THE

TRANSACTIONS

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I. *On* Koonunga cursor, *a remarkable new Type of Malacostracous Crustacean. By* O. A. Sayce, *Melbourne University.* (*Communicated, with a Supplementary Note, by* W. T. Calman, *D.Sc., F.L.S.*)

(Plates 1 & 2.)

Read 4th June, 1908.

TOWARDS the end of last year I gave a preliminary description of *Koonunga cursor*, a remarkable crustacean with primitive Malacostracan characters *, and briefly compared it with apparently allied forms, such as *Anaspides tasmaniæ*, G. M. Thomson, and the Euphausiacea and Mysidacea. I now offer a detailed description of its external anatomy and further discuss its possible affinities. I have also been able to examine a larval form, which is described below.

I desire at the outset to acknowledge my indebtedness to Dr. W. T. Calman, of the British Museum, for his kindness in seeing this paper through the press.

The following short descriptions are those published in my paper, but with some slight amendments, due to the opportunity afforded me by Mr. Geoffrey Smith, Fellow of New College, Oxford, of seeing drawings of a new form, evidently also belonging to the order Anaspidacea, which he discovered on a recent visit to Tasmania.

Order ANASPIDACEA, Calman, 1904.

Body generally slender, integument thin. Carapace absent. Thoracic somites distinct, or with the anterior one fused with the head. Abdomen of about equal length to the cephalon and thorax combined, somites distinct. Eyes stalked or sessile. Auditory organ at base of first antennæ. Peduncle of second antennæ four-jointed,

* 'Victorian Naturalist' (Melbourne), vol. xxiv., Nov. 1907, pp. 117–120; reprinted in Ann. & Mag. Nat. Hist. ser. 8, vol. i., April 1908, pp. 350–355.

scale present on second joint, or absent. Mandibles without a secondary cutting-edge (*lacinia mobilis* of Hansen). Maxillipeds and succeeding pairs of legs uniform in general structure and adapted for walking. Swimming-branches (exopods) on all but the last two or three pairs of legs. Branchiæ forming a double series on all but the last one or two pairs of legs, simple, lamellar, wholly uncovered. Pleopoda natatory, no *appendix interna*, inner branch (endopodite) rudimentary or wanting, except in the males, when it is modified in the first two pairs for sexual purposes. Telson and uropoda normal, together forming a "fan." No marsupial plates (oostegites).

Fam. 1. ANASPIDÆ, Thomson, 1894.

Thorax of eight segments. Eyes pedunculated. Antennal scale arising from the second joint. Mandibles with single dentate cutting-edge, "spine-row" or setose ridge, and molar expansion. Maxillipeds with exopodite small, simple, and lamellar; epipodite quite small and simple, possessing also small gnatho-basic lobes on the inner face. First five pairs of legs with well-developed swimming-branch. Branchiæ on all but the last pair of legs, which are without any appendages. Pleopoda with rudimentary endopodite.

Fam. 2. KOONUNGIDÆ, Sayce, 1907.

In general appearance like Anaspidæ. Thorax with anterior segment fused with the head, leaving seven distinct subequal segments. Eyes sessile. No antennal scale. Mandibles with a single dentate cutting-edge and molar expansion, no definite "spine-row." Maxillipeds without any trace of gnatho-basic lobes, otherwise like Anaspidæ. Pleopoda absolutely uniramous, except the first two pairs in the male.

Genus KOONUNGA, Sayce, 1907.

Cephalon about equal in length to the following two segments combined, possessing a short transverse sulcus on each side at about the middle distance, posteriorly to which the margins are produced downwards and inwards. Frontal margin of cephalon scarcely produced, incised above the attachment of the second antennæ, forming a small lateral lobe. Eyes small, round, situated on the dorsal surface at the angles formed by the union of the frontal margin and the incisions. Antennæ long and filamentous, the upper with basal joint of flagellum possessing sensory modification in the male, lower nearly as long as the upper.

Mandibles with a three-jointed palp. First maxillæ with a small but distinct palp. No swimming-branch on the last two pairs of thoracic limbs.

Remarks.—The name is derived from the aboriginal name of a creek which runs near where specimens were collected.

KOONUNGA CURSOR, Sayce.

Specific Description.

Anterior portion of the body of subcylindrical form, becoming gradually rather broader, deeper, and cylindrical posteriorly. All the segments of the thorax and abdomen subequal. Abdomen equal in length to the thorax, last segment not longer than the preceding one, with one or two dorsal spines close to the attachment of the telson. Telson entire, slightly broader than its length, of triangular form and rounded apex, margin fringed with two or more series of stout spines. Uropod with peduncle extending to half the length of the telson, its branches somewhat longer than the peduncle, inner one fringed along the inner margin with upturned spines, and three longer ones at the apex pointing outwards; outer margin and apex fringed with very long feathered setæ; outer branch fringed with long feathered setæ, and the outer margin also with a row of upturned spines.

Mandibles each with a broad cutting-plate, that of the left side curving outwards, and the edge divided into six stout teeth; that of the right side also broad, curved in the reverse direction, and the edge divided into five stout teeth; molar process similar in each, forming a well-extended broad ridge clothed with short, stout setæ, surrounding a minute triturating surface with chitinoid papillæ.

Maxillipeds rather stouter than the legs, extending directly forwards about as far as the distal end of the peduncle of the upper antennæ, the seventh joint (dactylus) minute, stout, and bearing four claws on the rounded extremity. The seventh joint, also, of each of the other limbs minute, and bearing three long, stout claws, the middle one rather longer than the other two, which are placed closely on each side of it and quite similar to each other.

Colour.—General appearance marbled dark brown. Microscopically showing a yellowish stratum, thickly dotted over with rounded areas composed of black granules.

Length.—Largest specimen measured 9·5 mm.

Occurrence.—From freshwater reedy pools beside a tiny runnel joining the Mullum Mullum Creek, Ringwood, near Melbourne.

Remarks.—It is remarkably active; usual form of locomotion running, but can spring forcibly forwards and also swim easily. It shuns strong light.

Detailed Description.

The largest specimen I have seen measured 9·5 mm. in length, and it differed morphologically in no important degree from others of at least 7 mm. The following description is made after examination of several specimens between these two sizes, some of which were seen alive. Its nearest ally appears to be *Anaspides tasmaniæ*, G. M. Thomson, and I have made comparisons with it from descriptions and drawings by Thomson (Trans. Linn. Soc., Zool. (2) vi. 3) and Dr. W. T. Calman (Trans. Roy. Soc. Edinburgh, xxxviii. pt. iv.).

In general appearance the colour is irregularly marbled dark brown on body and appendages; microscopically the dark areas are resolved into small irregular and roundish patches, composed of dark brown and black granules, the intermediate stratum being yellowish. Alcohol specimens show scarcely any difference in colour.

The *body* is very slender, fully eight times as long as broad, and of almost uniform breadth throughout. Anteriorly it is slightly dorso-ventrally compressed and of subcylindrical form, but the depth gradually increases posteriorly, so that the last few segments are cylindrical. The integument is smooth, thin, and membranous, and contains no lime salts. There is no development of pleura, and the epimera are inconspicuous. It is divided into fourteen distinct segments, comprised of cephalon, seven thoracic and six abdominal ones, all but the cephalon being subequal. They are freely articulated one to another and all with similar powers of flexion.

The *cephalon* (Pl. 1. figs. 1, 2, 3) is about equal in length to the following two segments combined, and is freely articulated to the following segment. Looked at from above the shape is subquadrate, with frontal margin above the attachment of the antennules, forming a wide evenly triangular projection, the obtusely-angled apex curving slightly downwards between the closely approximated antennules. On each side of the base of this triangular area the margin is incised, so that a narrow lateral lobe is formed between it and the inferior margin.

I have critically examined the position corresponding to that where Calman has observed what he thought might possibly be ocelli in *Anaspides*, but cannot find the slightest indication of any in the present species.

Viewed from the side the dorsal line is almost straight, curving slightly downwards anteriorly and posteriorly, and slightly depressed in the middle. The lobe on each side is about the width of the basal joint of the antenna, the attachment of which it overlies; its upper corner is right-angled and the frontal margin meets the inferior margin in an even curve, thence it runs almost straight hindwards for half the length of the head; from here a definite sulcus runs obliquely backwards for a short distance, then turns straight upwards and merges in the dorsum, where no trace of it can be seen; this sulcus commences immediately posterior to the insertion of the mandibles, and corresponds to the apparently definite division which separates the head from the thorax in *Anaspides*. Immediately posterior to this sulcus the inferior margin commences to descend gradually to a depth equal to that of the following segment, then to curve upwards to meet the posterior margin. There is no branchial cavity formed. I can find no trace of any lateral sulcus nor indication of division running obliquely across in the position corresponding to that on the first thoracic somite of *Anaspides*.

The eyes are situated on the dorsum, at the angles formed by the union of the frontal margin and the lateral incisions, and quite close to the frontal edge. They are very small, circular, and uniformly black.

Peræon or Mesosome.—The seven segments are each of equal width to one another, but gradually increase a little in depth posteriorly, the back is evenly arched from side to side, the inferior margins slightly excavated above the attachment of the appendages, and there are no definite epimera.

In the female just in front of the last pair of legs there is a development of the sternum to form a small pouch (spermatheca), which is described later when dealing with the appendages.

The *Pleon or Metasome* is of similar length to the peræon, and its segments subequal, except the terminal one, which, although of equal length to the preceding, becomes rapidly attenuated, the dorsum declining in a straight line to the base of the telson; the posterior margin is slightly excavated above the attachment of the telson, and immediately lateral to that appendage it is produced to form a small acute triangular tooth, at the base of which, on the inner side, there are one or two stout spines, pointing upwards; lateral to the tooth the margin declines obliquely forwards along the line of articulation of the uropods, to meet the inferior margin in a right angle. The inferior margins of this and the preceding segment are inclined obliquely in opposite directions, which allows of deeper flexion than the preceding segments. There is no development of pleura.

In male specimens there is a remarkable unpaired appendage projecting from the sternum in the mid axis, and closely associated with the sexual endopodites of the second pair of pleopoda. This I believe to be a development of the sternum and I will describe it later when dealing with the appendages of the abdomen.

The *antennules* (figs. 5 & 7) are nearly half the length of the cephalon and body combined: the peduncle is stoutly built and equal in length to the cephalon; it is formed of three joints, the first is broad, and as long as the succeeding two combined. and bearing but few setæ. The auditory organ is situated in this joint with the opening on the upper surface, and its form appears to be quite similar to that of *Anaspides.* The second and third joints are narrower than the first, subequal to each other, and the inner and outer margins tufted with setæ, most of which are slightly feathered. The outer flagellum is slender, about twice as long as the peduncle and with about twenty (more or less according to the size of the individual) short articles. The secondary or inner flagellum is about one-half the length of the primary one and has about eight articles.

The antennules have the following modifications in the males (figs. 7 & 7 *a*). Arising from the distal extremity of the last peduncular joint, at the inner angle, there is a short broad linguiform lobe with the edge evenly rounded, and fringed with long curving faintly feathered setæ. This lobe partly shields a remarkable pedunculated eye-like organ, which projects obliquely towards the mid axis and underlies the basal part of the secondary flagellum; it arises from the distal inner angle of the first joint of the primary flagellum, which is distinctly stouter than the succeeding ones.

In shape it is somewhat like an ordinary pedunculated eye, but there is no pigment; the rounded outer surface is studded with closely packed minute hyaline hollow cups, each attached to the surface by a short stalk (fig. 7 *a*). From a casual observation this organ might easily be mistaken for an eye, but on closer examination that idea cannot be accepted. I am disinclined to believe it is of sensory function, and think it more likely to serve a mechanical action, such probably as clasping the female; the surface, studded with its tiny hollow disks, would help in discharging this function. It, however, requires more careful study by means of sections than I have so far been able to give, and it may be a sense-organ. *Anaspides* possesses sexual modifications in the males on the first seven articles of the inner flagellum, but of quite different form to the above.

Antennæ (Pl. 1. fig. 6).—The peduncle is slender compared with the peduncle of the antennules, and the last peduncular joint but little stouter than the first articles of the flagellum. The peduncle is formed of four joints, the first quite short and subquadrate, the second about twice as long, the third as long as the first and second combined, and the fourth rather more slender and a little shorter than the previous one. The flagellum is long and slender, about twice the length of the peduncle and formed of about 18 articles.

In *Anaspides* there is a definite scale arising from the second peduncular joint, but in the present species there is not even a vestige of one; otherwise they are in close agreement.

The anterior lip (fig. 8) is thick and fleshy, curving evenly downwards without any transverse ridge (epistome), the margin broadly and evenly rounded, and the tip furred with short setæ.

The *mandibles* (figs. 10, 11, 11 *a*) agree closely with those of *Anaspides*, except that there is no clearly defined spine-row. The body is stout and supplied with a three-jointed palp, the cutting-plate long, broad, and strongly curved between its lateral edges (the curve of one side opposing the other in opposite directions); its distal margin declines but very slightly inwards, and is divided into numerous strong acute teeth (six on the left and five on the right hand side), and the inner lateral margin descends almost at a right angle to join the basal part of the molar expansion. The molar expansion is well developed and rises abruptly to form a rounded cushion-like ridge, thickly clothed, in part upon the summit, and for some distance surrounding it, with long spiniform setæ; the outer edge of the summit is raised a little to form a minute grinding-surface studded with chitinoid papillæ, hidden by the surrounding setæ. Between the cutting-plate and the molar expansion there is no sign of any secondary cutting-plate nor definite spine-row, but the setose cushion-like area united to the chitinoid extremity may possibly have originated from one (fig. 11 *a*).

The palp is three-jointed and directed forwards and inwards, so that the distal ends almost meet in the mid axis, a little in front of the anterior lip. The first joint is short and free from setæ; the second almost three times as long, with a row of about six long feathered setæ along the inferior margin of the distal half; the third is minute, apically broadly rounded, and bearing several long feathered setæ.

Posterior lip (fig. 9).—This is formed of two membranaceous, narrow, ovoidal, widely divergent lobes, connected together at the base, and the inner edges of the lobes are fringed with setæ.

