown fish; they are found indiscriminately on the head or different parts of the body, but never within the gill-covers. A European species has been said to live under the scales: we have never observed this peculiarity in the species on this coast; indeed, the closeness of the small scales of the cod, renders it impossible.

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* It has not been satisfactorily ascertained whether the cod of this coast is identical with the European species, Morrhua vulgaris; this, however, is the common opinion.

† These investigations were made at the city of New York, and occupied the latter part of November last, together with the following months, December and January.

When disturbed, they move with rapidity over the fish, and either backward or forward with nearly equal facility. In swimming, their motion is equally rapid. They thus travel over the body of the fish at will, and, we doubt not, occasionally leave one fish for another.

Both sexes frequently occur on the same fish, though the females (during the months of November, December, and January) have been far the most abundant. The latter are, in general, readily distinguished by the two filiform appendages to the body, which are the external ovarian tubes; or, if these are wanting—as often happens—by the larger abdomen, whose greater size is owing to the eggs it contains. If destitute of eggs, it does not present this peculiarity. The sexes differ, moreover, in the form of the first and third pair of feet, as will be particularly noticed when speaking of these members.

The sizes of the individuals which have come under our notice, have been very various. The adult males frequently attain a length of five ninths or nearly two thirds of an inch, (fig. 2, Pl. III.) The females are always smaller than the males, and seldom exceed a half inch, exclusive of the ovarian tubes, (fig. 3.) The smallest individual seen, was one tenth of an inch long. Its legs had less slender proportions than usual; otherwise, it did not differ from the adults.

The Caligi live several hours on the body of the cod taken from the water; but generally die soon after the death of the fish. When taken from the fish and confined, they exhibit a strong inclination to leave the water. We have often observed, after the introduction of fifteen or twenty into a glass of salt water, that the greater portion of them seek the surface, where they attach themselves to the glass; and quite a number leave the water entirely, crawling up the glass an inch or two above the surface. The water they confine under their broad shell, which is closely attached at its margin, supports them for a while; but, unless assisted again to their element, they remain, without any apparent attempt to return, and in a few hours die.

These animals, like the cod, on which they live, require a low temperature, and have been observed to swim, with scarcely diminished activity, in water that was freezing. In some instances, when the water had evidently reached a temperature below 32° F., without congelation, they have been rendered torpid, and

apparently dead; but on bringing them into a room not above 45° F., they have soon resumed their usual activity. When the temperature has been as high as 60° F., they have generally died in the course of a short time. This may be owing in part to the deterioration of the air in the water, arising from the decomposition of the animal matter contained in it. They die almost immediately when thrown into fresh water.

Although the imperfect descriptions of the European Caligi, by early authors, have been improved by subsequent investigators, still, in consequence of the obscure structure of these animals, their characters are yet very inaccurately described. We have therefore been unable to satisfy ourselves fully, that the species of this coast is distinct from the European. Yet, as many of the characters stated respecting the foreign species, do not apply to ours, we have ventured to propose it as new, under the name given at the head of this article.* The following description, together with the accompanying plates, it is hoped, will enable the future investigator of the European individuals to decide in regard to their identity.

The results of our investigations have shown, that many of the errors of authors are of the most fundamental character. Among the principal of them, we find that a front pair of cups, serving for the attachment of the animal, have been mistaken for its eyes;—the exserted ovarian tubes have of late been considered the respiratory apparatus;—and what is still more essential, as it affects the late classification of the Crustacea, the mouth is supposed to be a sucker, whereas it contains large dentated mandibles, and other manducatory organs, appertaining to the maxillated species. This last character has been proved to belong also to the Argulus, another of the *Siphonostoma*, or *Crustacés Suceurs*, in an article on that animal, in this Journal, Vol. xxxi, 1837.

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* We find in a folio volume by M. Duhamel du Monceau, entitled *Traité Générale des Pesches*, MDCCLXXIII, *Paris*, at page 294, a description of the Caligus found on the Salmon, accompanied by drawings, which, if at all accurate, show that the species are not identical. The same conclusion may be drawn from Desmarest's figures in his Gén. Consid. des Crustacés, if they can be relied on. Other figures that we have seen are so evidently inaccurate, or so destitute of details, that we would not venture to form an opinion from them.

I. Tegumentary System.

a. *Segments of the Body.*

The body of the Caligus is provided with a flexible, subcorneous, and perfectly transparent covering. By dissection, we were able to distinguish only two coats. The internal is a thin, moist membrane, easily separable from the exterior, and often presenting, especially in old individuals, numerous dendritic delineations of an ochre-yellow color. Occasionally, they are so abundant as to give the animal an ochreous tinge. The exterior coat or shell is pellucid, very flexible, and somewhat elastic, and does not exhibit a fibrous structure. In some portions of the shell, and particularly about the eyes, it is divided into areas, as represented in fig. 8, Pl. IV. The shaded subtransparent area in this figure passes longitudinally over the space between the eyes.

When the animal dies, it assumes, after some time, a rose-red tint. Under the microscope, this color is found to be disposed in dendritic delineations, like the yellow color above noticed, and apparently in the same membrane with it; and in a few instances, we are confident that the dendrites which before were yellow, have this reddish hue. We cannot say that this is true of all these delineations.

The body is composed of four distinct segments, (fig. 7,) of which the first two include the head and thorax, and the third and fourth, the abdomen. The anterior of these segments, which we may designate the *cephalo-thoracic*, is divided into four portions, by imperfect articulations. Two of these articulations are longitudinal, and separate the lateral portions of this segment from the central. The other articulation connects the centre of the two longitudinal articulations, like the cross-line in the letter H, and thus divides the central part of this segment into an anterior and posterior portion. The two lateral portions correspond to the united epimeræ of the higher crustacea, and may be called the *epimeral* segments; the anterior of the two central, may be called the *cephalic* portion, and the posterior forms the anterior portion of the *thorax*. The anterior or cephalic segment presents an imperfect articulation near its front margin, which separates a narrow segment; this segment we shall hereafter designate the *anterior* or *first cephalic* segment, and the remaining portion the *posterior*, or *second cephalic* segment.

Viewed as a whole, the *cephalo-thoracic* segment is slightly convex, and has an obtuse ovate form, a little broader posteriorly, with an emargination in front, (A, fig. 7,) and a deep sinus on each side in the posterior margin, (B.) It is bounded, both anteriorly and laterally, by a thin transparent margin, which appears transversely striated, when highly magnified. The lateral margin is about four times as wide as the anterior. A row of extremely minute curved spines project above the junction of the membranous margin, as is exhibited in figs. 1 and 19. Similar spines are scattered over the back; but a very high magnifying power and the most favorable light are required to discover them.

The articulation of the first with the second cephalic segment, though mostly imperfect, approaches a perfect joint towards each side, (C, fig. 7,) where there is an osseous process in the two segments, with opposite articulating surfaces. The process on the first segment is narrow, and transversely oblong. That on the second is long and slender, and extends to a point laterally in advance of the eyes; it is much enlarged at the articulation, and at that place resembles the process on the anterior segment.

The articulation of the cephalic with the thoracic portion of the cephalo-thoracic segment of the body is curved parallel with the anterior margin of the animal, and terminates on each side, near the centre of each lateral half of the cephalo-thoracic segment, (D, fig. 7.) From this point the articulation of the epimeral with the central segments commences. A thin semi-corneous margin extends from the cephalic segment, and covers its articulation with the adjacent parts. The junction of the epimeral and cephalic segments is directed towards the anterior portion of the lateral margin, but becomes obliterated before reaching it; the junction with the thoracic segment is continuous in a curve, concave inward, to the posterior margin just outside of the sinuses in the latter segment. An osseous articulation, similar to that between the two cephalic segments, unites the epimeral and cephalic segments, (E, fig. 7;) the process on the former is long and slender, and curves backward, giving firmness to that portion of the shell.

The *thoracic* portion of the cephalo-thoracic segment approximates to a circular form. The sinuses before referred to, (B, fig. 7,) are situated in its outer posterior margin. Between each sinus and the articulation of the epimeral segment, there is a narrow

lobe, which is provided, on its interior margin, with a folded membrane. The lobe is slightly movable upon a joint at its base, and the membrane has a very free motion, and serves to close the sinus.

The *posterior thoracic* segment (F, fig. 7,) is quite short; its breadth nearly equals one third of the greatest breadth of the anterior portion of the body. Laterally it terminates in an angle, from the posterior side of which, the legs arise which belong to this segment.

The *first abdominal* segment (G,) differs in form in the two sexes. In both, the length and breadth are nearly equal, though in general the former is somewhat greater in the female, and the latter in the male. The sides are much curved in the male, (fig. 7,) and the whole is narrower anteriorly. In the female, (fig. 18,) the form approaches a square with rounded angles. The posterior angles in the male are projecting, and furnished with three short hairy setæ; the same in the female are provided with the same setæ, but they scarcely project beyond the adjoining parts. These peculiarities only exist in the gravid female. When the abdomen is destitute of eggs, it resembles that of the male.

The *remaining abdominal* joint, (H, fig. 7,) has a flattened subovate form, and is about two thirds the breadth of the preceding. Two short leaf-like appendages are obliquely articulated with its posterior extremity. These leaflets are furnished with three terminal plumose setæ or pinnulæ, the ciliæ of which have a length equal to three times the breadth of the seta. There are two short setæ exterior to the pinnulæ, and one interior. These leaflets are ciliated on their internal margin.

b. *Organs appertaining to the several segments.*

1. *Anterior Cephalic Segment.*—This segment presents, in its front emargination, (A, fig. 1,) two minute rounded papillæ, covered on their inner surface with very short hairs, which appear to correspond to the inner antennæ of other crustacea. Below and just behind their insertion we observe a small semicircular process convex outward, which projects a short distance beyond the surrounding surface.

Toward the lateral extremity of this segment, on its lower surface, there is a remarkable organ, which the animal employs in attaching itself, (I, fig. 1 and fig. 19,) but which has heretofore been considered its eyes. It consists of a thin nearly circular

membrane, attached by its central portions. Its surface is finely marked with lines running towards the outer margin; on the inner margin, these lines, though possessing the same general direction, freely anastomose. We have often tested the use of these organs by applying the blade of a knife to the front margin below, while the animal was on its back, when in numerous instances it has adhered with sufficient force to be lifted from the fish and carried some distance. The membrane of the segment extends beyond the cup and curves around over the base of the antenna adjoining, (fig. 7, Pl. IV.) These antennæ have no connection with the cup.

About two fifths of the distance from the cup to the centre of the front margin, we find, on the back, a single slender naked seta. (K, fig. 1.)

The *antennæ* which terminate laterally this first cephalic segment, (L, fig. 1, and fig. 19, Pl. V,) are articulated with it by a joint passing obliquely upwards and inwards, towards the cup. They are two-jointed. The first joint is broad and large at base, and somewhat triangular in form. Its anterior and apical portions are covered with soft ciliated oblong papillæ, (fig. 19,) each of which receives a distinct branch of the large nerve that passes to this organ. They shrink up and become obliterated on drying, and in this respect differ from similar appendages to other parts of the body, and even from the naked setæ that terminate the apical joint of the antennæ. This apical joint is nearly cylindrical in form and is about two thirds the length of the basal. The terminal setæ are of two kinds; those at the inferior part of the apex are slender and acute, and those at the superior part, short and somewhat obtuse. A single naked slender seta, usually curved or bent, may be observed near the middle of the posterior margin of this joint.

2. *Posterior Cephalic Segment.*—The *mouth*, (figs. 1 and 12,) is situated in an oblong mass, which lies entirely external, along the under surface of the body, near the centre of the posterior cephalic segment. This buccal mass is in part a hollow organ, (fig. 12, Pl. IV,) bounded above and below by distinct membranes, a portion of which represent the upper and under lip. It has a lunate opening between the approximating lips, (a a and b, fig. 12,) and contains a pair of strong mandibles and other organs, which we shall soon describe. It is articulated with the cephalic segment by its broad posterior portion.

The lateral and anterior margin of the buccal mass is formed by a slender bone, (c b, fig. 12,) which forms a projection posteriorly where it suddenly curves around inward, and runs backward a short distance nearly parallel with the margin. These bones form the sides to the *lower* membrane of the cavity of the mouth. At the anterior extremity of the buccal mass within, they are connected with several small bones which run to the medial line of the mouth, and constitute part of its manducatory apparatus, (m, l, and n, fig. 13, r, s, t, fig. 17, an under view;) these bones lie either on or in the lower membrane of the mouth. No portion of the *upper* membrane of the buccal mass is connected with the bones of the lateral margin except a small subtriangular piece near the anterior angle, (d a e, fig. 12.) These pieces leave between them and the anterior margin of the buccal mass a semicircular opening; the edges of this opening are furnished with ciliæ, and constitute the lower margin of the lunar opening, or the *lower lip*. This lower lip is divided at its centre, (b, fig. 12,) and the edges thus formed are curved inward, so that in a vertical view several ciliæ are projected together, and have the appearance of one branching cilia.

The whole membrane forming the upper portion of the buccal mass may be called the *upper lip*. It is represented separate in fig. 15. It is united with the lower portions, at its posterior extremity, (p p, figs. 12 and 15.) It may be viewed as consisting of two parts, an anterior movable, and a posterior, apparently immovable. The *movable* portion, which is very much the smallest, is an elliptical, nearly circular, membrane, inserted in a semicircular concavity (a a) in the anterior margin of the *immovable* portion. Its front edge is coarsely subcrenated and furnished with ciliæ. The large immovable portion of the upper lip is bounded by a bony edge, on all sides except posteriorly. At f, (figs. 12, 15,) there is a curved process elongated outward, serving for the attachment of a muscle.

Through the opening between the lips, (fig. 12,) we may observe the two slender bones l, (fig. 13,) and just within these, there are visible, through the membranes, two dentated organs, which, when the membranes above are removed, appear as represented in fig. 14. These organs are the *mandibles*. They are long slender organs with a falciform termination, curved inward and dentated on the interior edge; the number of teeth is about

twelve. The outer margin of the dentated portion is provided with a narrow corneous transparent edge. These mandibles extend backward and pass out of the buccal mass just anterior to the lateral projection, c, (figs. 12 and 13,) and behind the process, f. Here they are connected with a bony tendon, to which the large muscles are attached which move the mandible. The mandibles have no appendages, and are very slightly connected at their base with the membranes of the buccal mass. When the buccal mass is separated from the body by force applied below, the mandibles invariably remain attached to their muscles.

The remaining corneous organs at the extremity of the mouth have been already described as connected with the lower membrane; the two pairs m, l, on the surface of this membrane, and the remaining, in its texture. The pair l, have just been referred to as seen through the opening between the lips. These bones approximate at their apices; at the other extremity they curve backward and terminate under the junction of the two lips, (fig. 13, and a a, fig. 12;) the bones, m, which are situated under the mandibles, are very finely pectinated on their outer margin; they terminate at the same place with the preceding pair.

The remaining bones form a kind of frame work for the lower membrane. Three slender bones r, s, t, (fig. 17,) occupy the extremity of this membrane, and the bones, o, its inner portion. The bones, o, extend backward and enlarge at the posterior part of the buccal mass, (g, fig. 17,) where they serve for the attachment of the muscles elevating the buccal mass. They appear to form by their union at their anterior extremity, (figs. 17 and 13,) a short, oblong process (k,) which is situated between the apices of the pectinated bones, m. The piece, n (figs. 13 and 17,) passes directly outward from this process, and is gradually lost in the membrane.

This complicated apparatus, the buccal mass, appears to be composed of the upper and lower lips, united with the different parts of a pair of maxillæ.

We have often observed through the upper membranes of the buccal mass, and just in advance of the bony arch a, a, fig. 12, an obscure curved line nearly concentric with the anterior margin of the buccal mass, (fig. 12,) which is frequently in motion. From the peculiarities of its action we suppose that there is here an internal opening to the esophagus. Within this inner mouth,

if we may so call it, there are several folds seen below, (fig. 17,) which may be the seat of the sense of taste. Above we observe, (fig. 12,) four fleshy oblong organs extending from a point deeply situated near the base of the esophagus, obliquely upwards to the upper part of the buccal mass. At their lower extremity, they are connected by a slender ligament with the bone, g. These organs appear to close the esophagus. They often open and close in consequence of the similar action of the processes, g, with which they are connected.

The articulation of the buccal mass with the surrounding parts is formed by means of a bony process situated in it below f, and another slender process (h, figs. 12 and 17,) extending backward and outward in the adjacent teguments. A curved bony process, (i, fig. 13,) connects the projection c (figs. 17, 13,) with the process below f, uniting the two portions of the buccal mass.

The remaining organs of the *cephalic* segment consist of four pair of feet, corresponding to the second pair of maxillæ and the three pairs of maxillipeds in the decapodous crustacea.

The *first pair* are three-jointed. The basal joint is broad and oblong, and is connected with the body by its long posterior side. At its inner extremity, which is directed outward nearly parallel with the basal, it curves upward and receives the following joint. The two terminal joints are very different in the two sexes. In the *male*, (fig. 1,) the second joint is large and subconical, with an obliquely truncated apex. It appears to be composed of two joints, but there is no articulation. The terminal joint is obliquely articulated with the preceding; it is small and short, and terminates in two strong curved spines, occupying like horns the lateral portions of the apex. A slender seta is situated on the outer margin, and another on the inner surface near the articulation. The exterior of the apical spines is often brought in contact with a prominence on the apex of the preceding joint. In the *female*, (fig. 18 and 18 a,) the second joint is large, but scarcely longer than its breadth. The terminal joint gradually tapers with an irregular curve to a pointed corneous extremity, which is bent downward at right angles with the preceding part. The basal joint is peculiar in having a stout spine directed backwards, on its posterior margin.

Exterior to the outer portion of the basal joint of this leg, there is a large hooked spine, arising from a broad base, and having an

oblique position. This may be considered an appendage to the maxilliped just described. It is similar in the two sexes.

The *second pair* of maxillipeds are rudimentary. They are situated along side of the buccal mass. The basal joint is a large fleshy mass, having a strong spine directed backward on its posterior side, (fig. 4, a.) Upon this mass near its anterior part, there is a very short cylindrical leg, of a single joint, which bears at its apex a long slender spine, and three or four small seta. It moves in every direction, and the spine is as frequently pointed inward or backward, as in the manner given in the figure.

The legs of the *third pair* are situated each on a fleshy base, just exterior to the spine of the preceding pair. They are long and slender, and composed of three joints. The basal joint is rather longer than the two terminal joints of the first pair, and diminishes very gradually to its apex. The second joint is one third longer than the basal, and about one fourth as large, and is of uniform size throughout. At its apex, below, it has a slender ensiform extension, which is doubly edged with a finely pectinated membrane, (fig. 4, b.) The terminal joint, is very similar to the process just described, but is much longer. A single short spine is situated on the second joint, a short distance from the articulation of the terminal joint.

The fourth pair, the last of those on the cephalic segment, is very dissimilar in the two sexes. In the *male* (fig. 1,) it consists of a very large basal joint, articulated at its extremity with a stout terminal claw, which curves inward and is usually brought in contact with a strong spine near the apex of the basal joint. The breadth of the basal joint is nearly one half its length, except at its insertion, where it is quite small. Between the strong spine just noticed, and the apex of this joint, there is a small fleshy prominence, and a stout spine. The terminal claw has a small seta near its apex.

In the *female*, (figs. 18 and 18 b,) the greatest breadth of the basal joint is scarcely one fourth its length, and it is destitute of the strong spine, near the apex; in some young females we see traces of it, and the leg has more bulky proportions than here stated. The terminal joint is much longer and larger, and more fleshy than in the male; it has a short spine at its apex, and three or four short setæ.

The remaining pairs of legs are four in number; three pertain to the anterior thoracic segment and one to the posterior.

3. *Anterior Thoracic Segment.*—The first two pairs of legs on this segment are natatory, the third is expanded into a broad apron. Preceding the first pair of these legs, there is, on the medial line, a broad furcate corneous process, directed backward, and capable of being elevated or depressed.

The articulations of the two pairs of natatories with the body are very remarkable. These organs not only move on their respective sternums, with which they are articulated, but the sternums have a hinge motion on their posterior margin, in which the legs participate. For this purpose the basal joints are attached to the adjoining parts of the venter by the greater part of their anterior side. The whole distance between the apices of the basal joints in the first pair of natatories, forms thus a single hinge on which the legs revolve; and in the second pair of natatories, the greater portion of the second joint is similarly attached, and for the same purpose.

Several of these joints are provided with long, finely ciliated setæ, or pinnulæ, similar to those terminating the abdomen, which renders them well adapted for swimming. The ciliæ, though very long, are exceedingly slender. The pinnulæ appear to be mostly hollow. They contain a central longitudinal line, which appears on the first view to divide them into two portions; further examination has led us to believe that this is not the case.

The *first pair*, are composed of three nearly cylindrical joints, the first two of which are very similar in size, and the third about one half the length of the preceding. The basal joint has a short movable hairy seta at its apex, and another on its posterior margin; also a very short jointed appendage on the same margin near its extremity. The second joint has a similar seta near its apex and is ciliated on its posterior margin. The terminal joint is furnished on its posterior margin with three long finely ciliated setæ, or pinnulæ, whose length about equals the preceding joint of the leg. The ciliæ are very short on the outer side of these pinnulæ; but of the usual length on the inner. At the apex there are four short obtuse naked setæ. The *sternum* to which this pair of legs is articulated, is very narrow and terminates on each side in a process lengthened posteriorly for articulation with the legs.

The *second pair* of natatories are composed of five stout compressed joints, with a large tri-articulate appendage to the second joint. The basal is very short, and has on its posterior margin a

curved pinnula, which extends over the median line. The second joint is very large and increases in size from its base to its apex. There is a short seta near its posterior margin, and another near its apex. On its posterior edge there is a broad membrane, exceedingly thin and transparent, and finely striated like the margin of the shell.

The *appendage* to this joint arises from the inner part of its extremity, and curves backward and inward. It is provided with seven long pinnulæ, which in general, extend with a curve to the median line of the body; the first joint has one of these pinnulæ, the second two, and the third four. These joints are mostly very flat. The first joint is short and very similar in form to the basal joint of the leg. It is furnished exteriorly with a broad plate, which is ciliated at its apex. The second joint of this appendage, is smallest at its base, and increases with a curve to its apex, which is rounded. Its outer margin is ciliated. A shallow concavity receives the apical joint, which is small and nearly semicircular.