The *first maxilla* (fig. 12) consists of two lobes: the outer or distal one bears a minute one-jointed palp on the outer face, pointing distally (not reflected backwards as in the Cumacea), and tipped with three very long spinules, feathered along their inner margins; the obliquely truncated summit of the lobe bears a double series of about ten strong yellow spines, not toothed, as in *Anaspides*, but faintly feathered, and the inner face curves outwards to form a small rounded expansion. The proximal or inner lobe is short and narrow, being only half the width of the outer lobe, and the summit bears one remarkably long stout feathered spine surrounded by four much smaller feathered ones, otherwise the lobe is unclothed.

The outwardly turned lacinia (exopodite) which this segment possesses in *Anaspides*, in common with the Euphausiacea and, to a less extent, the Mysidacea, is inconspicuous—if, indeed, it exists even in a rudimentary form. The corresponding part of the segment in the present species appears to curve a very little outwards, but there are no setæ fringing it.

Compared with *Anaspides* this appendage is more specialized, showing a certain resemblance to that of the Amphipoda. The outer lobe is quite similar to that of *Anaspides* except for possessing a more definite palp; the inner lobe, however, is not simply foliaceous, but more modified and there is no definite exopodite.

The *second maxilla* (Pl. 2. figs. 13 & 13 *a*) is a little smaller than the first maxilla and is formed of four foliaceous lobes: the innermost is very short and the others gradually increase successively in length; the first or innermost is quite narrow, the extremity occupied by one short and two longer straight feathered spinules; the second broader, and apically bearing five feathered and plain slightly curved spinules and setæ; the third broader still, and bearing about ten spinules and setæ of a similar kind. The fourth lobe is divided by a faint line of articulation, and may be considered the palp; it is rather broader than any of the other lobes, and carries ten or more long spinules, and a little below the summit on the outer side there is another single feathered one.

This appendage agrees essentially with that of *Anaspides*, but in that genus the lobes are shorter and broader. In fig. 13 the lobes are flattened somewhat out of normal shape to make the drawing clear.

The *maxillipeds* (figs. 3, 4, & 14) agree in their general form with the succeeding limbs, but are distinctly stouter, and have no multiarticulate exopod, but instead a small simple one of branchial function. They are set close together at their origin, and extend directly forwards, covering the buccal area, and reaching far past the head to the limit of the peduncle of the upper antennæ. They serve principally as legs and for grasping purposes, and also to a very slight extent as foot-jaws. The three attached lobes fulfil a respiratory function.

The first joint (coxa) is short and very broad, and attached to the ventral surface of the cephalon; both it and the succeeding two joints are flattened on the inner face so as to embrace closely the buccal area; the outer face is strongly convex, and close to the frontal edge there arise, close together (not wide apart as Calman has shown in *Anaspides*), a pair of small, simple, narrowly ovoidal lamellæ of branchial function, which are transversely segmented near their proximal end, and between these and the ventral surface of the cephalon, also on the outer side, there is a minute tubercle covered with fine setæ. The inner side is expanded, the edge quite straight and closely opposed by its fellow of the other side; the distal margin is prolonged into a short triangular extension beyond the union of the second joint, with its apex tipped with a few short setæ (fig. 4). Had this arisen from the second joint one might have felt justified in considering it a rudimentary masticatory plate, which becomes such a pronounced feature in the Amphipoda. It may, however, be merely a specific character without morphological interest. These parts are best seen from the ventral aspect, with the appendages in their natural position, as shown in fig. 4; when dissected out the rather peculiar joining of the second joint to the first makes the parts difficult to understand. There is no vestige of the gnatho-basic lobes which are found in *Anaspides*.

The second joint is short, of subquadrate form, and from the frontal or upper margin of the outer face there is a linguiform lobe (the exopodite), which extends forward to a little beyond the end of the third joint and is transversely divided near its proximal end.

The third joint is subquadrate and clothed rather densely on the inner face with long setæ, most of which are faintly feathered. The fourth is about one-third longer than the preceding one, swollen to a slightly ovate form and bearing a few long setæ; the fifth is quite short and its articulation with the preceding joint permits great flexion; the sixth is slightly longer but not narrower than the fifth; the seventh is minute, appearing as a broad rounded tubercle, bearing on the apex a row of four stout curved claws.

Compared with *Anaspides* there is one joint less in number, due to the complete coalescence of two joints, which I think most likely to be the second and third; the relative lengths of the third, fourth and fifth are very different, but the three terminal ones are in agreement. As previously mentioned, the appendage does not possess any gnatho-basic lobes.

Appendages of the Perœon or Mesosome.—All the legs have the corresponding joints almost identical with each other, and, except for being more slender, also with those of the maxillipeds. The first three pairs are of about equal length, the fourth distinctly longer, the fifth and sixth subequal to the anterior three, and the seventh rather longer but not so long as the fourth. The first six pairs have the joints articulated, so that the claws point backwards, but the last pair are quite reversed, so that they point forwards; this is brought about by the reversal of the flexion of the three last joints. There appears to be no information concerning the arrangement of the legs in *Anaspides*, and I am not aware of any crustacean being quite like *Koonunga* in this respect, except some Decapods, e. g. *Astacopsis serratus*, and also *Astacus fluviatilis* according to the drawing in Howes's biological atlas. However, this character is not a reliable one for a natural classification, in proof of which it may be pointed out that most of the Amphipoda and some Isopoda of widely different genera agree in having the anterior four legs bending backwards, and the remaining three forming another series bending in the reverse direction. This reversal, however, takes place at the articulation with the body, but that does not affect the question as to the reliability for a means of classification. Each pair will now be considered in detail.

The *first appendage of the perœon* (corresponding to the second thoracic of *Anaspides*) (figs. 3, 4, & 15) is of similar form to the maxillipeds, but more slender; the first joint, together with the branchial lobes, is quite similar, except that the lobes are larger, although not so large as in *Anaspides*. It is united to the body-segment without any coxal plate or line of division. The second joint compared with *Anaspides* is formed by the complete coalescence of two joints; it is stout at the base, but narrows considerably beyond the origin of a large and strongly developed swimming-exopod, the peduncular joint of which is stout and carries a flagellum of about seven articles, each bearing two long curved feathered setæ. The third joint, corresponding to the fourth in *Anaspides*, is narrower than the preceding one and of subquadrate form; the fourth of equal length to the second and third combined; the fifth is short, and it is apparent that the articulation between the fourth and fifth is more flexile than any of the others; the sixth joint is nearly as long as the fourth, but narrower; the seventh minute, and bearing a row of three (not four as in the maxillipeds) closely-set stout claws, the middle one being distinctly longer than the other two, which are equal to one another. All the joints except the first are sparsely tufted with long setæ, some of which are faintly feathered.

The *second*, *third*, and *fourth* are so much like the first pair that nothing further need be said of them, except that the fourth has the three last joints distinctly longer than the preceding appendages.

The *fifth* agrees closely with the preceding legs, but is not so long as the fourth. In the female, in addition, there projects from the inner margin of the coxa a small lamellar lobe fringed distally with incurved setæ (fig. 16), close beside which is the opening of the oviduct. The clothing is much like that of the preceding limb, and in addition there is, on the distal inner margin of the fifth joint, a transverse row of five or more long acute spinules, pectinated on each side for half their length, thence finely setose to the apex (Pl. 2. figs. 17 & 17 *a*).

The *sixth* agrees in all respects with the fifth but has no exopodite, and the branchiæ are smaller; the female also possesses a similar setose lamella on the inner side of the coxa.

The *seventh* is longer than the preceding limb and without any branchial lobes or exopodite, neither are there any setose coxal lobes in the female. In other respects they are alike. In the males the opening of the vas deferens is on the inner side of the first joint. The female has a peculiar development arising from the sternum, in the median region and a little in front of the legs; it consists of two small closely approximated ovoidal lamellæ, widely attached at the base, and just behind these there is another minute one, and the three together form a little pocket or pouch, which is likely to be a receptacle for the spermatophore (spermatheca).

In comparison with *Anaspides* the appendages of the peræon agree pretty closely, except that in the present species the branchiæ are smaller, the peduncular joint of the endopodites stouter, and also the second joint represents the second and third of *Anaspides* completely coalesced.

Calman says in respect of this that in *Anaspides* the second joint is "very small, and partly fused with the third joint, from which, however, it is marked off by a distinct line . . . ." and " becomes less distinct as we go backwards, while in the sixth pair the fusion of these two joints is complete, and the exopod appears to spring from the ischium" (third joint). In *Koonunga*, therefore, the legs are chiefly flexed at the articulation between the fourth and fifth joints, as is the case in the Euphausiacea and Decapoda, instead of the fifth and sixth joints, as shown by Calman to occur in *Anaspides*.

The relative length of the several joints is seen to be in close agreement in the two species by reckoning the second and third together in *Anaspides* as equalling the second in *Koonunga*. It will be seen, therefore, that this does not mean any more than that what is partly coalescent in one species is completely so in another. Dr. Hansen has adduced reasons for using this character as a basis for classification, but it is certainly not reliable in the present order, and I venture to think that Dr. Calman's * definitions of his divisional groups would be better without its inclusion, for it is not always easy to correlate the several joints by numbers from the base.

Abdominal Appendages (*Pleopoda*).—In the female the first five pairs are quite similar to each other, except that they successively become a little shorter. They are used for the purpose of swimming, and each consists of a short stout basal joint followed by a longer one; then follows a long multiarticulate flagellum with each joint bearing two long feathered setæ. There is no vestige of a secondary branch (endopodite) as in *Anaspides*. In the males the third, fourth and fifth are quite like those of the females, but the first two pairs possess endopodites modified for sexual purposes (figs. 18, 19, & 20). The form of these endopodites is almost identical with that observed in *Anaspides*. The first pair is short and broadly spatulate, with the distal margin deeply incised, and the inner margin distally bearing some coupling-spines (figs. 18 & 19). It lies underneath the body, and is directed forwards between the last pair of thoracic limbs, with its deeply concave surface uppermost, and when united by the coupling-spines to its fellow of the opposite side it forms an efficient pouch, which, probably, serves the purpose of a receptacle for holding the spermatophore after passing from the vas deferens, the opening of which is on the first joint of the last pair of legs and thus quite close to it. The endopodite of the second pair is exactly like that of *Anaspides* (figs. 18 & 20) and forms a long two-jointed styliform appendage; the first joint with a row of coupling-spines, and the second joint apically pointed, and hollowed out on its distal inner face to form a deep concave area, which, together with that of the opposite side, forms a little pocket, and when lying horizontally is located within the anterior spermatophore carrier. Each is articulated, so that together they have power of movement downwards. By these organs a spermatophore may easily be passed from the vas deferens to the receptacle formed by the union of the first endopodites; from this it can be received in the pocket formed by the union of the second pair of endopodites, and from this it can easily be transferred to the receptacle in the female, which is medianly situated on the sternum in front of the last pair of legs, and behind the openings of the oviducts on the inner side of the first joint of the fifth pair of appendages of the peræon. How the ova are fertilized is not clear, nor is it known if the spermatozoa are filamentous or not.

Immediately behind the second appendages there is a peculiar median appendage arising from the sternum, which, in ventral view (fig. 20), is of sagittal form, the apex

* Ann. & Mag. Nat. Hist. (7) vol. xiii. p. 156 (1904).

pointing backwards, and the base closely occupying the area between the pair of endopodites. Viewed from the side (fig. 18) the apical portion is seen to curve downwards. Probably the purpose of this process is to aid in holding the female during copulation.

Uropoda (Pl. 2. fig. 21).—These have, relatively to *Anaspides*, a longer basal part, and the two branches (endopodite and exopodite) are slightly narrower and without any keel or transverse suture. The peduncle is stout and projects halfway to the end of the telson, with a few spines on the upper surface; the branches are subequal, of lanceolate shape, and not much longer than the peduncle, the inner one fringed along the inner margin with strong spines and three longer ones distally, and the outer margin fringed with very long feathered setæ; the outer branch fringed throughout with long feathered setæ, and the outer margin in addition fringed with spines.

The *telson* (fig. 21) is short, broad, and of triangular shape, with the apex broadly rounded; the dorsal surface is convex and the margin fringed with two or more series of stout spines. Compared with *Anaspides* it is very much shorter.

Description of a Larval Form.

I have been able to examine one specimen of a larval form (figs. 22–25). It measures 2·5 mm. in length and its general appearance is like that of an adult. All the appendages of the head and peræon are well developed, and so also are the terminal pair of the abdomen, but the five preceding pairs are rudimentary. I offer some details concerning it.

The cephalon has the first thoracic somite joined to it without any distinct mark of division more than a lateral sulcus as in the adult. The front, in dorsal view, is broadly and evenly rounded with the margin entire, the eyes small and situated on the dorsum, and the body-somites all clearly marked off and quite similar in form to the adult.

The antennules have no difference from those of the adult, except that the joints of the flagella are relatively stouter, longer, and much fewer in number. This is also the case in the antennæ (fig. 24), so that there is no apparent difference between the peduncle and flagellum.

None of the appendages of the buccal area showed any structural differences, and although I suspected that I might be able to determine a spine-row in the mandibles, I failed to do so.

The first appendage of the peræon is quite similar to that of the adult, except in having fewer articles in the flagellum of the exopod. The three claws of the dactylus are fully matured. The second and third pairs offer no important differences from the preceding one. The fourth (fig. 25) is also in agreement, except that the dactylus has but one very long claw, and a seta on each side of it, instead of three claws (fig. 25 *a*). This seems to show that the two lateral claws which exist in the adult, and also in the preceding limbs of this larva, are modified setæ; and this gives some support to Dr. Hansen's view that the terminal claw of the Malacostracan limb represents a separate joint. However, I only know of Hansen's generalization through

Dr. Calman (Ann. & Mag. Nat. Hist. (7) xiii. p. 152), and I emphasise the facts for others to accept for what they are worth.

The fifth, sixth and seventh appendages of the peræon are in close agreement with the fourth. The appendages of the pleon (fig. 23) are, with the exception of the terminal ones (uropoda), quite inconspicuous and functionless, appearing only as minute one-jointed papillæ on each somite. The uropoda and telson are, however, quite similar to those of the adult form.

Habitat.—The only locality where *Koonunga* so far has been found is a small extent of shallow marshy country through which a tiny rivulet flows, at Ringwood, near Melbourne. The water is almost entirely dried up for a few months each summer, and indeed is entirely so during some years of less rainfall. The elevation is but slightly above sea-level.

The little crustaceans inhabit the small weedy pools and they are remarkably active; their usual form of locomotion is running, but they can swim rapidly. On one occasion I saw one swimming on its back, just as some Phyllopoda do, but this is quite exceptional. On most of those examined there were a number of sedentary Rotifera of the genus *Floscularia*, and these were lodged principally on the branchiæ.

Systematic Position of Koonunga.

The foregoing description will have amply demonstrated the relationship of the sessile-eyed *Koonunga* to the stalk-eyed *Anaspides*, and warrants my placing them together in the same order; and also, I think, proves my previous statement to be justified, that it is the most primitive Edriophthalmatan so far known.

The following synopsis of characters of these two forms may help to focus the mind upon their features of agreement and disagreement:—

	Anaspides.	*Koonunga.*
Body	Divided into 8 thoracic and 6 abdominal segments, all subequal.	In close agreement, except that the anterior thoracic segment is coalesced with the head.
Eyes	Stalked.	Sessile.
Antennules	3-jointed peduncle and two flagella; auditory organ in basal joint; sexually differentiated in male.	Similar.
Antennæ	Peduncle of 4 joints, scale on 2nd joint.	Similar, but no scale.
Mandibles	Cutting-edge broad, spine-row and molar expansion; no secondary cutting-plate; 3-jointed palp.	Similar, but no spine-row.
1st maxillæ	Two lobes; rudimentary palp and exopodite.	Two lobes, no exopodite; palp more definite.
2nd maxillæ	Four lobes.	Similar.

	Anaspides.	*Koonunga.*
Maxillipeds	Pediform, 8-jointed, with two branchiæ and exopodite, and two gnathobasic lobes.	Relatively stouter, 7-jointed, branchiæ and exopod similar, no gnathobasic lobes.
Peræopoda	Anterior ones 8-, posterior ones 7-jointed. Each, except last, with 2 branchiæ. A swimming-exopod on the first five pairs and a rudimentary one on the sixth pair.	Of similar form, all 7-jointed. Each except last pair with 2 branchiæ. Swimming-exopod on the first five pairs only.
Pleopoda	Natatory, endopodite rudimentary, first two pairs modified in male.	Quite similar, but endopodite absent, except in first two pairs of male.
Uropoda and telson . . .	Together forming a fan.	Similar.
Oviduct	?	Opening on the antepenultimate legs.
Spermatheca	?	On sternum in front of last legs.
Vas deferens	?	Opening on the last legs.
Copulatory organs . . .	The endopodites of the 1st and 2nd pleopods.	Similar.

It is obvious from a review of these two forms that *Koonunga*, more particularly, shows conspicuous modifications in the direction of the sessile-eyed characters, notably in the coalescence of the first thoracic segment and head, the character of the eyes, the mouth-parts, and also in the absence of any antennal scale.

I was hopeful that *Koonunga* would have shed considerable light on the Cumacea and Tanaidacea, but after careful examination I fail to find any of importance. The divergent sessile-eyed branch of the stalk-eyed stem seems to have a wide gap between *Koonunga* and other forms. It may be mentioned, however, that in *Koonunga* there is a good deal that points to the Amphipod type, at least, more than to the Isopod, notably in the general form of the body and its somites, the position of the eyes, which are above the base of the antennæ, not lateral to them, as in the Isopoda, the shape of the first maxillæ, the pleopoda, and also in the short terminal somite and its uropoda, together with the telson; but there are very many characters of dissimilarity to that order, as well as to the other sessile-eyed forms; of these the following characters may be mentioned: the absence of a brood-pouch, the antennal peduncle having four instead of five joints, the absence of a secondary cutting-plate (lacinia mobilis) in the mandibles, and the possession of an auditory organ at the base of the upper antennæ.

Undoubtedly there is a much closer relationship with the stalk-eyed forms, and of these it is nearest to the Mysidacea and Euphausiacea, but, although there are many characters of agreement, there are such marked and apparently dominant characters of difference that I believe it better placed in a separate order from either of them. Of the two, *Koonunga* is nearest to the Euphausiacea, at least in its external anatomy, notably in the uniformity of the maxillipeds and thoracic limbs, the mandibles not having a spine-row, the pleopoda, with their sexual differentiation, and the absence of a brood-pouch. One would have expected that it would have been in closer relationship to the Mysidacea, but, judging from its outward appearance alone, this is not so.

From these two groups the following fundamental external differences occur:—Absence of a carapace, presence of a double series of leaf-like epipodial branchiæ on the thoracic limbs, which are seven-jointed and well adapted for walking, also the presence of an auditory organ in the base of the upper antennæ. In all of these *Anaspides* also agrees.

It must be acknowledged that until more is known of the internal anatomy and embryology of the Anaspidacea the systematic position is rather uncertain. I understand from Mr. Geoffrey Smith that he will shortly make a further contribution to our knowledge of the anatomy of *Anaspides*, and, if opportunity permits, I hope to do something for *Koonunga* during this year. I am alive to the importance of a knowledge of its embryology, and will do my best to procure material for this also.

In respect to other forms that bear a rather close resemblance in some important characters to the present species, I may refer the reader to Dr. Calman's paper in the Journal Linn. Soc., Zoology, xxvii. (1899) pp. 338–344, on *Bathynella natans*, Vejdovsky, a minute crustacean taken from a well in the city of Prague, and also to his remarks concerning some forms from the Palæozoic Coal-Measures (Trans. Roy. Soc. Edinburgh, xxxviii. (1897) pp. 796–801). Restored drawings are there given, with valuable remarks on the comparison with *Anaspides*.

EXPLANATION OF THE PLATES.

Plate 1.

Koonunga cursor.

Fig. 1. Side view of whole animal, a male, × 16.
2. Outline of a female, dorsal view, × 13.
3. Side view of cephalon and first segment of peræon, × 37.
4. Ventral view of appendages of cephalon and of first segment of peræon *in situ*, × 37.
5. Part of antennule of a female, from above, × 37.
6. Part of antenna, × 37.
7. Part of antennule of a male from underneath, showing sexual modifications, × 200. 7 *a*. Part of the surface-armature of male organ in side view.
8. Anterior lip, × 45.
9. Posterior lip, × 37.
10. Mandible of right side, × 75.
11. Mandible of left side, × 75. 11 *a*. Showing continuity of cutting-plate and molar expansion, increased magnification.
12. First maxilla, × 127.

Plate 2.

Fig. 13. Second maxilla, × 127. 13 *a*. Palp, × 195.
14. Maxilliped, side view, × 45.
15. First appendage of the peræon, × 45.
16. Part of the fifth appendage of the peræon of a female, showing the inner coxal lobes of each side in normal position, × 45.

Fig. 17. Distal portion of the seventh appendage of the peræon, × 90. 17 *a*. Two of a series of spines on the fifth joint, increased magnification.

18. Side view of portion of the last somite of the peræon and the first and second somites of the pleon of a male, showing the sexual organs; * denotes the opening of the vas deferens on the inner side of the coxa of the last leg, × 45.

19. Ventral view of the first pleopod of a male, × 45. 19 *a*. Inner edge of endopodite showing some coupling-spines, × 172.

20. Ventral view of the second pleopod of a male, and the endopodite of the opposite side, together with the sternal process in natural position, × 45.

21. Telson and uropod, × 45.

22. Dorsal view in outline of a larva, × 27.

23. Side view of abdomen and last somite of the peræon with the appendages, same larva, × 27.

24. Antenna of larva, × 75.

25. Fourth appendage of peræon of larva, × 97. 25 *a*. End of the same, × 172.

Note on some Characters of Koonunga *and* Anaspides.

By W. T. Calman, *D.Sc.*, *F.L.S.*

In presenting to the Society Mr. Sayce's account of his very remarkable discovery, I take advantage of his kind permission to add a few observations.

In the original account of *Anaspides*, the positions of the genital apertures were wrongly given. *Anaspides* agrees with *Koonunga* and with all other Malacostraca in having the openings in the female on the sixth and in the male on the eighth thoracic somite. The oviducts open on the inner face of the coxopodites of the sixth pair of thoracic appendages. Just distal to the aperture, the coxopodite bears a setose lobe, turned forwards, and similar lobes are present on the coxopodites of the fifth and seventh pairs. The male ducts open, not on the coxopodites, but on the sternum of the last thoracic somite, by oblique slits converging anteriorly. The terminal part of the vas deferens is enlarged and apparently glandular.

On the sternum of the last thoracic somite in the female is a curious structure representing the spermatheca which Mr. Sayce has discovered in *Koonunga*. It is a rounded prominence, directed forwards, with a wide transverse slit at the tip. This aperture (erroneously described as the opening of the oviducts) gives entrance to a blind sac with thick walls, on each side of which at the base is what appears to be a racemose gland opening into its cavity by a short duct.

It seems to me a significant fact that the only structures (so far as I know) comparable to this spermatheca are found among the Decapoda, with which, it may be recalled, the Syncarida also share the possession of an antennal statocyst. In the Penæidæ the structure described by Spence Bate as the "Thelycum," situated on the thoracic sternum between the bases of the last two pairs of legs, is now known to be a sperm-receptacle *. In the Lobster (*Homarus*) a sperm-receptacle in the same position has been described by Bumpus †, and in the Crayfishes of the genus *Cambarus* a similar structure is known as the "annulus ventralis." Andrews ‡ does not consider the structures in the Lobster and Crayfish to be homologous, and does not refer to that of the Penæidæ. It seems probable, however, that a comparative investigation of the three types of organ in the Decapoda together with that of the Syncarida might yield results of interest.

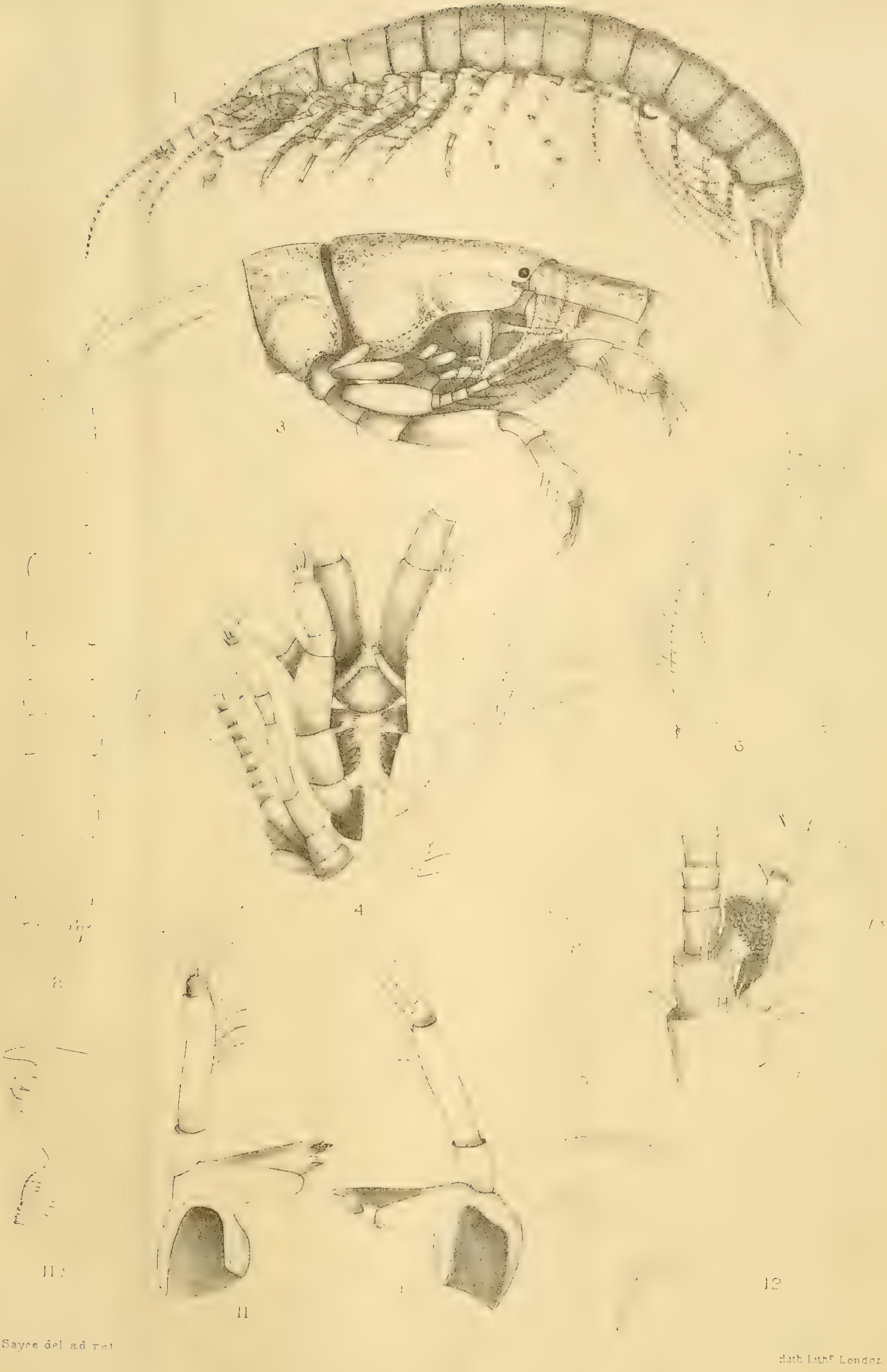
The most striking and unexpected character of *Koonunga* is the sessile condition of the eyes, which makes still more plain the impossibility of continuing to regard the two genera as "Schizopoda." I see no reason to modify the opinion which I formerly expressed §, that *Anaspides* must be regarded as representing a distinct Order, forming by itself a Division of the Eumalacostraca, to which Packard's name Syncarida has been given. To this Order *Koonunga* must now be added, and I do not think that the modifications thereby rendered necessary in the definition of the group in any way impair its distinctness from the other Divisions of the Malacostraca.

* Kishinouye, "Japanese Species of the Genus *Penæus*," Journ. Fisheries Bureau, Tokyo, viii. No. 1 (1900).

† "Embryology of the American Lobster," Journ. Morphology, v. p. 216 (1891).

‡ E. A. Andrews, "The Annulus Ventralis," Proc. Boston Soc. Nat. Hist. xxxii. No. 12, pp. 427–479, pls. xliii.–xlviii. (1906).

§ "On the Classification of the Crustacea Malacostraca," Ann. & Mag. Nat. Hist. (7) xiii. p. 155 (1904).