The remaining joints of this leg, are also furnished with seven long natatory pinnulæ, of which one appertains to the third joint of the leg, one to the fourth, and five to the fifth. The third joint is broad and oblong, and is ciliated on its inner margin. A large stout spine, with a thin corneous expansion on two opposite sides, is articulated with the apex of this joint. The fourth joint is shorter than broad, and has a small spine at its apex. The terminal has nearly equal length and breadth, and is obliquely truncated at its extremity. There are two short spines at its apex. The pinnula terminating this joint, is provided with ciliæ only on its inner margin. The other margin is furnished with a thin membrane, which extends from the apex, to an enlargement in the seta near its base.

The sternum uniting the legs of this pair, is quite large; its breadth is one third its length. The posterior margin is somewhat fleshy and thin, and provided with a delicate membrane, whose breadth is nearly as great as that of the sternum. The anterior articulating margin of this sternum is firm and osseous. The adjacent teguments with which it is articulated are similarly ossified, and supported both before and behind by two strong osseous processes, situated in the teguments. The anterior processes are short, and terminate in a curve between the two sternums. The posterior are nearly three times the length of the sternum;

they diverge from their insertion and extend to the base of the apron, (fig. 18.) Here they are united by a slender osseous process, which forms the upper limits of the sternum of the apron. They continue on, making at first one or two irregular curves, and form also the lateral boundaries of this sternum. By this remarkable arrangement, the articulation of the sternum of the large natatory legs is rendered sufficiently firm for their powerful action in the motions of the animal.

The *third pair* of legs has been already stated to be expanded into the form of an apron, forming a broad lamellar appendage to the cephalo-thoracic portion of the body. This apron is composed of the same parts as the natatory last described, and there is an almost perfect coincidence in the number and nature of the appendages.

The sternal piece is very wide and lamellar. On its posterior margin there is a broad membranous expansion, identical in structure and position with that appended to the preceding sternum. The portion of the apron corresponding to the small first joint of the natatory leg, is very narrow, and has very imperfectly defined limits; we see an indication of its presence in the single pinnula, behind, adjacent to the sternum.* The second joint is expanded into a broad, irregular trapezoidal figure, with concave sides excepting its posterior margin. Like the same joint in the natatory, it is furnished with a broad thin membrane posteriorly, and a jointed appendage provided with pinnulæ. The first joint of this appendage is quite small, and bears a single pinnula as in the perfect leg; the remaining portion is circular and is furnished with six pinnulæ. We find the analogue of the third joint of the natatory in a broad nearly circular plate, which is the lateral termination of the apron; it is connected with the basal portion by an indistinct suture. The posterior margin of this joint, like the same joint above, bears a ciliated leaf-like expansion. The analogy of the parts is still farther apparent in the strong articulated spine and pinnula attached to this joint, and in the two small terminal joints, furnished with pinnulæ; the first with a single pinnula and a spine at its apex, and the second with four pinnulæ, and two short apical spines.

* The corresponding parts of the apron, and the second pair of natatories, are indicated in the figure by the similar numbers in them.

4. *Posterior Thoracic Segment.*—The legs attached to this segment arise from the posterior part of the lateral surface. They are composed of four joints, which gradually diminish from the base to the apex. The basal joint is large, nearly cylindrical, and irregularly rounded at each extremity; there is a short hairy seta at its apex. The second joint is scarcely half the diameter of the preceding. It gradually diminishes to a pointed apex, furnished with a curved spine. The third joint is flat, and is articulated, by its obliquely truncated base, with the inner side of the preceding joint. There are two long setæ on its inner apex, which are edged on two opposite sides with a pectinated membrane. There is a short pectinated appendage, projecting like an epaulette over the base of each of these setæ, and also over the articulation of the following joint. This terminal joint is long, slender, and setiform. It has a row of short spines along its inner edge.

5. *Abdominal Segments.*—The anterior abdominal segment is entirely destitute of any articulated appendages. Posteriorly, on each side, there is a broad lamellar sub-triangular organ, which, in the male, is much elongated, while in the female, excepting young individuals, it is very short.

The appendages to the terminal joint have already been described.

Change of Skin.—But few facts have come under our observation respecting the change of skin; these few, however, appear quite peculiar and worthy of remark.

When the time for shedding the old skin approaches, the internal membrane, which is to form its new envelop, is very variously folded into ridges throughout the whole body. In some parts, the ridges or folds are situated around the bases of the muscles, and enclose regular areas. These folds continue increasing in size, till the time of moulting. This process produces a singular arrangement of the *anterior* portions of the inner shell, or, we may say, inner animal, as it affects the form of the included parts. The centre of the front margin of the internal shell is drawn inward and backward, as represented in fig. 23, Pl. V, in which c d represents the outer margin, and c′ n d′ the corresponding edge of the inner shell, e f the articulation in the old shell, and e′ m f′ the corresponding articulation in the inner.

These folds undoubtedly result from an increase of the animal within a shell too small to admit of its expansion. The internal

members, like those of animals having a soft skin, appear to increase in actual quantity of matter, as rapidly when enveloped in their unyielding corneous covering, as in their new membranous envelop.

There is a remarkable fleshy appendage to the anterior portion of the soft internal animal, the importance or functions of which we are unable to explain. It is represented at m n, fig. 23, in its natural position. It lies wholly external to the inner shell, and is attached only at o, its anterior extremity. Figure 24 is a profile view of this appendage; similar letters mark the corresponding parts in the two figures. After separating the outer skin, it may be drawn forward into the position in fig. 25. In one instance, we found an animal with this singular appendage, in front, presenting very much the appearance in fig. 25. It was, however, composed of three of these appendages, m n, placed end to end, and appeared to have undergone three successive moultings.

In external appearance, this organ very much resembles a muscle, as it is striated, like them, though very coarsely. It is probably attached, by its large extremity, to the outer shell.

II. Muscular System.

The muscles moving the several members, may, in general, be distinctly seen and traced to their insertions through the pellucid covering of the body. Yet, under a magnifying power of five hundred diameters, we have not succeeded in detecting the ultimate fibres as given by Straus. With a much lower power, however, we have observed that all the muscles appear transversely striated, and by means of this important character, have been enabled to distinguish the nerves from the muscles, which, without this aid, would in many instances have been difficult or even impossible. These striations are most distinctly seen in the flat, simple muscles; those composed of several bundles of fibres, which is the case with many of the large muscles on the back, exhibit it, but less perfectly. We have examined the muscles of the common lobster, (Astacus marinus,) and have found these striæ in some instances, though with less distinctness. These striations vary much in their fineness. In general, they are from $\frac{1}{7000}$ to $\frac{1}{8000}$ of an inch apart. In some muscles, among which we may mention those elevating the buccal mass, we found them as coarse as $\frac{1}{3000}$ of an inch. We have conjectured that they are

the result of minute folds in the muscular fibres; but we have been unable to detect an approximation of these striæ, or any alteration in their appearance, during the contraction of the muscle: this, however, may be owing to their extreme minuteness.*

On account of the very peculiar forms and motions of some of the organs in this animal, it contains several muscles of very unusual character. We reserve the description of them till these organs come under consideration.

a. *Muscles of the Segments of the Body.*

The first cephalic segment is flexed by two short slender muscles on each side, (R, R′,) situated just exterior to the process which forms the articulation of this segment, (figs. 1 and 7,) and directed backward and outward. They unite in a common short tendon. They act in depressing this segment, and assist in attaching its cup and anterior margin. This margin is provided with a narrow ridge, which is striated or wrinkled transversely, like the cup, and is apparently intended to produce a closer attachment of this margin.

For the mutual motions of the cephalic and thoracic segments, there are three pairs of muscles situated in the former, two attached near the median line, and one pair laterally. A pair of short muscles (I, I, fig. 7) run nearly parallel with the median line; they produce the slight flexion admitted at this articulation. Another pair of muscles, long and large, (S, fig. 7,) are situated on each side of the preceding; they pass obliquely outward. In addition to aiding in flexion, they produce a lateral sliding motion, often observed between these segments. A third pair (K, fig. 7,) also assist in flexion. The large muscles, (K′,) situated in the posterior segment, appear also to pertain to this joint; but we are not fully assured that this is really their insertion.

The extensor muscles of the posterior thoracic segment, and of the abdomen, arise adjacent to the median line, near the centre of the anterior thoracic segment. Three pairs of muscles are attached at this point. The outer (L) pass obliquely outward and

* Since writing the above, we have found that these striations have been observed by Dr. Hodgkin in the muscles of man. He says: "Innumerable very minute but clear and fine parallel lines, or striæ, may be distinctly perceived, transversely marking the fibrillæ." These observations have led Dr. Hodgkin to doubt the globular constitution of the contractile fibre. We have also observed them distinctly in some of the Arachnides.

are inserted near the apex of the thoracic joint. The two pairs (M, N,) appear to continue through the thorax, to the last joint of the abdomen. Another pair of muscles (O) commence in the thoracic joint, near the median line; they pass obliquely outward to a point in the first abdominal segment, just below its centre, where they are inserted into the teguments. Another pair of slender muscles (P) arise near the insertion of the last, and pass to the following segment.

The flexor muscles of these segments, situated along the venter, are remarkable for having but two anterior attachments, although, counting the several insertions in the posterior segments, there appear to be six distinct muscles. Two broad muscles arise on each side of the medial line opposite the prehensile legs. As they pass between the sternums of the natatory legs, they divide into three portions as represented in fig 5 a, Pl. I. The large muscle here suddenly contracts in size, and afterwards continues on, much diminished in volume; exterior to this continuation two muscles are attached, each by a tendon, to the diminishing portion of the main muscle. Though apparently distinct, these three muscles continue connected, and pass on beyond the sternum of the second pair of natatories, where there is a second subdivison of the muscle. We observe an oblique constriction of the whole, (fig. 5, b,) below which, the three muscles are continued of nearly their former size, and a fourth is added, exterior to the three. Thus divided, the muscle continues into the abdomen, where the four parts are separately inserted: the exterior pair diverge and are attached near the base of the abdomen; the interior, are inserted below the centre of the abdomen, directly under the insertions of the extensor muscles of the back; the two remaining pairs are continued into the terminal abdominal segment, the outer passing beyond the centre of this joint. Another pair of small muscles are inserted in the base of this joint, which arise near the attachment of the interior pair of abdominal muscles.

The other set of muscles, consisting of two pair, arise a short distance below the sternum of the posterior natatory, exterior to the muscles just described. One pair, the outer, is inserted in the base of the thoracic joint, and the inner, laterally below the centre of the abdomen.

The lateral motion of these joints is produced by the simultaneous action of the flexor and extensor of the same side. The in-

sertion of the more powerful of the abdominal muscles below the centre of this segment, in preference to an attachment near its base, enables the animal to give this segment great flexion. When the animal has been attached to the glass out of the water, we have often separated the anterior portion of the body from the glass, till it formed an angle of 75° or 80° with the abdominal portion, and generally the animal has succeeded through the action of these muscles in restoring its head again to the glass.

The muscle (O) on the back may possibly be attached to the muscle (N) and not to the thoracic segment. We have not succeeded, in our dissections, in exposing these muscles in order to determine this point.

b. *Muscles of the organs appertaining to the several segments.*

1. *Anterior Cephalic Segment.*—In the following account, we shall in general describe only the muscles moving the basal joints of each of the legs. More minute particulars may be obtained by reference to the plates.