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II. *On some new Alcyonaria from the Indian and Pacific Oceans, with a Discussion of the Genera* Spongodes, Siphonogorgia, Chironephthya, *and* Solenocaulon. *By* Ruth M. Harrison, *Lady Margaret Hall, Oxford.* (*Communicated, with a Prefatory Note, by* Prof. G. C. Bourne, *M.A., D.Sc., F.L.S.*)

(Plates 3-7.)

Read 6th February, 1908.

PREFATORY NOTE.

The following paper by Miss R. M. Harrison is the partial fulfilment of a piece of work undertaken by me some years since and long overdue. It is necessary that I should give an explanation of the circumstances under which the first collection of Alcyonaria made by the Trustees of the Calcutta Museum came into my hands, and why the publication of this work has been so long delayed. The Alcyonaria were sent in the first instance to Mr. W. L. Sclater for identification and description: on his leaving Eton College for S. Africa he found himself unable to complete his preliminary investigation of the material, and after asking several other authorities to undertake the work, he eventually entrusted it to me, with the consent of the Trustees. By 1899 I had made some progress in working out the Spongodidæ and Siphonogorgiidæ, but on the outbreak of the war in S. Africa I was called away on military duties and the work was laid aside. Since then the pressure of other work has prevented my resuming it, and in 1907 I gave the collection together with my notes and drawings to Miss Harrison, and asked her to begin the investigation afresh. This she has done in a very able manner. But I was not aware, for I had not been informed, that meanwhile the Trustees of the Calcutta Museum had officially entrusted the description of the collections of Alcyonaria made by them in the Bay of Bengal to Professor J. Arthur Thomson, and he was equally unaware that the earliest collection was in my possession. Consequently there has been a certain amount of overlapping in the work done under his direction and mine on collections of Alcyonaria from the same area. My apologies are due and are hereby tendered to the Trustees of the Calcutta Museum and to Professor Thomson for the long delay, which has possibly introduced a confusion in the naming of certain species. At the same time I have to thank Professor Thomson for prompt and kind co-operation, which I hope will minimize any confusion that may possibly arise.

It will be observed, however, that one of the five new species of *Spongodes* and seven of the eight new species of *Chironephthya* described by Miss Harrison do not come from the Indian Ocean, and do not form part of the collections of the Trustees of the Calcutta Museum.—G. C. Bourne.

Oxford, January 10, 1908.

I.—INTRODUCTION.

THE forms dealt with in this paper come from three sources. The greater number of Siphonogorgiidæ (*Siphonogorgia* and *Chironephthya*) were collected by Capt. Bassett-Smith, R.N., of H.M.S. 'Egeria,' in the Admiralty Islands, and presented by him to the British Museum. A single and interesting species of *Spongodes* was collected by Capt. Chimmo in the China Seas and presented to the Oxford Museum. The remainder of the species described form a part of the first collections made in the Bay of Bengal by the Trustees of the Calcutta Museum, and eventually entrusted to Professor G. C. Bourne. I am glad to have this opportunity of expressing my thanks to Professor Bourne for providing me with this material and also for placing at my disposal all the resources of his laboratory, but more especially for his invaluable help and kindness during the progress of my work. My thanks are also due to Professor F. Jeffrey Bell for allowing me to examine the *Spongodes* and Siphonogorgiidæ in the British Museum (a description of some new Siphonogorgiidæ will be found in the following report); to Professor J. Arthur Thomson, of Aberdeen University, for the loan of two of his *Spongodes*; and to Dr. E. H. J. Schuster, Fellow of New College, Oxford, for the beautiful photographs on Plate 3.

The paper is confined to five species of *Spongodes*, all of which are new, two *Siphonogorgia*, of which one is new, ten *Chironephthya*, of which nine are new, and four *Solenocaulon*.

The difficulties in the identification of these forms have been very great, owing partly to the fact that such numbers of new species have been created, frequently based on only a single character, and partly because many of the descriptions and figures are quite inadequate, and the same characters are seldom consistently described in the different species. Sometimes stress is laid on the shape of a colony or the mode of branching; sometimes on the spicules of the stem or branches, special attention being paid to their size, their character, or their arrangement; or the armature of the polyp or the tentacles may have been considered of primary importance.

Kükenthal (30) has revised the classification of the genus *Spongodes*, and he bases his main divisions on the mode of branching of the colony and the grouping of the polyps on the terminal branches. He recognizes three types:—(1) Glomeratæ: branching slight; polyp-bundles in smaller or larger rounded groups, surface of polyp-bearing part consequently much broken up. (2) Divaricatæ: branches much spread out and diverging from one another; polyps scattered on slender terminal twigs and not gathered together in bundles. (3) Umbellatæ: terminal twigs form umbels, with polyps borne on the surface of the polyp-bearing portion, and never on stem or main branches. He makes further subdivisions, using such characters as the predominance of the stem and main branches over the polyp-bearing twigs in the development of the colony or *vice versa*; the regular or irregular outline of the polyp-bearing part; the plane in which the polyp-bearing part develops, or its shape.

Having had an opportunity of inspecting the British Museum specimens, and judging from the five species described below and the beautiful photographs which illustrate the papers of Kükenthal (30), Holm (20), and Burchardt (5), I feel convinced the foundation on which Kükenthal has built his three main divisions touches a question of primary importance. Just as an oak or an elm or a beech stripped of its leaves shows a totally different mode of branching, so, I believe, the way in which the polyps are grouped on the terminal twigs, the mode of aggregation of the twigs to the branches, of the branches to the stem are characters of subgeneric value. On the further details of shape I feel less stress should be laid, for I am of Professor Hickson's opinion that the exact form and mode of branching of a colony is influenced to a large extent by the external conditions. Since that is a subject on which we can get no positive information, it seems to me safer to neglect details of form and shape and to confine the specific diagnosis to the mode of aggregation of the twigs and branches. For example, while I consider the difference in the form of growth between *Spongodes thomsoni* and *Spongodes chimmöi* sufficient to be of subgeneric importance, such distinctions as to whether the polyp-bearing surface is a long oval or a broad oval or practically spherical are highly unsatisfactory. I am unable to add anything as regards the anatomical and histological characters, owing to the poor state of preservation of my material. But I believe that a reliable character on which to base specific groups is to be found in the spiculation. The sterile stem bears spicules totally different in character from those of the branches, and the spicules of the inner partition-walls are different again from those of the outer wall. The armature of the polyp-heads of a colony shows a general agreement in the arrangement of the spicules, although there may be a considerable amount of variation in the individual polyps. The variation between the polyps of different colonies is often very striking, as is obvious from a comparison of such forms as *S. argentea*, *S. clavata*, *S. hicksoni*, or *S. kölliikeri*, all examples of the division Glomeratæ. These variations are accompanied by differences in other characters. Taking the spicules of the partition-walls: *argentea* has broad warty spindles 1·2×0·3 mm. in size; *clavata* has merely little rods 0·06 mm. long; *hicksoni* and *kölliikeri* both have spindles much the same size, 2·0×0·35 mm. and 2·0×0·2 mm. being the given measurements, but those of *hicksoni* are mentioned as being hooked and curved. In the branch-walls *argentea* has slender thorny spindles; *clavata* has two kinds—spindles 2·6 mm. long, and numerous small thorny spindles 0·2 to 1·2 mm. in length; in both *hicksoni* and *kölliikeri* the spicules are set transversely, but the difference in size is 2·8×0·22 mm. and 6·0×0·19 mm. respectively. These examples leave little room for doubting that the four species are quite distinct and are rightly separated. It is when such characters as these are not consistently different or consistently similar that the task of species-making becomes so difficult. An added difficulty is the variation between different described specimens of the same species. For example, in the British Museum there are two specimens labelled *S. divaricata*, in one of which the body of the polyp is unarmed, the tentacles only bearing spicules; in the other each point has one large projecting spicule and two or three smaller ones inclining towards it; in neither case do they answer to Kükenthal's description of a polyp armed with "Doppelreihen von je fünf spitz konvergierenden Spiculapaaren." Again, the one with no spicules in the polyp has large spicules in both the outer and inner walls, the other has small spicules in the outer walls and none at all in the canal-walls; in neither could I find spicules resembling those figured by Kükenthal. It is difficult to see on what grounds these specimens have been considered the same species, and Gray's original diagnosis is so sketchy that it is not possible to determine which form has prior claim to the name *S. divaricata*. On the other hand, it is probable that there are many instances where new species have been made on insufficient grounds. With this in view, Kükenthal has considerably reduced the number of described species. For example, the two 'Challenger' specimens named by Wright and Studer *S. cervicornis* and *S. rhodosticta* respectively, he regards as one and the same species, on the grounds of great similarity in the general plan of growth and in the armature of the polyp. They also agree in the absence of spicules from the canal-walls, although this seems to have escaped his notice. There is, however, a striking difference apparent even to the naked eye on which he scarcely lays sufficient stress; this is the contrast between the spicules of the barren stem. In *S. cervicornis* they are long spindles disposed more or less transversely; in *S. rhodosticta* they are small, very irregular, thorny, many-rayed structures. The polyp-heads are also different in colour, being purple-red in one and orange-red in the other. If these differences are not sufficient to outweigh the points of agreement and to justify a separation of the species they are at least worthy of special mention. At all events, the above examples illustrate some of the difficulties to be contended with in the identification of species and show how necessary are co-operation and comparison in a genus of such variability and magnitude.

The subfamily Siphonogorgiaceæ was made by Kölliker (25), who regarded it as intermediate between the Alcyoniidæ and the Gorgoniidæ, and in it put the single genus *Siphonogorgia*. Wright and Studer (57) placed *Siphonogorgia*, together with *Chironephthya*, *Paranephthya*, and *Scleronephthya*, in the subfamily Siphonogorgiinæ of the family Nephthyidæ, distinct from the other subfamily Spongodinæ in the abundant presence of spicules in the canal-walls. Kükenthal (27) removed the genera *Paranephthya* and *Scleronephthya* to the new genus *Paraspongodes* in the family Nephthyidæ, and raised the subfamily Siphonogorginæ to the rank of a family equal to the Nephthyidæ as the family Siphonogorgiidæ, and in it he placed the genera *Siphonogorgia* and *Chironephthya*—the justification for this step being that the Siphonogorgiidæ are intermediate in form between the Nephthyidæ and the Gorgoniidæ; and he gives as the diagnostic characters of the family: "Ein Stammteil fehlt. Kolonie aus wenig verzweigten cylindrischen Asten bestehend, auf denen die in einen Kelch zurückziehbaren Polypen sitzen." I do not know what is meant by "Ein Stammteil fehlt." In many of the species there is an obvious stalk figured—for example, *Siphonogorgia pendula* or *Chironephthya dipsacea*; and it is so very easy for the stalk to become broken in the process of dredging that it could hardly be a character of much value. In the present report I follow Kükenthal in recognizing the family Siphonogorgiidæ, with the following characters:—Erect tree-like colonies with stiff, slender, cylindrical branches. Polyps may or may not be retractile. Canal-walls richly filled with spicules.

The family contains two genera, *Siphonogorgia* and *Chironephthya*.

The original diagnostic characters of the two genera have been shown by Prof. Hickson (18) to be inconstant, but I believe there is a really reliable distinction in the form of growth and the mode of branching of the canal-system. *Siphonogorgia* is a solid massive growth in which both stem and branches are round and cylindrical, the whole colony being of a rigid brittle consistency. *Chironephthya* may or may not have a round cylindrical stem, but the branches lose the solid appearance and become somewhat flattened and deeply grooved, and the terminal twigs are very much more slender than those of *Siphonogorgia*. Turning now to a section, the reason for this becomes obvious. In the barren stem of *Siphonogorgia* (text-fig. 1) there is one large central canal and numerous

Fig. 1.

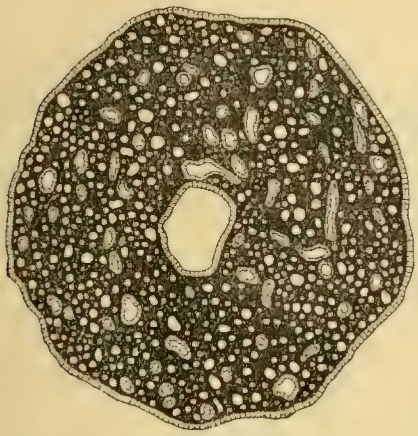


Fig. 2.

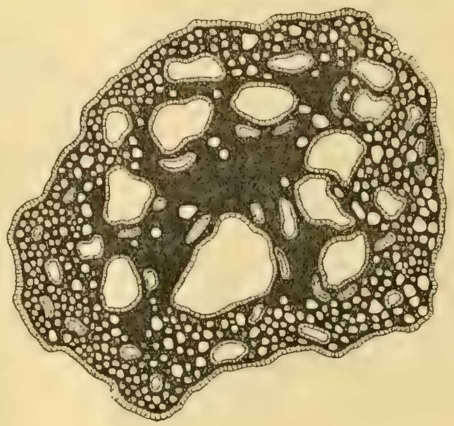


Fig. 1.—Transverse section through the barren stem of *Siphonogorgia rotunda*. In this and the succeeding text-figures the mesoglœa is represented in black; the cavities occupied by the spicules before decalcification are left white; the endoderm lining the central canal and solenia is represented conventionally.

Fig. 2.—A transverse section through the stem of *Chironephthya pendula*.

small anastomosing solenia; the whole cœnenchyma is studded with numerous spicules of varying size with their long axes vertical, to the presence of which the stem owes its rigidity. In the branches (text-fig. 3) the main canal will have divided into several secondary branches, which in their turn branch further until they terminate in a polyp-cavity. The solenia of the branches are few in number; quantities of spicules are again found everywhere.

In the stem of *Chironephthya* (text-fig. 2) there is a ring of about eight canals surrounding a mass of cœnenchyme practically without spicules; outside this ring the cœnenchyme is filled with spicules, but their absence from the centre makes the stem very much more lax than that of *Siphonogorgia*. In the branches (text-fig. 4) the canals become immense and the cœnenchyme is very much reduced, and in consequence of there being no solid mass of tissue strengthened with spicules to keep the branch stiff and rigid the walls collapse and give the grooved irregular effect already noticed.

In this family, as Professor Hickson (18) has already pointed out, a study of the spicule arrangement in the polyps is disappointing, for no single colony or even branch of a colony has exactly similar polyps, but the extent of the variation is not very great; in fact, a general type of arrangement can be given as a diagnostic character of the genera. In *Chironephthya* there are generally two to four spicules arranged "en chevron" in the points of the anthocodiæ, while in *Siphonogorgia* the spicules of the points are arranged irregularly or practically straight and not inclined towards one another. But even among the *Chironephthyæ* there are considerable variations in the armature of the polyps. The three original 'Challenger' specimens are so similar in form and general spiculation that Prof. Hickson suggests that "it will be found in the future that it is not advisable to recognize in them more than one species." Having had an opportunity of examining the actual specimens I doubt this. The polyp of

Fig. 3.

Fig. 4.

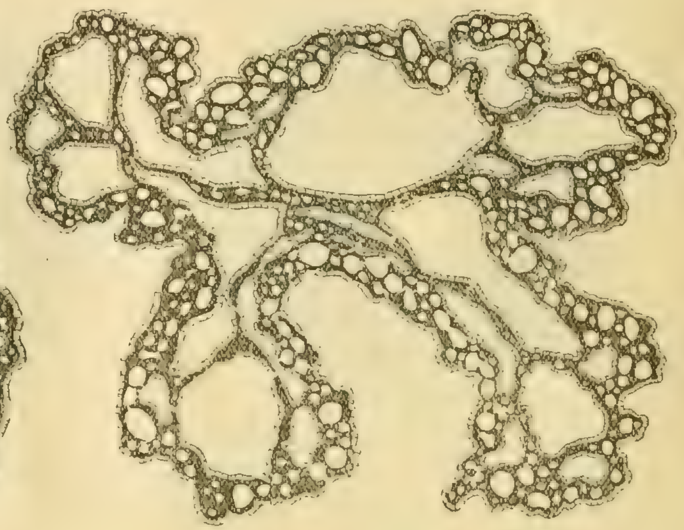


Fig. 3.—A transverse section through a branch of *Siphonogorgia rotunda*.
Fig. 4.—A transverse section through a branch of *Chironephthya pendula*.

C. dipsacea is entirely different from that of the other two; and although I admit that *C. crassa* and *C. scoparia* are probably the same species, I think *C. dipsacea* should be kept distinct, or at any rate notified as a distinct variation. I append three camera drawings (Pl. 6. figs. 61, 62, 63) of the polyps of the 'Challenger' specimens, which have not been figured before. It will be seen that the polyp of *C. dipsacea* is not only smaller but is much more like a *Siphonogorgia*. Another very characteristic feature of *Chironephthya* is the presence in the partition-walls of a large number of minute elongate spicules averaging about $0{\cdot}25 \times 0{\cdot}02$ mm., pointed at both ends and beset with short spikes, and generally tinged with a paler shade of the characteristic colour of the colony. For example, in the three specimens of *C. variabilis* these spicules are orange, red, and pink respectively. These characters seem to me to express in a decisive manner what Wright and Studer originally meant when they said that "the habit of the colony was more suggestive of *Nephthya*," and are of far more importance than such characters as the retractility of the polyps or the arrangement of the spicules of the anthocodiæ. As a matter of fact, the polyps of *Chironephthya* are seldom retractile, and there are generally four spicules in the points of the anthocodiæ arranged "en chevron"; but the complete retractility of *C. siphonogorgica* and *C. retractilis* and the armature of the polyps of *C. dipsacea* show that the characters are not infallible. Therefore until a series of intermediate forms is described it will be found convenient to distinguish *Chironephthya* from *Siphonogorgia* by the mode of branching of the canal-system. This is the course I have adopted in the present report, and in the systematic part will be found the necessary readjustment of the already-described species.

With regard to the genus *Solenocaulon*, Janower (22) has given such an excellent historical review that I need only here refer to it.

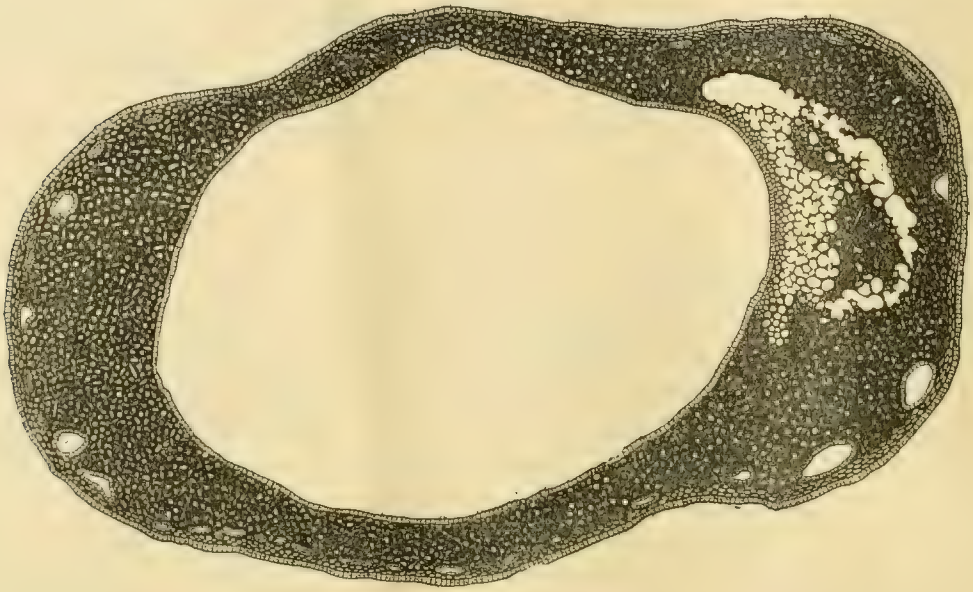
Of the four *Solenocaulons* in this collection, one is undoubtedly Hickson's new species *S. ramosum* * and calls for no special comment. The other three form an interesting series, and as I believe them to be all the same species I shall refer to them as A, B, and C. The first most noticeable feature common to all three specimens is that they are unbranched—that is to say, that each colony consists of a single straight hollow main trunk which gives off small lateral twigs, with polyps borne both on the twigs and the main trunk; there is no extensive branching such as Janower figures in the photograph of Gray's original *S. tortuosum* (22) or Genth's figure of *S. tubulosum* (11). The second striking feature is the retractility of the polyps. In A they are very much expanded, a conical calyx projects from the smooth surface of the main trunk or twig, and the polyp-heads project conspicuously beyond. In B the same thing occurs, but not so markedly. In the flattened tubular nature of the little branches both these forms resemble *S. tubulosum* (Genth). In C the polyps are completely retractile, and only a very slight elevation marks their position externally. In this and in the solid grooved appearance of the twigs the colony resembles *S. tortuosum*.

With regard to the solid axis about which there has been so much controversy: in A and B there appears to be a "porous calcareous rod . . . . which does not break up on boiling in 5 % potash." This is shown in text-figs. 5 and 6. Text-fig. 5 is a transverse section through the main trunk, and text-fig. 6 a transverse section through a terminal twig; in both this porous rod is obvious. It is absent in the stalk, of which a quadrant is shown in text-fig. 7. When Germanos (12) made his classification, in which he relied so much on the presence or absence of a "solid axis," I doubt that he ever meant to imply more than a "porous rod," such as is shown to exist in the present specimen. Turning now to specimen C, which outwardly resembles *S. tortuosum*, the circumstances are different, for here the "porous rod" is not continuous, but appears to consist of a series of calcified centres in which the spicules are fused together as in A and B, alternating with tracts in which the spicules are disposed quite loosely in the cœnenchyme. This is shown by a comparison of text-figs. 8 and 9, which are two sections from the same series: text-fig. 8 is a transverse section through a branch and a lateral hole, and shows the porous rod; text-fig. 9 is taken just below the lateral hole where the main trunk has become tubular again, the porous rod is entirely absent. It will be noticed in text-fig. 8 that there is a similar calcification in the branch, but I am quite unable to find

* I have changed the feminine termination of *ramosa* to the neuter *ramosum*, to agree with the neuter noun.

any connection between it and the porous rod in the main trunk. There is no appearance of this discontinuity externally.

Fig. 5.



Transverse section through the tubular main trunk of *Solenocaulon tortuosum*, specimen B, decalcified, showing the position of the "porous rod" and arrangement of the nutritive canals.

Fig. 6. Fig. 7.

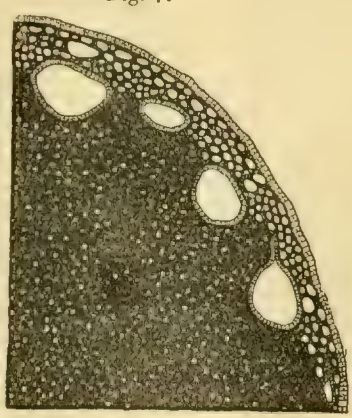


Fig. 6.—Transverse section through a terminal twig of *Solenocaulon tortuosum*, specimen B, decalcified. The section passes immediately below a polyp on the right-hand side; hence the nutritive canals of that side are pushed from the periphery nearer the central "porous rod." Note the absence of nutritive canals from the grooved (upper) surface.

Fig. 7.—Quadrant of a transverse section through the stalk of *Solenocaulon tortuosum*, specimen B, showing the absence of the "porous rod."

The spiculation of these three specimens, and indeed that of *S. ramosum*, shows a very remarkable conformity. In all the bark consists of numerous small, more or

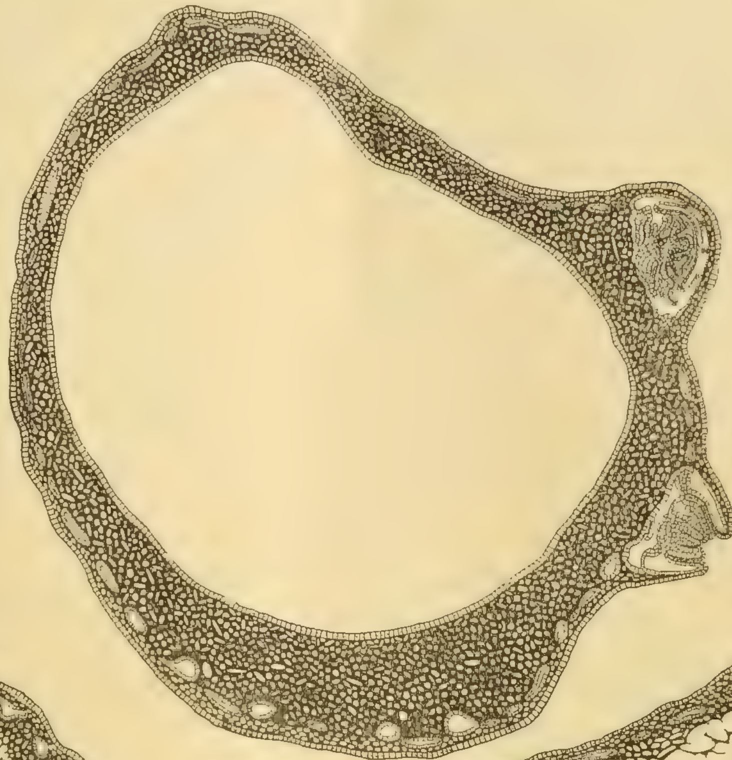


Fig. 9.—Transverse section through the tubular main trunk of *Solenocaulon tortuosum*, specimen C, showing absence of porous rod.

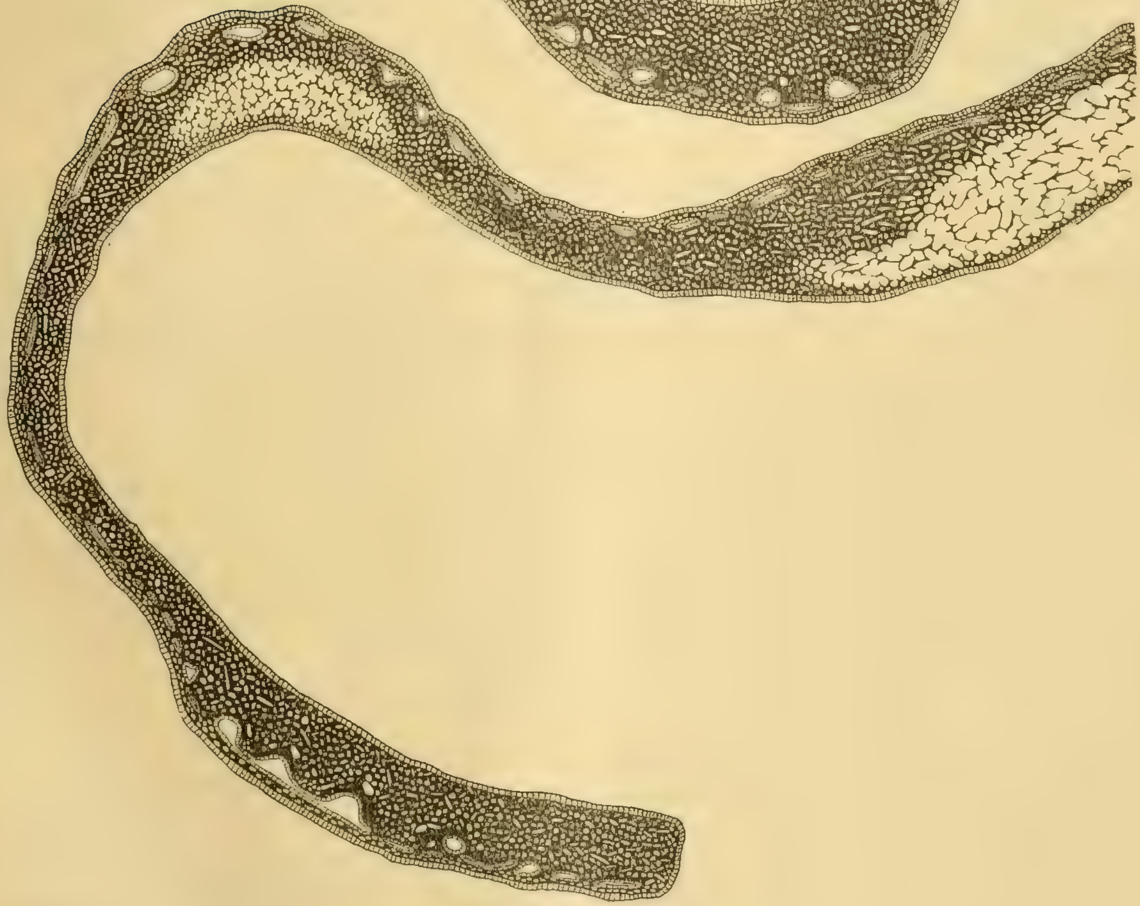


Fig. 8.—Transverse section through a branch and lateral hole of *Solenocaulon tortuosum*, specimen C, showing the porous rod.

less oval spicules, covered with very irregular warts or spines: the axis contains elongated spicules beset with few blunt spines. In the tubulur colonies one might expect to find that the spicules lining the tube would be of the same nature as those of the bark: as a matter of fact, this is not the case. These spicules (to which I shall refer as those of the "inner bark," to distinguish them from those of the "outer bark") resemble more closely those of the axis, but they are very much shorter. The spicules of both inner and outer bark are practically the same size in all three specimens. I cannot find the great variability in length quoted by Janower: for instance, he states that the length of the bark-spicules of *S. tubulosum* varies between 0·04 and 1·2 mm., and those of *S. tortuosum* between 0·05 and 0·6 mm.; moreover, he finds spicules in the axis of *S. tortuosum* only 0·03 mm. long. As he calls no special attention to the minuteness of these spicules, and as there are instances in his paper where the decimal point has been omitted, it suggests a doubt as to the correctness of the statement in the one case, and what is meant in the other.