The muscles moving the cup, have not been satisfactorily determined. A slightly elevated line passes from each side with a curve into the membrane of this organ, which may be muscular; if so, they act in flattening the cup preparatory to its attachment.

The antennæ have two extensors and one flexor. The two extensors are inserted in a tendon, occupying the anterior margin of the base. They extend half way to the eyes; one (a, fig. 7 and fig. 1) above the flexor of the anterior cephalic segment, is attached to the upper shell; the other, (a′, fig. 1,) much the smallest, passing under the same muscle, is attached below. The flexor (b, figs. 7 and 1,) is inserted near the outer part of the base, by means of a short tendon, and is attached near the base of the preceding muscles. These organs have but little motion, and are seldom observed in action.

2. *Posterior Cephalic Segment.*—The elevators of the *buccal mass* are four short narrow muscles, inserted in the bony processes, g, (figs. 12 or 17,) and attached to the teguments below, under the anterior extremity of the mouth; the insertion of one is exactly posterior, and of the other, a little lateral, as is represented in fig. 17. By means of these muscles the buccal mass may be elevated to a right angle with the surrounding parts. On dying, the mouth is often left in this elevated position. A muscular band passes across the back part of the buccal mass and after

attaching itself to the curved process, f (fig. 12,) on each side, continues on, and is inserted in the shell. At c, (fig. 7,) near the eyes, we observe the attachment of a pair of muscles which are in action when the buccal mass moves; we have not detected their insertion, but suppose from their position that they act in depressing it.

The internal parts of the mouth which receive distinct muscles are as follow: the upper lip, the mandibles, and the parts of the inner mouth. The upper lip is provided with two pairs of retractors which are attached near the centre of the exterior membrane of the mouth. The interior pair are very slender; they are inserted in a minute process near the extremity of the lip, (fig. 15,) and move merely the extremity, giving it the position in fig. 16. The exterior pair are four times the width of the interior; they are inserted near the middle of the lip and retract this organ nearly to the bony arch.

The mandibles are provided with muscles of extraordinary length and power. There are two pairs connected with the same slender bony tendon, the one with its extremity, and the other with its posterior side. The former, (d, figs. 1 and 7,) pass outward and a little downward, and on approaching the apex of the basal joint of the third pair of maxillipeds, curve suddenly backward; they are finally inserted in the margin of the shell opposite the articulation of the head and thorax, after having run over a space equal to one half the whole length of the cephalo-thoracic segment. The other pair extend obliquely backward and outward under the base of the rudimentary feet. Although these organs are provided with such remarkable muscles, they are very confined in their motions. They occasionally have a vibratory motion when the animal is nearly exhausted, and this is the only action we have observed. Their position and the form of the adjacent parts satisfies us that their extremities cannot be projected out of the mouth; and probably they can scarcely reach the opening between the lips.

On account of the thickness of the enveloping membranes, and the difficulty of dissecting the internal parts of the buccal mass, we have not discovered the muscles moving these parts. We can only specify one pair of slender muscles, which are inserted in the lateral portions of the process g, (fig. 17.) It is the retractor of these processes, and through them opens the folds which

close the esophagus, by means of a tendon inserted in the lower extremity of these folds.

The basal joint of the *first pair* of *maxillipeds* has but little motion. There are two short muscles, elevating or depressing the extremities of this joint, which we may consider a flexor and an extensor. The flexor, which is inserted near the interior extremity, is directed backward and a little outward to its attachment to the lower shell, exterior to the base of the following pair of feet. The extensor is inserted at the posterior margin of the joint, and extends obliquely inward, approaching the attachment of the flexor. In the female these muscles have nearly the same position as in the male (fig. 18 a;) the flexor is inserted near the spine on this joint. The united action of these muscles draws the anterior margin of this joint from the shell. To oppose this motion there is a large muscle inserted near this margin and extending one side below the eyes, (e, fig. 7,) where it is attached to the back shell.

The extensor of the second joint of this pair of legs is a long broad muscle attached to the shell above the large curved spine, (f, fig. 7.) There is a small flexor of this joint, attached to the posterior apex of the basal joint.

The rudimentary feet, or *second pair*, are provided with but few small muscles, requiring no remarks.

The *third pair* are remarkable for having as various motions as could be afforded by a ball and socket joint. This arises from their insertion on a fleshy prominence, composed probably of the rudiments of the small basal joints in the corresponding organs of the higher crustacea. To produce these various motions, each leg is provided with five muscles radiating from the base, some of which are of very peculiar form. Four of these muscles are inserted into the base of the first joint and one along its posterior margin. The latter appears to be attached to the back near the median line, a short distance behind the eyes, (g, fig. 7.) Of the remaining muscles, two pass forward and outward, (h, i fig. 1 and fig. 7,) one directly outward, and the fourth, (k, fig. 7,) backward and outward. The most anterior (h) is a slender muscle, attached just exterior to the base of the first pair of maxillipeds. The second (i, fig. 1 and fig. 7) is composed of two parts inserted into the same tendon. These parts continue together through half their length, then separate, and soon after each di-

vides into two nearly equal portions, which diverge under the large curved spine and pass to their attachment at the margin of the shell.

The base of the *fourth pair* of maxillipeds has a narrow prolongation, which affords attachment to two muscles; one passes posteriorly, and is attached near the articulation of the head and thorax, (m, fig. 7,) another extends outward in front, beneath the extremity of the adjacent spine. Two other short muscles are inserted at the base of the prolongation, and are also attached near the spine; one on the back, and the other below. The last of the muscles moving this pair of legs, extends outward and is attached to the epimeral articulation, (l, fig. 7.)

The terminal claw is provided with flexor muscles of great strength. A large conical muscle attached along the whole posterior margin, is inserted in a bony tendon extending from the inner portion of the base of the claw. Another large muscle arises from the basal portion of the joint and is inserted into the preceding muscle a short distance from its insertion. There is the same arrangement in the female, (fig. 18 b.) A small extensor is inserted in the outer part of the base of the claw and attached to the outer posterior margin of the first joint.

3. *Anterior Thoracic Segment.*—The two legs of each pair of natatories, have been described as simultaneous in their action, which consists in their rotation with the included sternum, on their anterior margin.

The principal elevator of the *first pair* of natatories is a large digastric muscle. This muscle occupies the space between the basal joint of these legs and the preceding pair. It is composed of four muscles which unite in a common tendon; this tendon passes under a curved osseous process, by which it is confined in its place, and is then united to another bundle of muscular fibres inserted in the lower surface of the leg. The depression of these legs is produced by a long muscle which is inserted in the joint near its base; it is directed forward and outward, passing under the digastric muscle beyond the articulation between the head and thorax, and is attached to the epimeral articulation (n, fig. 7.) This pair of legs, though thus provided with muscles of considerable strength, is seldom used by the animal in effecting its motions.

We have already seen that the *second pair* of natatory legs are well adapted to form powerful propelling organs; that the

flabelliform arrangement of their pinnulæ, the attachment of these pinnulæ to two distinct articulated branches, added to the flattened form of the joints, give the oars a broad expanded surface for action on the water in swimming. They are farther fitted for this object by the provision of a large number of powerful muscles, which occupy nearly the whole of the thoracic segment.

Inserted in the anterior part of these legs, there are three large muscles attached to the back shell, two of which (o, p, fig. 7) arise on the median line—a third (q) at the articulation between the head and thorax. Four powerful muscles are inserted in its posterior margin; the three outer (u, t, s,) pass backward, and are inserted in the posterior and medial part of the segment above. The fourth (r) is attached to the back shell over the anterior part of the base of the leg, near the medial line of the body; it first passes inward and backward, then curves outward around the base of the muscle adjoining, (s,) and finally extends upward to the posterior margin of the leg. The circular form of this muscle is so very extraordinary, that we at first doubted its muscular nature. We have however assured ourselves of this fact by frequent dissections. Two other short muscles with converging fibres, (w, v,) arise laterally from a broad base in the epimeral articulation, and serve to retract the leg to the shell. These muscles probably cooperate with the posterior, in the depression of the leg.

If these oar-like legs struck the water with the same broad expanded surface, in their backward motion, as in their forward propelling action, the animal would advance but slowly, if at all; for the latter would be counteracted by the former. There is a provision against such a defect, in the muscles moving the several joints of these legs, by the action of which, the terminal portions receive a partial revolution, and cut the water, when drawn backward, by their thin anterior edge. Their special adaptation for this purpose is apparent, even in the pinnula terminating the leg, which instead of being ciliated on both edges, is furnished anteriorly with a thin membranous expansion.

These legs appear to be the only organs for walking as well as swimming.

The principal extensors of the *third pair* of legs, or the *apron*, are four in number; two (y, z) arise on the back near the medial line, and pass laterally to the outer insertion of the apron. One

of the remaining two, (x,) arises just above the posterior sinus, and the other from the inner margin of this sinus; both are attached on the back, and inserted near the articulation of the sternum. The flexor muscles arise below, just outside the apron, and occupy the greater part of its interior. A single muscle is attached near the articulation of the sternum, and passes into the basal portion.

This apron, appended to the cephalo-thoracic segment, forms the anterior portion of the body into a large, broad cup, which is perfectly closed, with the exception of a small opening at each of the posterior sinuses. These we have already described as provided with a folded membrane, furnished with muscles capable of drawing it over and completely shutting the opening. The membranous margin of the animal near the antennæ, has also a fold by which a small leak, if it be such, is closed. Considering these several provisions, it is probable, that the whole of this anterior portion of the animal is especially adapted to enable the animal to attach itself firmly during the rapid motions of the fish, and that the small marginal cups in front are relied on, only while the fish is stationary, or but slowly moving.

The remaining pair of legs are moved by short slender muscles, and seem to possess little power. They usually hang loose and motionless while the animal is swimming, and when attached to the body of the fish, are commonly extended by the side of the abdomen.

III. Nervous System.

a. *The organs of the senses.*

The only organs in the Caligus, which we have been able to distinguish as the undoubted residence of special senses, are the eyes and the antennæ. The latter organs have already been described; it remains to explain the structure of the eyes.

The *eyes* are wholly *internal*, and are situated near the centre of the posterior cephalic segment, directly over the lower part of the buccal mass. They are two in number, simple in their structure, and placed near one another, on a single reddish-black ground. They project from each side of this colored ground, with a spherical surface, somewhat exceeding a hemisphere. On dissection we readily distinguish the following parts.

1. A *cornea*, which is thin and transparent and forms the spherical surface of the eye:

2. A *lens*, simple, spherical, and distant from the cornea; its diameter is about half that of the cornea:*

3. A colorless, transparent fluid, which we presume to be the *aqueous humor*, occupying the space just within the cornea:

4. A deep red, nearly black *pigment*, which forms the colored spot supporting the eyes.

We have not observed the vitreous humor. In the spherical form of the lens, the eyes resemble the same organs in fishes. They are not movable, and have no connections except by the optic nerve. The adjacent parts are transparent, enabling the animal to see in both directions. We have already described the shell above, and referred to its representation in fig. 8, Pl. IV. It is perfectly flat, without any spherical projection, corresponding to that of the cornea within. The translucent elongated space in fig. 8, lies in the shell, and passes over the space between the eyes.

b. *The nerves.*

The nervous system contains but two ganglions, and these by their close approximation appear at first, to compose but one. They are situated directly behind the eyes, the one above the esophagus, and the other below it, and are so intimately connected on each side of this portion of the alimentary canal, that it has been found impossible to separate them, (fig. 20.) Indeed, it would scarcely convey an incorrect idea of the *form*, to describe it as a single mass, with a longitudinal cavity through the centre, for the passage of the esophagus. The size of the united ganglions is rather greater than that of the buccal mass. The nerves arising from these ganglions are flat, fibrous cords, enclosed within a membranous envelope or neurolemma. This neurolemma is often one fourth wider than the bundle of nervous fibres contained within, and these fibres appear to pass through without any attachment. The neurolemma is sometimes slightly folded, which gives a crenated appearance to the margin of the nerve.