The result of a comparison of these forms, which have points of resemblance to *S. tortuosum* on the one hand and to *S. tubulosum* on the other, leads me to Professor Hickson's conclusion that the two species are probably one and the same. At all events, I am convinced that the three specimens in the present collection belong to the same species, and I have accordingly called them *S. tortuosum*.

II.—SYSTEMATIC PART.

Fam. NEPHTHYIDÆ.

Genus SPONGODES (Lesson, 1834).

Branching tree-like Nephthyidæ whose polyps are always united in bundles protected by one or more projecting spicules. Three types are distinguishable:—

1. Glomeratæ: branching slight; polyp-bundles in smaller or larger rounded groups, surface of polyp-bearing part consequently much broken up.
2. Divaricatæ: branches much spread out and diverging from one another; polyps scattered on slender terminal twigs and not gathered together in bundles.
3. Umbellatæ: terminal twigs form distinct umbels. These umbels may be separate from one another, or several joined together to form larger umbels, or all the umbels or groups of umbels may form one continuous surface. In all cases the polyps are found on the surface of the polyp-bearing portion.

Kükenthal has reduced the number of described species to eighty-seven, of which twenty-eight are new. In addition to these species are twenty-nine other described species, of which four are not given a position in his systematic scheme owing to their inadequate descriptions; sixteen have been referred to other species; eight are referred to the genus *Spongodia* under the new name *Stereonephthya*, of which two are new; and eleven are referred to the genus *Nephthya*. Since the publication of Kükenthal's paper, Thomson and Henderson (51, 52, and 53) have described seven new species;

and I now add five more, bringing the total number of *Spongodes* up to $87+4+7+5=103$ and *Spongodia* to 8. Considering the slight variations on which many new species are formed, these numbers are probably far too large; but so long as the present method of classification of the genus is adopted, it is necessary to record details of variation.

The most interesting form in the present collection is undoubtedly *S. biformata*, in which the flattened branches bear polyps of alternating sizes; a table of measurements is given with the description of the species. It is most unfortunate that the cell-layers are in such a poor state of preservation that it is impossible to make any histological observations on it; but the regular alternation of long stalked and short sessile polyps is sufficiently pronounced to suggest that a thorough investigation might prove interesting to anyone who is fortunate enough to obtain a similar specimen fresh or well-preserved. It is probable that polyps of alternating size occur in all species that have flattened foliate branches. Such appears to be the case in *S. rubescens*, but the lower branches are all so much broken that it would be rash to make a definite statement.

Lastly, I do not follow Kükenthal in changing the name *Spongodes* to *Dendronephthya*. The name *Spongodes* was invented by Lesson 73 years ago, and Kükenthal can find no better reason for changing it than its similarity to the allied genus *Spongodia*. The similarity, if apt to be confusing, is not, in my opinion, sufficient to justify the change, and throughout I have employed the original name.

Spongodes thomsoni, sp. n. (Pl. 3. fig. 4; Pl. 4. figs. 17, 18, 19; Pl. 5. fig. 35.)

Belonging to the Divaricate *cervicornis* group of Kükenthal. Two specimens.

A.—Length 18 cm., greatest breadth 9 cm., sterile stalk 2 cm. Main stem gives off branches up its entire length more or less at the sides in one plane. These break up into a large number of twigs bearing bunches of 3–10 polyps. Polyps on stalks 1–2 mm. long, and borne at right angles to stalk. One spicule projects beyond each polyp-head for 1 mm. Spicules of anthocodia in 8 double rows arranged *en chevron*, one large spicule to each point, other smaller spicules irregularly disposed. Stem-spicules various: curved spindles $0·8 \times 0·1$ to $1·0 \times 0·05$ mm.; mostly irregularly tri- or quadriradiate forms reaching $0·5 \times 0·4$ mm. from arm to arm; all covered with warty projections. Branch-spicules: curved spindle type $1·0 \times 0·05$ mm. Spicules of partition-walls very scarce and minute, $0·1 \times 0·02$ mm. Tentacles double row of small irregular spicules about $0·05 \times 0·01$ mm. Spicules of supporting bundle $2·7 \times 0·1$ mm.

Colour. Stem and main branches yellowish white; twigs becoming gradually orange; polyps white.

B.—Length 19 cm., breadth 7·5 cm., sterile stalk two-fifths of whole length. Mode of branching and spiculation of stem, branches, partition-walls, and anthocodiæ like that of specimen A.

Colour much paler. Twigs never becoming more than a pale yellow ochre. Polyps white.

Hab. Bay of Bengal.

SPONGODES ELEGANS, sp. n. (Pl. 3. fig. 2; Pl. 4. figs. 26, 27; Pl. 5. figs. 36, 37.)

Belonging to the Divaricate *cervicornis* group of Kükenthal. Length 10 cm., breadth 6 cm., sterile stalk 3·5 cm. Main stem divides into two branches, each of which divides again into two, and these further subdivide into numerous twigs. Two lower branches form a flattened collar nearly encircling the stem. Polyps on stalks of 1 mm. in clusters of 4–8; one large spicule projects sometimes as much as 2 mm. Anthocodia has 8 double rows of 4–6 spicules arranged *en chevron*, outermost larger and projecting beyond bases of tentacles. Tentacles with double row of irregular colourless spicules. Stem-spicules: straight or branched spindles, or definitely tri- or quadriradiate forms, 1·35×0·2 mm. or 0·45×0·4 mm. from arm to arm. All covered with large warty projections. Branch-spicules: spindles only, of very varying size, 4·0×0·4 mm. to 0·2×0·05 mm. Larger spicules with warty projections; these become less numerous and prominent in the smaller forms. Spicules of the supporting bundle may reach 5·5×0·35 mm. Spicules of partition-walls: stem closely filled with spicules of quadriradiate type varying in size between 0·1×0·02 and 0·4×0·35 mm. In the branch partition-walls spicules are less numerous, of spindle type, 1·4×0·25 mm.; also minute spicules 0·1×0·02 mm., with forked extremities.

Colour. Sterile stem a light brick-red; main branches white, shading gradually from pink to red twigs. Polyps red, with white tentacles.

Hab. Bay of Bengal.

SPONGODES RUBESCENS, sp. n. (Pl. 3. fig. 1; Pl. 4. figs. 28, 29; Pl. 5. figs. 30, 31.)

Belonging to the Divaricate *rigida* group of Kükenthal. Length 8 cm., breadth 4·5 cm., sterile stalk 2·75 cm. Whole colony very firm and rigid. Main stem divided into numerous short branches, which subdivide into smaller branches and twigs, bearing polyps in groups of 2–8 at about right angles to branch. Lower branches flattened: one encircling stem for about one-third of its circumference; others form flattened plates with polyps borne all round the edge. One spicule projects beyond polyp for about 1 mm. Spicules of anthocodia more or less in 8 double rows, but chevron arrangement not very distinct. Spicules project beyond base of tentacles. Tentacles with double row of deep red spicules. Spicules of stem: curved spindles covered with warty projections varying between 2·7×0·4 and 0·4×0·1 mm. Branch-spicules: variation greater, between 5·4×0·5 and 0·1×0·02 mm. Partition-walls: spicules of two kinds, both scarce—(1) large warty spindles, and (2) very minute thorny spicules, 0·1×0·02 mm.; in the stem the spindles vary between 1·75×0·3 and 0·1×0·02 mm., and in the branches between 3·0×0·5 and 0·1×0·02.

Colour. Stem and main branches white; secondary branches and twigs yellow; below the bunches of polyps the spicules show a red core and there is a gradual transition from yellow to red. Polyps red.

Hab. Bay of Bengal.

SPONGODES BIFORMATA, sp. n. (Pl. 3. fig. 5; Pl. 4. figs. 23, 24, & 25.)

Belonging to the Divaricate *cervicornis* group of Kükenthal. Length 3·2 cm., breadth 2·0 cm., sterile stalk 1·4 cm. Two lower branches flattened, forming two nearly complete semicircles round stem: above this are two lateral branches, and above this again the main stem divides into two branches; these branches subdivide further and bear polyps in bundles of 4–8 on stalks of 1–2 mm. Polyp-heads protected by a bundle of 3–5 spicules, of which 2 or 3 project slightly beyond polyp-head. On the lower flattened branches polyps are alternately borne on stalks or are sessile on the edge of the leaf-like branch. The branching is very distinctly in one plane. Spicules of anthocodia arranged *en chevron* in eight double rows, with 4–6 spicules in each row, all about the same size and not projecting beyond base of tentacles. Spicules of stem and branch: nearly straight spindles covered with warts. Tentacles have a double row of comparatively large thorny spicules, 0·1×0·02. I am quite unable to find any spicules in the partition-walls, and therefore cannot identify this species with *S. involuta* (Kük.). The spicules in both stem and branches are longitudinally disposed; below the polyp-heads they show a slight spiral twist.

Colour. Extreme base nearly white, all other spicules, stem, branch, anthocodia, and tentacles yellow.

Hab. Bay of Bengal.

The following is a list of measurements of a series of transverse sections through a flattened branch, where the alternation of stalked polyps with polyps sessile on the edge of the leaf suggests dimorphism. My series takes in eight polyps—four stalked, and four sessile; and although the following measurements do distinctly show that the polyps are different in size, it must be borne in mind that the observation is a difficult one; the polyps frequently are bent, and the figures can only be taken as approximately correct.

Spicule-measurements in mm.

	Four stalked polyps.	Four sessile polyps.
Length of stomodæum	0·074; 0·070; (0·072); 0·071	0·061; 0·039; 0·038; 0·055
Length of mesenterial filaments below stomodæum	0·042; 0·047; 0·038; 0·035	0·022; (0·022); 0·022; 0·020
Total length	0·116; 0·117; (0·110); 0·106	0·083; (0·061); 0·060; 0·075

From this it appears that the greatest difference between a long stalked and a short sessile polyp in the stomodæum is 0·036 mm., in the mesenterial filaments is 0·027 mm., in the total length 0·057 mm; and the least difference in the stomodæum is 0·009 mm., in the mesenterial filaments 0·013 mm., in the total length 0·023 mm.

The figures in brackets imply that the specimen was somewhat broken and the length had to be either judged or the average taken.

The following species is a *Spongodes* from the China Seas, presented to the Oxford Museum by Captain Chimmo:—

Spongodes chimmöi, sp. n. (Pl. 3. fig. 3; Pl. 4. figs. 20, 21, 22; Pl. 5. figs. 32, 33, & 34.)

Belonging to the Umbellate *florida* group of Kükenthal. Length 6·5 cm., breadth 5·0 cm., thickness 2·3 cm., sterile stalk 2 5 cm. Colony rigid, developed in one plane. Stem has long stolons, some of which reach a length of 4·0 cm. Branches given off all round stem; lower ones at right angles and upper ones vertical, but lower branches are not flattened out. Polyp-bearing twigs very closely crowded together, so that the colony has a very compact appearance and regular outline. Polyps in clusters of 8–16, at about right angles to stalk, supported by bundles of (generally) three spicules, of which one projects beyond polyp-head for 0·5 to 1·0 mm. Polyps measure 0·6×0·8 mm. Spicules in eight double rows of 5–6 each, all about the same size and not projecting beyond base of tentacles. Stem-spicules: irregularly disposed, various shapes and sizes. i. Curved spindles thickly beset with blunt spines; ii. Spindles bifid at one end, thus forming a three-armed spicule; iii. Spindles with spines of one side very much longer than those of the other; iv. Long spines of one side grouped together in bunch, approximately in middle of long axis; v. Long spines drawn out so as to form third arm, but arm comes from middle of spicule, and not from bifid end as in ii.; vi. Large number of much smaller spicules, some straight, some curved into semicircle, some with 3 or 4 arms. Spines disposed (*a*) evenly all over, (*b*) with large ones grouped together at one end, or (*c*) in one, two, or more tufts on different parts of spicule. Long spines may be absent altogether, or spicule may appear to consist of large spines only and axis reduced.

Spicules of branches and twigs elongate spindles with small blunt spines evenly distributed all over surface. In main branches general tendency of spicules is to lie transversely to long axis of branch, but in terminal twigs direction becomes longitudinal. Tendency for spicules to lie transversely carried to marked degree in spicules of partition-walls of stem; here long axis of spicule invariably placed in horizontal axis of stem. Spicules large, some nearly straight, some curved, some bifid at one end, some have 3, 4, or 5 arms; all covered evenly with short, blunt, very numerous spines. Also a few spicules irregular in shape with much reduced spines.

I also found two bright red spicules in the branch partitions. These were much smaller and thinner in proportion to the ordinary form of spicule, and spines very much less prominent.

Tentacles without spicules, and can be completely folded over mouth to form an operculum.

Colour. Stem and main branches white, gradually shading in the terminal twigs to crimson. Polyps white. In the lowermost branches both twigs and polyps are white.

Hab. China Seas.

Spicule-measurements in mm.