The *brain* or cephalic ganglion has a broad ovate or sub-cordate form. It gives off three pairs of nerves.

The first pair, (a fig. 20, Pl. IV,) leaves the central part of the anterior margin and passes directly to the eyes. As the eyes are adjacent to the ganglion, these nerves are very short.

* The lens in the simple eyes of crustacea is usually described as being in immediate contact with the cornea: it was very evidently distant from this membrane, in the Caligus.

The second pair, (b fig. 20,) arises from the same margin laterally, and extends upward towards the cup, (fig. 18,) passing just within the articulating process of the cephalic segments. It gives out large branches which are distributed to the surrounding muscles and teguments. The anterior extremity which goes to the cup is scarcely one third the size of the base.

A small hollow vessel, (fig. 18,) extends from the organs which we have considered analogous to the inner antennæ in other crustacea, along the median line, and appears to terminate in a bulb, about half way to the brain. This vessel has been the subject of much investigation, without removing all the doubts respecting its nature. When separated from the body, it appears to be a large neurolemma, containing two small bundles of nervous fibres, and this is our final conclusion, though adopted with some hesitation. It appears probable, from the result of some of our dissections, that this bulb receives a nerve from each side, which either arises directly from the brain, or, is a branch of the nerve last described. If this is a distinct pair, it corresponds to the *third*, or inner antennary pair in the lobster, as given by Edwards, and the pair described as passing to the cup, and surrounding teguments and muscles, is the analogue of the *fourth* pair, which has a similar distribution in the lobster.

The remaining pair of nerves, (c,) arise from the anterior angles of the brain, and pass to the antennæ; they are one half larger than any other in the body. Near the origin, they give off exteriorly a slender branch, which continues nearly parallel with the main nerve, and passes to the muscles of the antennæ. Without farther branching they extend in nearly a straight line to the base of the antennæ, where they subdivide into four large branches, which are distributed to the fleshy papillæ, (fig. 19, Pl. V.) Two nerves from the posterior branch run along the muscles, and are continued into the terminal joints, one to each of the two terminating sets of setæ. The antennæ are so abundantly furnished with nerves, that they must be the seat of an important sense. The sense of touch is the only one for which their peculiar form, and their delicate papillæ, appear adapted.

The thoracic ganglion, which is composed of all the thoracic and abdominal ganglions united, has a cordate form, and is somewhat larger than the brain. Its inferior extremity extends rather

farther beyond the brain, than the brain beyond it in front. This ganglion gives off seven pairs of nerves in front and laterally, and two pairs behind, besides a central nerve or the spinal cord.

The first two pairs originate at the centre of the anterior margin, (d, e, fig. 20.) The inner is quite slender and appears to enter the mouth each side of the esophagus. The second has twice the diameter of the first; it curves more outward, and is supposed to go to the mandibles and their muscles. These nerves pass under the buccal mass, and cannot be traced while it is in its natural position. They invariably appear broken off when the buccal mass is removed; and sometimes after detaching it, a nerve equal in size to the first, has been seen entering the mouth near the esophagus, as above stated. These facts have been deemed sufficient to authorize the above opinion respecting the destination of these nerves.

The *third* pair (f, fig. 20) arise from the anterior angle of the ganglion. They give out a branch exteriorly to the muscles of the first pair of legs, and afterwards continue to these organs, and pass into the terminal joints after giving a branch to the basal.

The *fourth* pair (g) arise just posterior to the last, and are distributed to the outer teguments. They afford a branch near their origin, which probably passes to the rudimentary legs: soon after they divide into two parts; one branch passes outward and a little forward towards the curved spine, and subdivides into four branches before reaching it, which are distributed to the neighboring teguments; the other branch, extends backward to the epimeral articulation, just below the articulating processes, where it passes to the epimeral segment; it then branches, and is distributed to the various parts of the inferior portion of this segment.

The *fifth* pair (h) arise from the lateral margin of the ganglion, some distance behind the preceding. They give off a slender branch near their origin, and pass along with the branch to the third pair of maxillipeds.

The *sixth* pair (i) arise near the preceding, and are large nerves. They divide immediately, and then subdivide into several branches, which are distributed to the fourth pair of maxillipeds, and their muscles.

The *seventh* pair (k) originate near the last, soon divide into two branches, which pass to the muscles of the same legs. They are slender nerves.

These seven pairs appear to correspond to those of the first thoracic ganglions in the macrural crustacea. The remaining nerves pertain to the thoracic legs, and the abdominal portions of the body.*

The outer pair (l) belong to the anterior natatories. They continue parallel with the spinal cord till they reach the furcate process on the venter; they then curve outward, exterior to the ventral muscles, give off three branches in succession from the outer side, to the muscles of the first natatory. Before entering the basal joints of these legs, they divide into three portions, which enter together; the inner branch is quite slender, and passes to the posterior movable seta, and the jointed appendage; the middle is distributed to the muscles of the basal joint; the outer branch gives a slender nerve to the apex of the basal joint, and then passes to the two following joints, dividing as it enters them. We refer for minuter details to figure 18, Plate V.

This pair of nerves give off a slender branch near their origin, (r, fig. 20,) which passes to the attachments of the stomach.

The next pair of nerves (m) are distributed to the second pair of natatories. They diverge from the spinal cord—to which they are adjacent—below the furcate process, and soon give off a branch

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* The apparent correspondence of these nerves, with those of the first thoracic ganglion in the higher crustacea, together with the great similarity in the last two pairs, to those which are distributed to the posterior pair of maxillipeds in the decapodous species, (see Edwards's Hist. Nat. des Crustacés, T. I. p. 137) have induced us to adopt the designations heretofore employed in speaking of the organs of this segment of the body, in which we consider the three posterior pairs of cephalic legs as the anologues of the three pairs of maxillipeds in the typical species. The only objection which can be urged to this view, arises from there then being but *four* pairs of thoracic legs. This objection will however be removed if we may consider the furcate bone on the venter, just anterior to the first pair of natatories, as the rudiment of the sternum of a fifth pair, which view is favored by its position, and its resemblance to the sternums of the following pairs.

If this conclusion is correct, the twenty-one rings, the *normal* number constituting the body, may be considered as distributed in the following manner:

The *anterior cephalic* segment, includes the second and third, as the first—the ophthalmic—is wanting. The *posterior cephalic* segment, contains the following six, corresponding to the mandibles, (fourth,) and a pair of maxilla, (fifth,) in the buccal mass; and the four pair of feet attached to this segment. The *anterior thoracic* segment will include the tenth, eleventh, twelfth and thirteenth rings, to which the furcate process, the two pairs of natatory legs, and the apron, pertain. The *posterior thoracic* segment, is the fourteenth ring. The remaining seven rings, the abdominal, constitute the terminal portions of the body; some of these last may however be wanting.

interiorly, which passes down the venter, and appears to be distributed to the ventral muscles. As they approach this pair of natatories, they give off another branch from the same side, which also passes backward, and is supposed to furnish nerves to the posterior muscles of these legs. On entering these natatories, the nerve divides into two branches, the upper of which soon gives off a third; the inner nerve, as in the preceding legs, goes to the posterior seta, and the articulated appendage; the middle furnishes the basal joint, and sends a branch into the terminal; the outer affords a small nerve to the seta at the apex of the basal joint, and then passes into the extremity of the leg.

This pair of nerves give off a branch exteriorly near their origin, (s, fig. 20,) which curves outward under the furcate process, (s, fig. 18,) *beneath* the ventral muscles, gives a nerve to these muscles, and is then distributed to the anterior muscles of the second pair of natatories, and to the adjoining teguments. Its branches may be seen at s′, s″, fig. 18.

The spinal cord, furnishes the nerves to the remaining members. It appears to be composed of two parts near its origin, but there is no division till it has passed beyond the sternum of the second pair of natatories. Previous to this division, a short distance below the sternum, this spinal cord gives off from each side a large nerve which goes to the apron. These nerves are seldom exactly opposite in their origin; as is also the case with the nerves, r and s, fig. 20.

The nerves to the apron, just before entering it, give off a branch exteriorly, which is distributed to the outer portions of the apron, or more properly its terminal joints. Soon after entering the apron the main nerve again divides, and one branch is distributed to the basal part, and the other to the muscles of the following portion of the apron.

The spinal cord, after giving off the nerves to the apron, soon divides. Thus divided, it gives off a pair of nerves to the remaining thoracic legs, and on entering the abdomen, furnishes a pair of nerves which branch in this segment. It thence continues to the last segment, and distributes fibres to the terminal portions of the body.

IV. Nutritive System.

a. *Organs of digestion.*

The alimentary canal, (fig. 9, Pl. V,) is composed of three distinct parts, corresponding to the esophagus, the stomach and the intestine.

The *esophagus* constitutes one sixth the whole length of the alimentary canal, and in large individuals is about one sixteenth of an inch long. It extends in the form of a long slender tube of uniform diameter to the stomach, and passes a short distance into its cavity. Its insertion in the buccal mass may be seen in fig. 17, which is an under view of this organ. The anterior opening is closed by two fleshy folds, which have already been described when speaking of the organs and muscles of the buccal mass. At its commencement, there is an oblong enlargement, (fig. 10,) longitudinally striated, which may be considered a pharynx. The communication with the stomach is closed, but whether by a sphincter or valve is undetermined. The peristaltic motion frequently seen in the stomach and intestine, never extends into the esophagus.

This portion of the alimentary canal is readily separated into two membranes. The inner, the mucous coat, is thin and transparent, and very smooth. The outer is much thicker, and scarcely semi-transparent; its muscular fibres are not apparent. When highly magnified, its exterior surface appears very uneven. If the mouth is detached from the body with care, the esophagus often continues attached to it, and presents the appearance exhibited in fig. 17. The inner coat is usually entire to its termination in the stomach, while the outer which is continuous with the exterior membrane of the stomach is invariably torn off, not far from the base of the esophagus, as in the figure.

The *stomach* has a broad cordate form, and is a little shorter than the esophagus, and when expanded is somewhat wider than long; vertically it is quite narrow. The anterior extremity lies between the prehensile legs, and posteriorly it extends under the furcate process on the venter. The lateral margin is very deeply crenated, owing to the peculiar arrangement of its muscles. The teguments of the stomach are composed of the same coats as the esophagus, and they present the same general character. The inner appears uniformly smooth and even. The outer contains

several muscular bands, which connect the opposite crenations; in their contraction the crenations are rendered more prominent. These muscles are connected by other slender muscles irregularly arranged, which contract the stomach longitudinally. The lateral portions of the stomach are connected on each side with the shell adjoining, by ligamentous or cellular attachments, as is represented in fig. 9. There is no valve between the stomach and the intestine, and when the peristaltic motion is reversed, as often happens, the fluids frequently return into the stomach.

The *intestine*, at its commencement, is between three and four times the diameter of the esophagus, and about one fifth the diameter of the stomach. It is slightly enlarged below the second pair of natatories, where there are two pairs of glands, contracts again as it passes below the apron, and thence continues of uniform size to the rectum. Its structure is very similar to that of the stomach, both in its inner and outer coat. The arrangement of its muscles in regular bands is represented in fig. 11; during their action the canal is crenated as in the figure. The intestine is attached by distinct ligaments at several places; near the glands, d, and the glands, e and f, we have distinctly seen these attachments.

The *rectum* occupies the terminal half of the last abdominal segment, and is about one half the diameter of the intestine. Its communication with the intestine, is closed in the natural state of the parts. This rectum, if it may be so called, appears to have a longitudinal opening below, extending its whole length and its walls are usually in close contact. The external opening or anus is situated at its extremity.

This portion of the alimentary canal is opened laterally by seven pairs of slender muscles. The first pair at the extremity pass directly outward along the margin of the joint; the second are inserted near the extremity, and pass upward and a little outward. The following three pairs, are attached near the middle, and pass outward and a little upward; the remaining two pairs, are inserted near the opening to the intestine, and have the same direction as the last. The muscles have often been seen in action, in expelling the fæces; the two sides move either simultaneously or alternately, according to the necessity of the case, in the act of expulsion.

The intestinal fluids are usually light yellow; occasionally they present a deep wine yellow color, especially below the sternum of the second pair of natatories. Solid vermiform masses of a brown color, are often seen floating in the fluids.

Along the alimentary canal, there are several small glands, which have a granulous structure and are in general but slightly colored. Their particular functions, are mostly conjectural.

The central projection between g, g, fig. 12, is the termination of a gland of considerable size, which is situated beneath the posterior extremity of the buccal mass, and is usually detached with it, on dissection. It is represented in fig. 9, a, where its size corresponds to the mouth in fig. 9. When separated from the mouth, a duct may be seen on each side, entering the mouth near the esophagus. Anterior to the mouth, another collection of glands is observed, (fig. 9, b, see also fig. 1,) which also communicate with the mouth by ducts. These are probably salivary glands.

The esophagus, especially near its base, is furnished with a large number of exceedingly minute, transparent globules, supported on short pedicels, (fig. 10, Pl. IV.) These appear to be glands, and their pedicels ducts.

Below the stomach in the thorax, there are four pairs of glands. One pair of nearly spherical form, are situated at the lower extremity of the stomach, (c, fig. 9.) The second pair, larger, of an oblong form, (d,) occur just below the sternum of the first pair of natatories, and are connected with the intestine by a duct under the following sternum. The third and fourth pairs, (e, f,) are situated on the enlargement of the intestine, below the sternum of the second pair of natatories. The functions of a liver are probably performed by some or all of these glands.

Two other pairs of small glands are situated in the abdomen, which we presume to be connected with the intestine; we have not however distinguished their ducts, neither have we by dissections obtained more than one of them separate from the body. They are possibly urinary glands.

The Caligi have heretofore been supposed to live by sucking the blood of the fish on which they are found. It is however apparent from the structure of the mouth, that they are wholly unfitted for this mode of life. There is no organ which can perform the functions of a sucker. Moreover, we have never detect-

ed any blood in the stomach of these animals, although we have often examined them, immediately on taking them from the fish. On the contrary, the fluids always have a light color.

We have not fully satisfied ourselves of the nature of its food, but presume that it lives on the mucus which covers the body of the fish. The mucus is one of the natural secretions of the fish, and is always abundant. The organs of the mouth are well formed for the collection of it, and the free motion in the whole buccal mass seems peculiarly fitted for this purpose.

Several specimens of the Caligus, when confined on their backs in but a small portion of water, just sufficient to cover them, have been observed to elevate the buccal mass, and take in globules of air, which passed down the esophagus into the stomach, and thence through the intestine. Occasionally the globules of air have been so numerous and taken in such rapid succession, as to fill the stomach, and very much inflate it. In their passage through the esophagus they usually stop for a short time at the entrance to the stomach, indicating the existence of a valve or sphincter at this place.

b. *Circulation.*

The blood of the Caligus, as in other Articulata, is a limpid fluid, containing suspended in it numerous minute colorless particles. These particles are very various in their form and size. The smallest scarcely equal $\frac{1}{300}$ of an inch. We have observed one particle the length of which was about $\frac{1}{150}$ of an inch, and its breadth $\frac{1}{4}$ its length; another had nearly the same length and a breadth equal to $\frac{1}{2}$ its length. These particles can accommodate themselves to the size of the passage through which the blood is flowing, becoming narrow and elongated if the passage is narrow, and again resuming their former proportions when they have reached a free open space.

The circulation in the Caligus is wholly lacunal; it appears to consist of broad irregular streams, passing through the spaces left among the internal organs, and in no part have we discovered distinct vessels. These streams have in general definite directions, yet are seldom uniform, continuous currents. They mostly advance by successive vibrations, depending on the palpitating action of the body. A single centre of circulation, or a *heart*, this animal can scarcely be said to possess. There are two points in the medial line where there is a valvular action, and each has its

claims to be considered as performing the functions of this organ, though neither is entitled to that name. One of these systems of valves, the more perfect of the two, is situated in the apex of the posterior thoracic joint, (fig. 6 a, b.) There are at this place three distinct valves; two laterally on the back, situated in the dorsal currents which are flowing *towards* the tail, and one centrally below, giving passage to the ventral current flowing *from* the tail. The dorsal and ventral valves open alternately. Their action may be seen in the figures above referred to; a, represents the dorsal valves as shut, and the ventral open, and b, the dorsal relaxed or open, and the ventral shut. The action of these valves is very regular, and the currents which pass them are more uniform than those in other parts of the body. The number of palpitations has been found to vary from thirty to forty per minute.

The blood coming down the back* from the head, and also in two lateral currents from the point of intersection of the head, thorax and epimeral segments, (fig. 7,) passes the dorsal valves. It continues posteriorly; a part into the terminal joint of the body, and then up the venter, entering the ventral current at the extremity of the intestine; another part, into the same ventral current near the centre of the abdomen, and at other varying points. The ventral current passes through the ventral valve under the anterior margin of the apron, and continues up the body—washing, at the same time, freely over the intestine and stomach, to the thoracic ganglion, where it divides, and passes each side of this organ. Each of these branches goes off laterally; one portion (A) enters the adjoining prehensile legs, and returns down the body, uniting with another current which we shall soon mention; a second (B) passes a little forward and outward, gives off blood to the third pair of maxillipeds, continues outward, accompanies the muscles of the mandible, and runs down the body near its margin; a third (C) goes forward outside of the base of the first pair of maxillipeds, continues to the antennæ, to which it gives a portion of its blood, turns inward passing into the anterior cephalic segment, and along its articulation to the medial line. At this place the currents meeting from the two sides, flow down the medial line to the mouth.

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* The course is marked by arrows on figs. 1 and 7.

The *second* instance of valvular action occurs in this last medial current, between the second joints of the first pair of maxillipeds, (fig. 1.) There is a single valve, composed of a membrane, playing backward and forward, and thus preventing the return of the blood that has passed it. Between this valve and the mouth there appears to be a large cavity for the reception of the blood, from which it is propelled by a palpitating motion or powerful muscular action in the buccal mass, and surrounding parts. It acts in the following manner: the current enters through the valve while the posterior part of the mouth is elevated; the valve then closes, and immediately the buccal mass is brought down, and forces it out in a current on each side. This very extraordinary action is carried on uniformly, and is absolutely necessary for the flowing of the blood. Indeed, the blood flows *in* by the out-currents, until the action of the buccal mass throws it out. We presume that the depression of this organ is produced by the muscular band which has been described as passing across the posterior part of the mouth, to an attachment in the shell on each side, (fig. 12.) If the mouth be cut off, the blood flows out in a large free current, and the animal soon dies from exhaustion.

A current passes from this cavity each side of the mouth, and others on the back. One portion of the side-current unites with the current C, before described, of which it forms the greater part, and thus soon returns to the buccal cavity. Another portion flows outward, following the muscle of the mandible, and unites with B; this current, thus much enlarged, passes near the margin to the posterior extremity of the cephalo-thoracic segment, returns up by the epimeral articulation, crosses the same just above the junction of the head and thorax, and then turns suddenly backward; a part flows on the back, forming the lateral current on the back before referred to; the remaining portion below flows to the base of each of the natatory legs and the apron, and enters them, and at the same time and place, passes in part on the back; the current from the apron flows laterally down the abdomen.

Another portion of the side-current leaves the buccal cavity just along side of the mouth, unites with it, and flows to the base of the first pair of natatories. The union of these currents is somewhat peculiar: the blood vibrates upward on the venter, to a spot near the base of the prehensile legs, where a portion remains, although the main current vibrates back on the venter; at this mo-

ment, the current comes from the buccal cavity and carries the whole below.

The irregularity in the circulation in this animal is even greater than will be inferred from the above description. These currents are merely main directions; the blood flows into them or from them, through all their extent. The current coming laterally down to the base of the second pair of natatories, besides going into the natatory and on the back, is carried up the venter at each of the upward vibrations of the ventral current. The current from the apron also passes into the same current, in addition to its backward course. When it is considered that the currents of blood occupy merely the spaces left by the muscles and other internal organs, it will be readily seen that similar irregularities must occur in various parts of the body. These directions are occasionally subject to singular deviations. One of the two currents which run from each side in front, and unite on the medial line, has been observed to cross the medial line into the other current, and thus continue flowing for some time with considerable force; soon after, each flowed by vibrations towards the centre, but with alternate motion. This was observed immediately on taking the Caligus from the water, when it was apparently very lively. As the cod, however, had been for several days confined in the harbor near the market, all the specimens examined may have lost part of the activity usual in the open sea. At times, the blood in some parts merely vibrates back and forward, without advancing in either direction; and occasionally the blood flows in a direction exactly the contrary to its usual course.

We have not fully satisfied ourselves of the mode of respiration in the Caligus. The natatory pinnulæ—to which we must add those of the tail, as they are identical in their structure—have been supposed to supply the place of branchiæ. When the animal is attached to any object, these legs keep up a very regular action, which appears to correspond to the palpitations in the body.* We have not, however, observed the blood to flow into their setæ, and the currents passing into the legs are among the least regular. We are disposed to believe that these pinnulæ are not the special organs for this function, but that aeration takes

* This action is not so rapid and branchial-like as in the Argulus, but takes place at intervals of about one and a half seconds.

place over the whole surface of the body. It is stated by Straus, that on separating the branchiæ of a lobster, the body absorbed nearly one half the oxygen usual before the removal of these organs. The thin envelop of the Caligus, and the extent of its external surface, must render its body a far more perfect substitute for branchiæ than the solid covering of the lobster. The vibrating action of the natatory legs serves to keep up a constant current of water, and thus affords continually a new portion to undergo the respiratory action of the body. It might be remarked that these legs, on account of their breadth, could not act so as to produce this current of water, when the whole margin around is attached. Probably the animal is not thus attached except when it is rendered necessary by the swift motion of the fish; under which circumstances, there is a sufficient current, without the action of these legs. We may presume that the special object of these marginal cups is to enable the animal to attach itself, and still keep the principal part of its body free, so that these natatory legs, when the fish is motionless, may have space to act, and sustain a continued current.