	Stem.		Branch.		Supporting bundle.
	Outer wall.	Partition.	Outer wall.	Partition.	
Spongodes thomsoni ..	0·8 × 0·1 to 1·0 × 0·05 0·5 × 0·4	0·1 × 0·02	1·0 × 0·05	Absent.	2·7 × 0·1
S. elegans	1·35 × 0·2 0·45 × 0·4	0·1 × 0·02 to 0·4 × 0·35	4·0 × 0·4 to 0·2 × 0·05	1·4 × 0·25 0·1 × 0·02	5·5 × 0·35
S. rubescens..........	2·7 × 0·4 to 0·4 × 0·1	1·75 × 0·3 to 0·1 × 0·02	5·4 × 0·5 to 0·1 × 0·02	3·0 × 0·5 to 0·1 × 0·02	4·0 × 0·2
S. biformata	1·3 × 0·1	Absent.	1·56 × 0·09 to 0·38 × 0·04	Absent.	2·0 × 0·17
S. chimmöi	0·77 × 0·13 0·4 × 0·1	0·98 × 0·18 to 0·4 × 0·3	1·48 × 0·16 to 0·32 × 0·04	1·4 × 0·13 to 0·86 × 0·15 Red spicules 0·48 × 0·05 0·25 × 0·035	2·14 × 0·14

Fam. SIPHONOGORGIIDÆ (Kükenthal).

This family contains the two genera *Siphonogorgia* and *Chironephthya*, distinguished by the following diagnostic characters :—

Genus SIPHONOGORGIA.

Stiff branching Siphonogorgiidæ, with smooth, round, cylindrical stem and branches, having one main central nutritive canal in the stem * which divides into several separate

* In making this statement I am not ignorant of Wright and Studer's figure of a transverse section of *S. köllikeri* in the 'Challenger' Reports, vol. xxxii. Alcyonaria, Suppl. pl. 6. fig. 5. Unfortunately I cut my sections and came to the above conclusions after having inspected the British Museum material, so that I was not able to examine it with this question of the branching of the canal-system in view. But when looking at the figure of the whole colony on pl. i. of the same work, and seeing how extremely short, in fact almost non-existent, is the stem, it seems probable that the section was taken at the base of a branch below the polyp-bearing portion but above the region of "stem proper" after the main canal has begun to divide. Even if sections through other Siphonogorgids should disprove the invariable occurrence of one central canal in the stem, the stiff smooth cylindrical stem and branches caused by the cœnenchyme being completely packed with spicules must, I feel sure, remain as a specific diagnostic character.

canals in the branches; cœnenchyme containing quantities of spicules; polyps capable of complete retraction, and spicules of anthocodia generally not arranged *en chevron.*

Genus Chironephthya.

Branching Siphonogorgiidæ with a ring of nutritive canals in the stem, outside which the cœnenchyme contains numerous spicules; in the branches the canals become larger and the partition-walls much reduced, large spicules are scarce, but small spiked spicules abundant; polyps generally not retractile, and points of the anthocodia have 2–4 principal spicules arranged *en chevron.*

Prof. Hickson has already suggested that *Siphonogorgia pendula* and *S. macrospina* should be referred to the genus *Chironephthya*; from the above definitions this suggestion is amply confirmed. From the short diagnosis and the figure of *S. squarrosa* described by Studer from a manuscript of Kölliker's, this species should also be placed in the genus *Chironephthya.* I have also little hesitation in placing in this genus: (1) Kükenthal's *Spongodes indivisa*, described as "Übergang zu *Siphonogorgia*" and founded for two specimens, and as the length given is only 9 mm., presumably this is the larger of the two; (2) Thomson's *Stereacanthia indica*, gen. et sp. nn. The description of the canals and anthocodia corresponds so nearly with my definition of *Chironephthya* that it leaves little room for doubt.

The described species of *Siphonogorgia* and *Chironephthya* are, then, as follows:—

1.	*Siphonogorgia godefroyi*, Kolliker	Pelew Islands.
2.	,, *mirabilis*, Klunzinger	Red Sea, Arafura Sea, North-west Australia, Ternate, Maldive Archipelago.
3.	,, *köllikeri*, Wright & Studer	Amboina.
4.	,, *pustulosa*, Studer	Api, New Hebrides, Admiralty Islands.
5.	,, *pallida*, Studer	Admiralty Islands.
6.	,, *miniacea*, Kükenthal	Ternate.
7.	,, *cylindrata*, Kükenthal	,,
8.	,, *rotunda*, sp. n.	Bay of Bengal.

1.	*Chironephthya dipsacea*, Wright & Studer	Hyalonema-ground, Japan.
2.	,, *scoparia*, Wright & Studer	,, ,, ,,
3.	,, *crassa*, Wright & Studer	,, ,, ,,
4.	,, *variabilis* (Hickson)	Maldive Archipelago, Indian Ocean.
5.	,, *macrospiculata*, Thomson	Indian Ocean.
6.	,, *squarrosa* (Kölliker) (Syn. *Siphonogorgia squarrosa.*)	West Australia.
7.	,, *pendula* (Studer) (Syn. *Siphonogorgia pendula.*)	Amboina.
	,, *pendula* var. *ternatana* (Kükenthal).	Ternate.
	,, *pendula* var. *bengalensis*, var. n.	Bay of Bengal.
8.	,, *macrospina*, Whitelegge	Funafuti.
9.	,, *indivisa* (Kükenthal) (Syn. *Spongodes indivisa.*)	Ternate.

10.	*Chironephthya bengalensis*, Thomson (*Stereacanthia indica.*)	Andaman Islands.
11.	„ *flavocapitata*, sp. n.	Macclesfield Bank, Admiralty Islands.
12.	„ *purpurea*, sp. n.	Tizard Reef, Admiralty Islands.
13.	„ *planoramosa*, sp. n.	Macclesfield Bank, Admiralty Islands.
14.	„ *hicksoni*, sp. n.	„ „ „ „
15.	„ *gracilis*, sp. n.	Admiralty Islands.
16.	„ *annulata*, sp. n.	„ „
17.	„ *retractilis*, sp. n.	„ „
18.	„ *siphonogorgica*, sp. n.	Indian Ocean.

Chironephthya variabilis (Hickson). (Pl. 3. figs. 6, 7; Pl. 6. figs. 48, 49, 50, & 51.)

The examples of this species are all broken fragments; no single colony is complete; but I do not hesitate to put them with this species, on account of their general form and mode of branching, the size and form of the spicules and their arrangement on the anthocodiæ. The colour is very variable; my three specimens differ, and all are different from the seven varieties described by Hickson:—

A.—Stem and branches pale yellow ochre, becoming slightly deeper in the terminal twigs. Polyps orange.

B. Three varieties.—In all stem and branches are red, becoming deeper red in the terminal twigs. Polyps bright yellow, pale yellow, and white respectively.

C.—Stem and branch pale pink. Polyps pale yellow.

Since the pieces are all somewhat fragmentary it is not possible to give exact measurements of their size. Probably A was about 6·0 cm. long and B slightly larger. The fragment C consists only of the base of a colony broken off at a height of 1·5 cm., with a single branch given off at about 0·75 cm. The spicules from the wall of stem and branches are spindles covered with warty projections. The measurements will be found tabulated below. Spicules of partition-walls elongate spindles nearly colourless in A, and pink in both B and C; also small very numerous thorny spindles, orange, red, and pink, in A, B, and C respectively. Hickson describes about ten rows of parallel transverse rows of spicules in the crown of the anthocodia. I cannot count so many in any of mine, six or seven being the maximum; but in his figure he only draws the latter number. The arrangement of the point-spicules is variable; the polyps figured on Pl. 6. figs. 49 & 50 are both from the same terminal twig, but it is generally possible to trace four spicules arranged *en chevron*, of which two are considerably larger.

Hab. Bay of Bengal.

Chironephthya pendula, var. bengalensis, var. n. (Pl. 3. fig. 8; Pl. 5. figs. 41, 42; Pl. 6. fig. 58.)

Siphonogorgia pendula (Studer).

Three fragments 6·0, 5·0, and 2·5 cm. in length respectively, probably all portions of the same colony. Stem erect, cylindrical; branches and upper part of stem deeply grooved. Polyps clustered on apices of terminal twigs also occur all along branches, and a very few isolated ones borne directly on main stem and branches. Polyps not retractile. Spicules of barren stem arranged irregularly, spindle-shaped, bearing large warty prominences. In the branches the arrangement becomes longitudinal and the spicules themselves are longer and more slender. Partition-walls contain spicules of two kinds:—(*a*) long spindles like those of the outer wall with warty projections, colourless; (*b*) small thorny spicules of a crimson colour. Polyp-spicules: crown consists of about five rows, points have each one large pair arranged *en chevron*, distal ends beset with small spines directed forwards. Tentacles with single row of thorny transverse spicules.

Colour. Stem white, with a few scattered crimson spicules. Branches crimson, shading to orange in terminal twigs. Polyps orange, with colourless tentacles.

The species agrees very closely with Studer's description of *Siphonogorgia pendula*, which, as has been already shown, should more correctly be called *Chironephthya pendula*. It differs from it in the immense size of the spicules of the partition-walls and in details of colour. With regard to the latter, colour is such a very variable feature that it cannot be taken as a character of any specific value; and as to the latter, although a point by no means unimportant, it is scarcely justifiable to create a new species on a single character when the agreement in other points is so close. These large spicules occur near the base of the colony, and it is quite possible that Studer took his sample from the upper branches, where they are absent. So that it seems safer to retain it in the species *Chironephthya pendula* as variation *bengalensis*.

Hab. Bay of Bengal.

CHIRONEPHTHYA SIPHONOGORGICA, sp. n. (Pl. 3. fig. 9; Pl. 5. figs. 43, *a* & *b*; Pl. 6. fig. 56.)

One small complete colony, 1·5 cm. high, dividing at a height of ·75 cm. into two branches. A larger colony 5·5 cm. high, but with basal attachment wanting. Branches few in number, not further subdivided and directed obliquely upwards. Polyps borne directly on main stem and branches, and five occurring on stem below the first branch. A definite calyx surrounds each polyp, into which it is completely retractile, and the calyx is capable of closing over the retracted polyp-head. Spicules of stem and branches disposed longitudinally, somewhat loosely packed together; long curved spindles thickly beset with small rugged warts. The canal-walls contain somewhat blunter spindles with larger but fewer warts. All these spicules are a uniform bright coral-red. The polyp-spicules are small and smooth; the crown has about five transverse rows and each point six to eight spicules with an ill-defined chevron arrangement. All polyp-spicules are a transparent bright yellow. Tentacles are colourless, contain no spicules, and bear long slender pinnules.

This species has many points of resemblance to a *Siphonogorgia*, such as the complete retractility of the polyps and the ill-defined chevron arrangement of the point-spicules, but the structure of the stem and branches leaves no doubt that it should be referred to the genus *Chironephthya*.

Hab. Bay of Bengal.

Siphonogorgia rotunda, sp. n. (Pl. 3. fig. 13; Pl. 5. figs. 38 & 39; Pl. 6. fig. 64.)

Two colonies, 23 and 20 cm. long respectively. Stem and branches solid, smooth, rounded. Branching not very great. Polyps borne all round stem, main and sub-branches. Lower part of stem barren. Polyps nearly completely retractile, borne at right angles to stem and branches. Spicules of outer walls blunt spindles covered with numerous low warts, size fairly uniform. Spicules of partition-walls of varying sizes, some larger than those of outer wall, and numerous quite small forms. In the polyp there are about five spicules in each point directed vertically upwards, below this are about eight spicules arranged *en chevron*, and below this a crown of about six transverse rows.

Colour. Stem and branches flesh-coloured, polyps white.

Hab. Bay of Bengal.

The following specimens belong to the British Museum:—

Genus Chironephthya.

Chironephthya flavocapitata, sp. n. (Pl. 3. fig. 12; Pl. 5. fig. 44; Pl. 6. fig. 52.)

Colony 14 cm. long, 9 cm. broad, sterile stalk 3 cm. Branches from main stem long and slender, only slightly further subdivided and inclined to droop downwards. Polyps directed practically vertically upwards, not retractile. Tentacles can be folded over oral disc. Spicules of outer wall of two kinds:—(1) large pale pink spicules covered with warty projections; (2) long slender colourless spicules with a considerable dark core and beset with few spines. In the branches large pink spicules are absent. Spicules of partition-walls very similar to those of outer wall, but pink coloration much fainter. Besides these two kinds there also occur much smaller spicules with thorny projections. Polyp-spicules: crown with about six transverse rows; points with two large spicules arranged *en chevron*, and smaller spicules irregularly disposed between them. Tentacles with a single row of small thorny spicules placed transversely.

Colour. Stem and branches pure white, with a few pale pink spicules interspersed. Polyps a deep orange, tentacles colourless.

Hab. Macclesfield Bank, Admiralty Islands.

Chironephthya planoramosa, sp. n. (Pl. 3. fig. 10; Pl. 5. fig. 45; Pl. 6. fig. 54.)

Colony 11·5 cm. long, 8 cm. broad, sterile stem 5·5 cm. Whole colony grows like an espalier pear-tree; branches at nearly right angles to stem, inclined to bend downwards, and very slender. Polyps spirally arranged, with a terminal bunch of five; not retractile. Spicules of the outer wall longitudinally arranged, of two distinct kinds:—(1) a few large straight spicules, pointed at both ends and thick in the middle, with a considerable dark core and beset with spiny warts; (2) numerous small blunter spicules covered with low warty projections. Spicules of the partition-walls: numerous small, fine, thorny spindles, one or two of which are tinted a very pale pink. Polyp-spicules: crown with about eight transverse rows, and points with about three to five spicules arranged *en chevron*. Tentacles have a single row of irregular transverse spicules.

Colour. Base of stem a rosy purple, all the rest of colony, branches, twigs, and polyps a pure white. This absence of all colouring-matter above the sterile stalk is a very remarkable and striking feature.

Hab. Macclesfield Bank, Admiralty Islands.

CHIRONEPHTHYA HICKSONI, sp. n. (Pl. 5. fig. 46; Pl. 6. fig. 57.)

One complete colony, 10 cm. high, 5 cm. broad, sterile stalk 2 cm. Stem erect, cylindrical, dividing into two main branches; short thick branches given off from these and from stem, very slightly further subdivided and tend to be directed upwards. Polyps on all branches, more numerous on terminal twigs; not retractile. Spicules of stem irregularly arranged, blunt spindles covered with warty projections. In the branches the spicules are arranged longitudinally; they are much longer, some reaching 3·7 mm., with a solid opaque core making them extremely conspicuous; smaller spicules are also abundantly present. In the partition-walls are large warty spindles and numerous typical small thorny forms. Polyp-spicules: crown with about five transverse rows; points with two or three spicules arranged *en chevron*, and smaller ones irregularly disposed between them. Tentacles with a double row of spicules more or less dovetailed into each other.