V. Organs of Reproduction.

On each side of the stomach, there is a large pyriform organ, (Pl. V, fig. 18,) of a glandular appearance internally, and provided with a distinct duct, which at first we unhesitatingly pronounced the liver. Subsequent observation proved that the duct, which we had supposed to enter the intestine, extends through the whole length of the thorax into the abdomen, where it is continuous, in the male, with organs known to be seminal, and in the female, with the egg-bearing vessels. These organs, thus shown to be connected with the organs of generation, have been since proved to correspond with the spermatic glands in the male and the ovaries in the female.

In the male, they are rather larger than the buccal mass, (Pl. V, fig. 21,) and are situated just anterior to the stomach, in part beneath the base of the prehensile legs and the spine of the preceding pair. Their small posterior extremity is produced into a short ligament, by which it adheres above the stomach; the anterior portions are so enveloped in their cellular or membranous attachments, that they are separated with great difficulty. In general appearance, it resembles a pyriform membranous sac,

with an internal granulose structure. The duct, which is attached on the outer margin, is a slender vessel, of a thin membranous nature. It continues of a uniform size through the thorax to the central parts of the abdomen, where it gradually enlarges and undergoes a few convolutions.

A short distance below the convoluted portion, there is a small oval gland, with well-defined limits, contained within a distinct sac. It is apparently composed of several concentric parts, of which three are very apparent; there are two less distinct. Its interior is a transparent globule; the outer coats are less transparent, and the one adjacent to the interior, the least so. The central part of this gland is connected with a small sub-corneous tube, which gradually enlarges, and passes into the anterior extremity of the above convolutions. On one occasion, when we had separated this gland and its duct from the abdomen, a fluid, containing particles similar in appearance to those in the blood, rapidly poured out. The convoluted vessel appears therefore to receive the secretions of two seminal glands, and probably corresponds to the vas deferens. Though much time has been employed in searching for the exit of the vas deferens, we are yet uncertain on this point. It is presumed, from the appearance of the parts, that it terminates either on the outer surface of the lappet at the extremity of the abdomen, or beneath this organ.

The ovaries in the female have the same situation and attachments as the spermatic gland in the male. (Pl. V, fig. 18.) They are however much larger, and extend above the stomach nearly to its centre. They may be distinctly seen through the back shell. They appear to contain a long convoluted vessel, which gradually diminishes in size, from its anterior to its posterior extremity; but whether this be truly its nature, cannot be determined. The duct arising from its margin, extends without any variation in its size, till it reaches the posterior joint of the thorax, where it enlarges gradually, and continues to increase as it enters the abdomen. In the gravid female, it passes through the abdomen, with a few convolutions, and extends out at the vulva, in the form of a long, whitish, nearly cylindrical membranous tube. This external portion of the oviduct is often a little longer than the animal.

The vessel in the ovary does not appear to contain divisions indicating the presence of eggs; but the oviduct usually contains eggs through its whole extent. Where exserted, it is very dis-

tinctly divided by membranous partitions into narrow compartments, each containing an egg, though not quite filled with it. The eggs in the anterior slender portion of the oviduct are oblong and uniformly transparent. As they increase in size, they present a clouded appearance, and become divided into two parts, corresponding to the *white* and the *yolk*. The latter appears clouded and composed of albuminous globules. The several portions are represented in the exserted portion of the oviduct, (fig. 18.) The eggs have the form of short cylinders with rounded edges.

In the advanced eggs, at the extremity of the ovary, we observed in one instance, that there were two distinct eyes at their outer extremity; they were approximate, but not situated on the same black ground. In these eggs, the yolk occupied nearly the whole space.

In addition to the ovaries above described, there is a pair of organs in the abdomen, connected with the system of generation. They are straight, flat-cylindrical organs, usually as broad as the external oviduct, and lie along the central portions of the abdomen. At the lower extremity, they are connected with the oviduct a short distance above the vulva, and at the upper, they terminate in a cul-de-sac. They contain a single series of transparent, flattened globules, (fig. 18,) occupying, like beads, their central line, and in width about one half the width of the ovary. These false ovaries, when torn or cut, do not emit an albuminous fluid, like the true oviducts, but appear to have a gelatinous consistence. They are as much developed in the young, as in the old females.

The eggs in females of the same size present very different degrees of development. We have seen full grown individuals with no eggs in the abdomen, and consequently, instead of the swollen appearance usual in the adult female, their abdomens could scarcely be distinguished from those of the male sex. Occasionally, very young individuals have had external ovaries; the smallest observed was scarcely one sixth of an inch long. May we not infer from this, that a single coition is sufficient to impregnate the individuals of at least *one* succeeding generation?

A few instances have come under our notice, of a very extraordinary irregularity in these organs. The extremity of the *false ovary* has been seen hanging externally in the place of the regular external ovaries, and no eggs, nor the internal oviduct,

were discoverable in the interior on that side. Moreover, the corresponding ovary near the stomach was discovered with difficulty, and appeared like a folded empty sac. At the same time the ovary and the ovarian tube on the other side presented their usual appearance. This singular derangement was observed in a full grown female, which was perfect in all its other organs.

An additional peculiarity as yet inexplicable, has been observed in some females. The lappets at the extremity of the abdomen, each side of the tail, have been already described as very short in the female. On their lower surface there is an irregular osseous process, from which a slender corneous organ, which we suppose to be a duct, runs forward and a little inward, gradually diminishing, and terminates with a few irregular curves, (fig. 18, Pl. V.) The peculiarity we refer to, is an appendage to this lappet, arising from the termination of the internal duct, (fig. 22.) It is a long corneous duct, wholly external, terminating in an oval sac of similar texture, and usually filled with a whitish fluid. These appendages have been observed in a few instances, hanging each side of the terminal joint of the body, (fig. 22.) In one instance the ducts were crossed over the adjacent articulation, and each attached by its sac to the lappet of the opposite extremity. These are the only facts that have been discovered respecting these singular organs. They were found attached to very few individuals, and in these the eggs were scarcely developed.

On account of the many similarities between this animal and the Argulus, it may be interesting to trace a few of its analogies.

The number of legs or organs for locomotion is the same, being eight in each. Of the four pairs of natatories in the Argulus, two are similar in their use in the Caligus, while a third is expanded into an apron, and a fourth is attached to a distinct joint, and has but little strength. The anterior pair of maxillipeds in the Argulus very much resemble in general form the same organs in the female Caligus. The fourth pair is large and prehensile in each, though very different in form. There is a distinct suture in the former, near the anterior margin of the animal, which corresponds to the articulation between the two cephalic segments in the latter; but this segment, which in the Caligus is furnished with antennæ, is wholly without even rudiments of these organs; we may hence infer that the Argulus is destitute of antennæ, as is

also evident from the nature of the organs that follow. The space contained within the U suture in the Argulus is the analogue of the much larger and more distinctly separated segment, which we have called the cephalic in the above description. The anterior abdominal joint of the Caligus is wholly wanting in the Argulus; and the valves in the circulation which occupy the posterior thoracic joint, *far* from the extremity of the body, have an analogous situation in the Argulus, *close* to the *last* joint of the body. This joint being small in the Argulus forms a very distinct and regular heart, and serves to keep up a much more active circulation than in the Caligus, where the corresponding part is large and less energetic in its action. It is remarkable that the circulation in the two should be the reverse in almost every particular; the ventral current instead of being upward in the Argulus runs towards the terminal joint of the body; instead of meeting from the two sides in front and returning down the medial line, it goes out in two currents near the medial line and returns in the wings of the shell. This however will not appear so extraordinary when we consider that the animals are the reverse of one another in some particulars. The cephalic segment in the Caligus is very large and broad, and there is therefore space for the current furnished to the antennæ and cephalic organs, to flow along the sides, and return along its centre; but in the Argulus, this portion is so small that there is only room for the out-current, and the blood is compelled to turn outward into the wings of the shell or thoracic portion, which is very much larger than in the Caligus. The currents are much more definite in their limits in the Argulus, and more uniform in their velocity and course; the particles of the blood are also less variable in size and form, being about $\frac{1}{333}$ of an inch, in length. The organs of the mouth are also similar in position and in the form of the mandibles. This analogy might be traced much farther; but we reserve further remarks for a future occasion.

EXPLANATION OF THE PLATES.

Plate III.

Fig. 1. Under view of a male, exhibiting the various organs, and the muscles that move them. A, minute papillæ, supposed to correspond to inner antennæ; I, a cup, for the attachment of the animal; L, antennæ; d, one of the muscles moving the mandibles. The arrows point out the course of the blood.

Fig. 2. Back view of male, natural size of one of the largest individuals.

Fig. 3. A female, natural size.

Fig. 4. a. View of the rudimentary or second pair of legs, or maxillipeds; b, termination of third pair.

Fig. 5. a. Ventral muscle, exhibiting its subdivision between the sternums of the two pairs of natatory legs; b, a second subdivision in the same muscle, below the posterior of the above sternums.

Fig. 6. a and b. View of the posterior thoracic joint, (see fig. 7,) with the valves in the circulation; the two lateral valves on the back and the central on the venter.

PLATE IV.

Fig. 7. Back view of a male, with the muscles seen in this view. Those marked with capital letters, move the segments of the body; those with small letters, move the several organs below. F, the posterior thoracic segment; G, the anterior abdominal; H, the posterior abdominal.

Fig. 8. A portion of the shell about the eyes, shewing the areolets exhibited by it; the dotted line marks the limits of the dark ground on which the eyes are situated, and the dotted circles the eyes themselves.

Fig. 9. Alimentary canal, exhibiting the esophagus, the stomach and the intestine, with its glands, and the muscles of the rectum. The mouth at the upper extremity is represented as turned back, so as to show its under surface.

Fig. 10. Anterior extremity of the esophagus.

Fig. 11. A portion of the intestine.

Fig. 12. View of the *buccal mass*, in its natural position. Between the line a a, and a b a, is the opening to the mouth. d, the outer extremity of the mandibles, with the tendon and its muscles attached.

Fig. 13. The same with a portion of the upper membrane and the mandibles removed.

Fig. 14. The mandibles, together with some of the organs adjacent to their inner extremities, showing their relative position.

Fig. 15. The upper lips, with its two pairs of muscles.

Fig. 16. The same, with the extremity retracted by the inner pair of muscles.

Fig. 17. Under view of the buccal mass, with the esophagus attached. h h are processes lying in the teguments of the body, with which the buccal mass forms an articulation at their anterior extremity. g the processes in which the elevators of the buccal mass are inserted.

PLATE V.

Fig. 18. Under view of *female*, exhibiting the nervous system, and the ovaries, and ovarian tubes. Fig. 18, a, the first pair of maxillipeds in the female; 18, b, the fourth pair in the same.

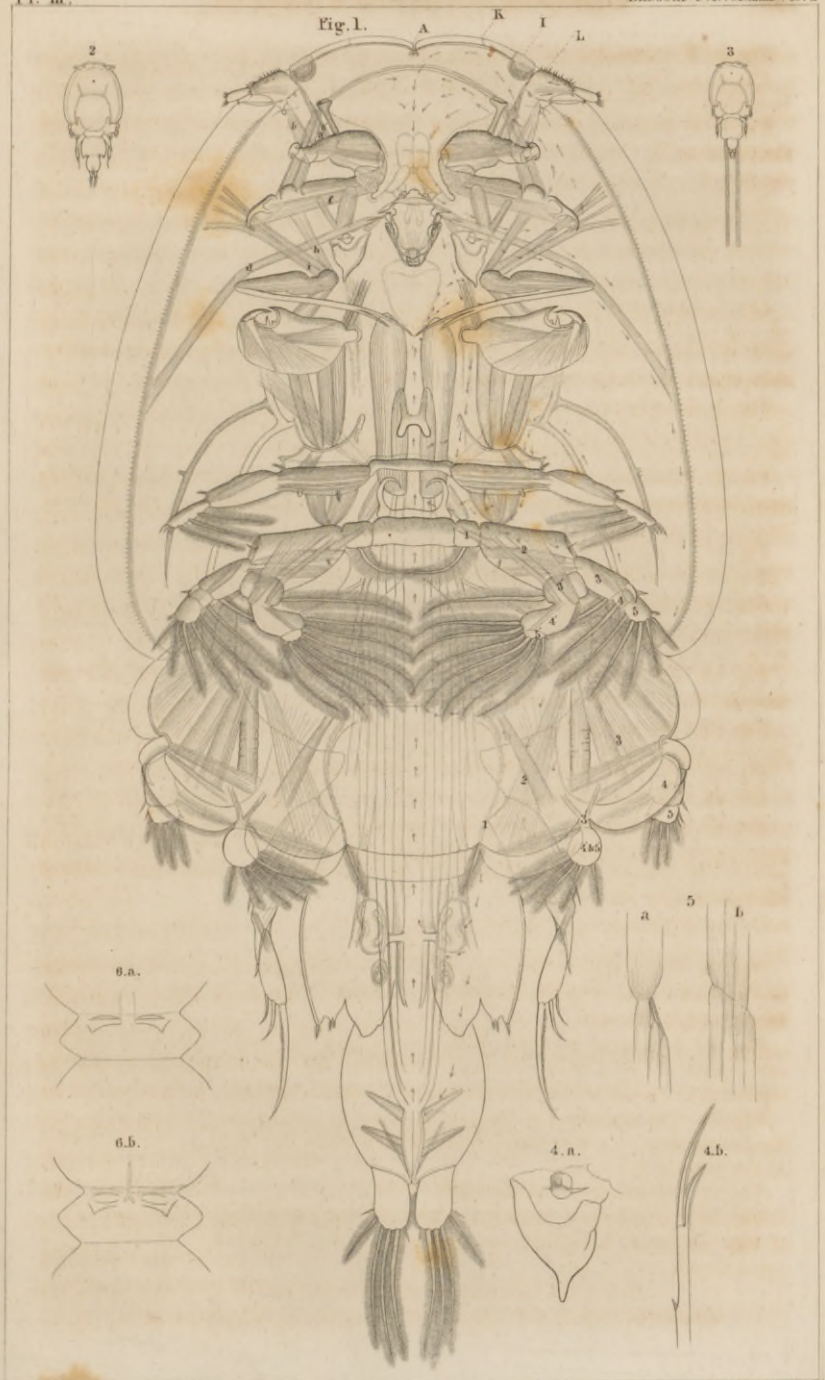
Fig. 19. A view of the cup and an antenna, together with a portion of the lateral margin of the animal, exhibiting its spines. The dotted lines in the antenna represent the nerve with which this organ is largely supplied.

Fig. 20. The cephalic and thoracic ganglions, exhibiting their close union, and the nerves they give out; the outlined organ in front, represents the eyes, attached to the ophthalmic nerves.

Fig. 21. Genital system in the male.

Fig. 22. Part of the abdomen of a female with an appendage to the same.

Figs. 23, 24, 25. Illustrate some facts connected with the change of skin.



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CALIGUS AMERICANUS

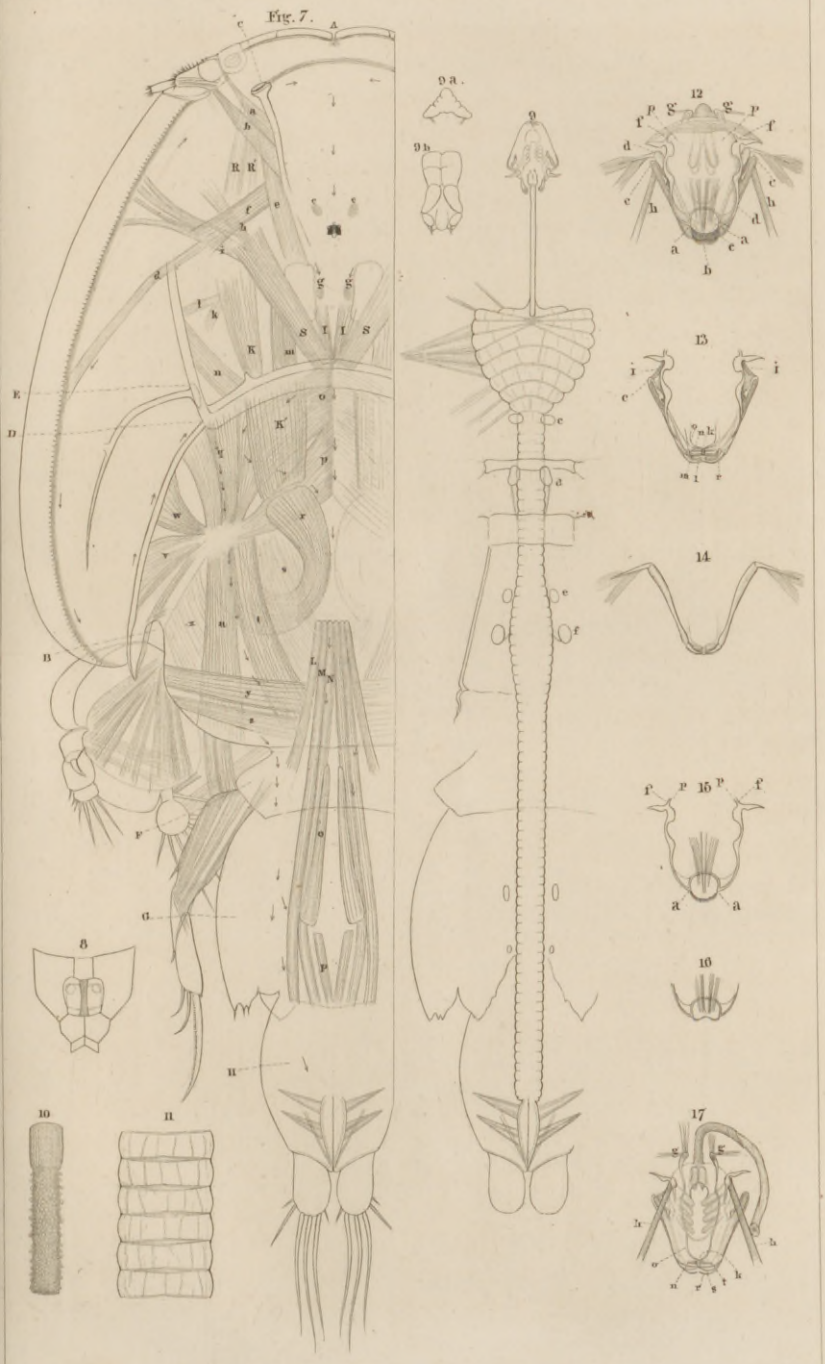

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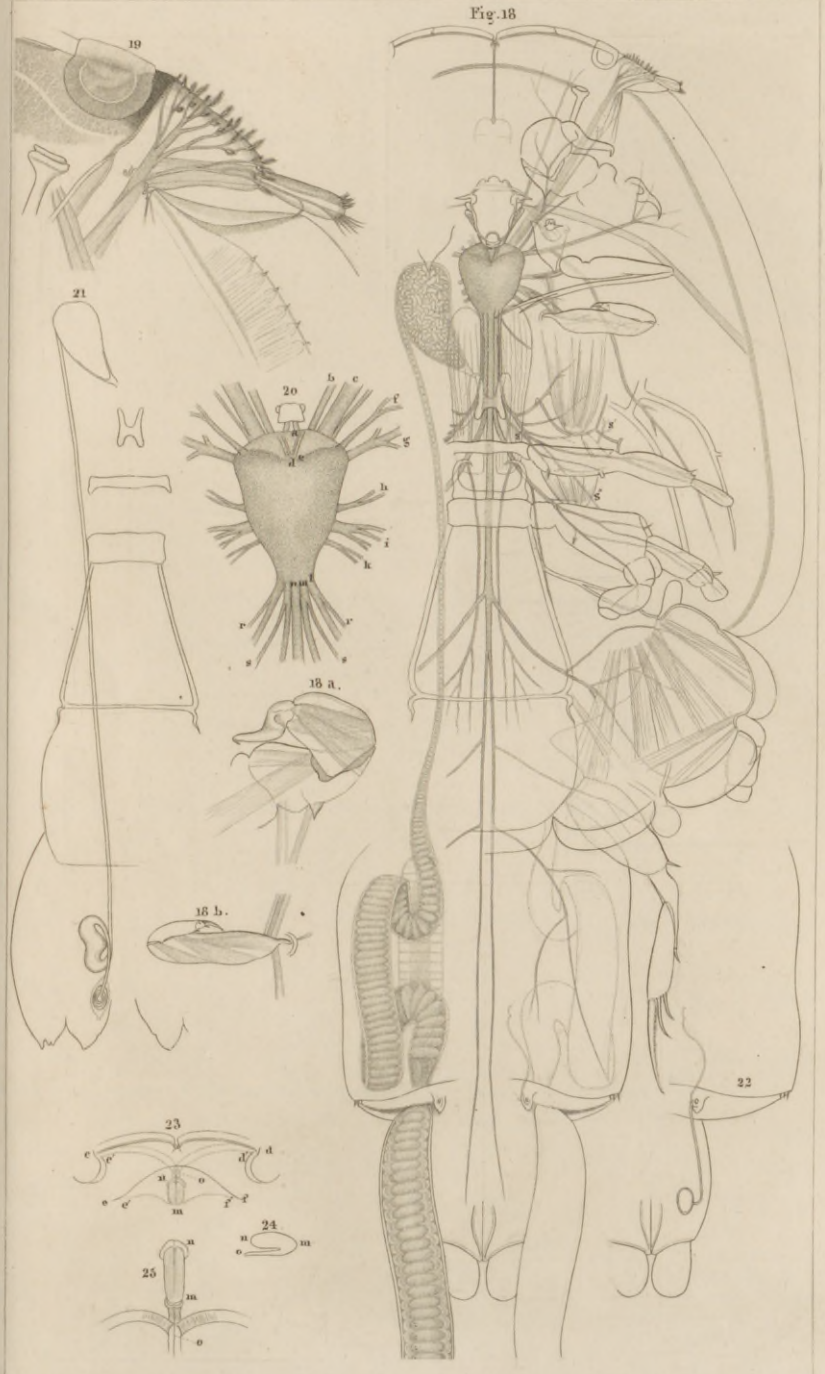
Fig. 18



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CALIGUS AMERICANUS