Colour. A uniform dull yellow, the opaque spicules of the branches standing out conspicuously; the tentacles only coloured a deep purple.

Hab. Macclesfield Bank, Admiralty Islands.

CHIRONEPHTHYA PURPUREA, sp. n. (Pl. 3. fig. 11; Pl. 6. fig. 53.)

Colony 7·5 cm. long, 3·5 cm. broad, sterile stalk broken off. Numerous branches given off, all directed practically vertically upwards; secondary branches few and small. Polyps borne on the stem, branches, and twigs; more numerous on twigs, directed vertically upwards and not retractile. Spicules of the outer walls: elongate spindles covered with low rugged warts, of various sizes; some large, reaching nearly 4 mm., but chiefly smaller ones not exceeding 1·5 mm. in length. Partition-walls crowded with typical small thorny spicules; some are rather larger than the usual type, reaching 0·4 mm. in length, but large warty spicules are absent. Polyp-spicules: crown with seven or eight transverse rows; points with three or four spicules arranged *en chevron*, but when four are present there is very constantly only one spicule on one side of the point and three on the other. Tentacles with a single row of small thorny spicules placed transversely. All the polyp-spicules are fairly uniform in size and the polyp has a very neat compact appearance.

Colour. Stem and branches white, becoming cream in the terminal twigs; polyps, including the tentacles, a deep purplish red.

Hab. Tizard Reef, Admiralty Islands.

CHIRONEPHTHYA ANNULATA, sp. n. (Pl. 5. fig. 47; Pl. 6. fig. 59.)

Colony 6·5 cm. long, sterile stalk 1·0 cm. Colony rigid; short thick branches given off all round stem, only one or two of which are long enough to further subdivide. Spicules of outer wall: elongate warty spindles of very varying length, some large opaque spicules of a conspicuous creamy-yellow colour reaching 3·35 mm. in length, others smaller, numerous, some yellow and some red. Spicules of partition-walls: typical small thorny spindles. Polyp-spicules: crown with about six transverse rows; points with three to five spicules, somewhat irregularly arranged *en chevron*, of which one is generally larger than the others. Tentacles with scattered small warty spicules.

Colour. Stem and branches deep crimson; terminal twigs have a few large conspicuous cream-coloured spicules, and are shaded from crimson to buff-yellow, terminating in yellow calices. Polyps crimson: the contrast between the colour of calyx and polyp gives a striking effect, and each polyp appears to be set in a yellow ring.

Hab. Admiralty Islands.

CHIRONEPHTHYA GRACILIS, sp. n. (Pl. 5. fig. 40; Pl. 6. fig. 60.)

Colony 14 cm. long, sterile stalk 6 cm. Stem divides into two main branches directed vertically upwards, from which several short very slender branches arise. Polyps borne on all branches, those on main branches sessile and single, those on terminal twigs in groups and generally on short stalks. Spicules of outer wall: long slender spindles with few small warts, of various sizes. Spicules of partition-walls: minute thorny spicules of typical form and size. Polyp-spicules: crown with about five transverse rows; points with three to five spicules arranged *en chevron*, larger than those of crown and with more pronounced warts. Tentacle-spicules comparatively large.

Colour. Stem and branches deep red; polyps bright orange.

Hab. Admiralty Islands.

CHIRONEPHTHYA RETRACTILIS, sp. n. (Pl. 6. fig. 55.)

Colony 5 cm. long, consisting of one main erect branch and two short branches given off at about 1·75 cm. from base. Polyps borne all round stem, completely retractile within calyx, which projects from stem, and closes over polyp by all the spicules of the calyx converging together in a point and not folding over as in a *Siphonogorgia*. The polyps contract in the same way, and the result of this converging of spicules into a point gives the effect of a number of sharp thorns projecting from the stem. Spicules of outer wall: warty spindles of varying size, some curved, mostly straight. Spicules of partition-walls: typical small thorny spicules. Polyp-spicules: crown with about five transverse rows; points with four spicules arranged *en chevron*.

Colour. Stem and branches cream, with crimson-purple polyps.

Hab. Admiralty Islands.

Genus SIPHONOGORGIA.

SIPHONOGORGIA PUSTULOSA (Studer). (Pl. 6. fig. 65.)

Several branches 3 to 4 cm. long, straight, unbranched, and presumably belonging to the same colony. Polyps borne all over branches, completely retractile within calyx, which bulges out from stem. Spicules of outer walls: elongate spindles, beset with warty projections; size very various, some are straight, some curved. Spicules of partition-walls thicker spindles covered with rough warts. Polyp-spicules: crown with about five transverse rows; points with four converging spicules. Tentacles with a single row of transverse spicules.

Colour. Violet-red; polyps bright yellow.

Hab. Admiralty Islands.

Spicule-measurements in mm.

	Outer Wall.	Partition-Wall.
Chironephthya.		
C. variabilis, A	2·7 × 0·2.	1·9 × 0·2. 0·25 × 0·02.
B	2·0 × 0·25 to 0·75 × 0·05.	2·35 × 0·25 to 1·4 × 0·25. 0·25 × 0·025.
C	2·3 × 0·15 to 1·25 × 0·1. 0·45 × 0·03.	0·9 × 0·07. 0·3 × 0·02.
C. pendula	2·9 × 0·3. 1·05 × 0·15. 1·15 × 0·075. 0·5 × 0·05.	3·0 × 0·25. 0·8 × 0·75. 0·15 × 0·01.
C. siphonogorgica	2·3 × 0·3 to 1·3 × 0·2.	1·45 × 0·15.
C. flavocapitata	1·15 × 0·1. 1·1 × 0·05 to 0·7 × 0·07.	1·25 × 0·12 to 0·65 × 0·04. 0·25 × 0·02.
C. purpurea	3·85 × 0·3. 1·5 × 0·15 to 0·55 × 0·05.	0·4 × 0·02 to 0·15 × 0·02.
C. planoramosa	2·8 × 0·35. 1·0 × 0·1.	0·3 × 0·02.
C. annulata	3·35 × 3·5. 2·0 × 0·2 to 0·4 × 0·05.	 0·2 × 0·02.
C. gracilis	1·8 × 0·2. 1·35 × 0·07 to 0·3 × 0·02.	0·17 × 0·017.
C. hicksoni	3·7 × 0·47 to 2·95 0·25. 1·35 × 0·15. 0·55 × 0·05.	1·8 × 0·3 to 1·1 × 0·2. 0·45 × 0·04.
C. retractilis	2·35 × 0·24 to 0·7 × 0·05.	0·2 × 0·02.
Siphonogorgia.		
S. pustulosa	1·3 × 0·25 to 0·37 × 0·1. 0·45 × 0·15.	1·05 × 0·2. 0·2 × 0·03.
S. rotunda	1·15 × 0·12.	1·7 × 0·23. 0·75 × 0·07. 0·15 × 0·03.

Fam. Briareidæ.

Genus Solenocaulon.

Stiff Briareidæ, branching chiefly in one plane, consisting of a solid cylindrical stalk and tubular or grooved main stem, branches, and twigs. The cœnenchyme consists of an outer bark containing loose spicules and an inner axis also containing loose spicules, but in some places they may fuse to form a porous calcareous rod. Polyps may or may not be retractile.

Solenocaulon tortuosum (Gray). (Pl. 3. figs. 14, 15; Pl. 7. figs. 66 to 77.)

Three varieties.

A.—Lower portion, 25 cm. in length, of a colony, of which 11 cm. is solid stalk bifid at the end. Lateral branches short, coming off in pairs on opposite sides of lateral holes. Polyps irregularly disposed on branches and main stem, but principally on the sides of the branches and spirally up the stem; non-retractile, projecting beyond conical calyx.

Colour pale pink; branches slightly deeper pink and stalk nearly colourless.

B.—Two specimens, in both the upper part is broken off. One 21 cm. long, of which 10 cm. is solid stalk. Colony flesh-coloured. The other 15 cm. long, of which 4·5 cm. is solid stalk. Lateral branches come off very regularly on alternate sides of the main trunk; tubular at their commencement, each becoming two parallel branches facing one another. Polyps non-retractile, but conical calices, not so much developed as in specimen A; borne on both sides of main trunk and branches.

C.—Portion of a colony 14 cm. long, but unfortunately broken at both ends. Lateral branches borne on opposite sides of lateral holes, and the lateral holes are exactly opposite one another, so that a front view of the colony looks like the tail of a kite and a side view shows a series of holes right through the main trunk. Polyps completely retractile, borne at sides of main trunk and branches.

Colour pink.

In all three varieties the polyps are white. Spicules of the outer bark numerous, small, and generally oval, entirely covered with large irregular warts. Length 0·04 to 0·1 mm. Spicules of inner bark slender, elongate, beset with few small spines, rather more numerous at the ends. Length 0·1 to 0·4 mm. Spicules of axis similar to those of inner bark in general appearance, but much longer. Length 0·18 to 0·78 mm. Axis-spicules may fuse to form a porous calcareous rod in main trunk and branches.

Hab. Bay of Bengal.

Solenocaulon ramosum (Hickson). (Pl. 3. fig. 16; Pl. 7. figs. 78 to 81.)

Colony 85 cm. long, sterile stalk 30 cm. Colony consists of a single upright main stem, from which arise six incomplete and three complete belts and numerous slender twigs from these belts. The specimen agrees with Hickson's diagnosis in every point except the greater size of the colony and the absence of all colouring-matter.

Hab. Bay of Bengal.

Spicule-measurements in mm.

	Outer bark.	Inner bark.	Axis.
Solenocaulon tortuosum, A	0·1 × 0·06	0·1 × 0·02 to 0·26 × 0·02	0·18 × 0·03 to 0·78 × 0·03
,, ,, B	0·04 × 0·04 to 0·1 × 0·04	0·13 × 0·02 to 0·37 × 0·03	0·2 × 0·03 to 0·63 × 0·03
,, ,, C	0·06 × 0·02 to 0·15 × 0·03	0·13 × 0·02 to 0·4 × 0·02	0·16 × 0·02 to 0·75 × 0·02
Solenocaulon ramosum	0·1 × 0·03 to 0·2 × 0·07.	......	0·37 × 0·02 to 0·95 × 0·03

Bibliography.

1. 1828. Audouin, J. V. Explication sommaire des planches de polypes de l'Égypte et de la Syrie. Description de l'Égypte, vol. xxiii.
2. 1830. Blainville, H. D. de. *Neptæa.* Dictionnaire Sc. nat. vol. lx.
3. 1834. —— *Neptæa florida.* Man. d'Actinologie.
4. 1900. Bourne, G. C. A Treatise of Zoology. Edited by Sir E. Ray Lankester. Part ii.
5. 1898. Burchardt, E. Alcyonaceen von Thursday Island (Torresstrasse) und von Amboina. Semon, Zool. Forschungsreisen, vol. v. Theil 1 u. 2, Jena.
6. 1846. Dana, J. D. Zoophytes. U.S. Exploring Expedition, Philadelphia, vii.
7. 1901. Delage, Y., et Hérouard, E. Traité de Zoologie concrète, vol. ii.
8. 1834. Ehrenberg, C. G. *Nephthya florida*, Blainville. Abh. Akad. Wiss. Berlin.
9. 1834. —— *Nephthya.* Korallthiere des Rothen Meeres.
10. 1791. Esper, E. J. C. Alcyonium. Pflanzenthiere.
11. 1867. Genth, C. Ueber *Solenogorgia tubulosa.* Zeitsch. f. wiss. Zool. vol. xvii.
12. 1897. Germanos, N. K. Gorgonaceen von Ternate. Abh. Senck. nat. Ges. vol. xxiii.
13. 1859. Gray, J. E. Description of some new Genera of Lithophytes. P. Z. S. vol. xxvii.
14. 1862. —— Description of some new Species of *Spongodes,* and of an allied Genus *Morchellana,* in Brit. Mus. P. Z. S. 1862.
15. 1869. —— Description of some new Genera and Species of Alcyonid Corals in the Brit. Mus. Ann. Mag. Nat. Hist. ser. 4, vol. iii.
16. 1869. Gray, J. E., and Carter, H. J. On *Spongodes conglomeratus* and a new Genus of Fleshy Alcyonids. Ann. Mag. Nat. Hist. ser. 4, vol. iv.
17. 1901. Hargitt, C. W., and Rogers, C. D. The Alcyonaria of Porto Rica. U.S. Fish Comm. Bull. for 1900, vol. ii.
18. 1903. Hickson, S. J. The Alcyonaria of the Maldives. The Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii. pt. i.
19. 1900. Hickson, S. J., and Hiles, J. L. The Stolonifera and Alcyonacea collected by Dr. Willey. Willey's Zool. Results, pt. 4.

20. 1895. HOLME, O. Beiträge zur Kenntniss der Alcyonidengattung *Spongodes*, Lesson. Zool. Jahrb. vol. viii.

21. 1904. —— Weiteres über *Nephthya* und *Spongodes*. Results of the Swedish Zoological Expedition to Egypt and the White Nile, 1901. No. 27.

22. 1904. JANOWER, M. Die Gattung *Solenocaulon*. Rev. Suisse de Zool. vol. xii.

23. 1877. KLUNZINGER, C. B. Die Korallthiere des Rothen Meeres, Theil 1.

24. 1865. KÖLLIKER, A. Icones Histiologicæ.

25. 1874. —— Eine neue Gattung der Alcyonarien (*Siphonogorgia*). Festschr. zur Feier d. fünf und zwanzigjährigen Bestehens der physic.-medicin. Gesellsch. Würzburg.

26. 1895. KÜKENTHAL, W. Alcyonaceen von Ternate. Zool. Anz. vol. xviii.

27. 1896. —— Alcyonaceen von Ternate. Abh. Senck. nat. Ges. Frankfurt, vol. xxiii.

28. 1903. —— Versuch einer Revision der Alcyonarien. Zool. Jahrb. vol. xix. Syst.

29. 1904. —— Jena, Denkschr. vol. xi. Festschrift zum 70sten Geburtstage von E. Haeckel.

30. 1905. —— Versuch einer Revision der Alcyonarien.—II. Die Familie der Nephthyiden. 2 Teil. Zool. Jahrb. xxi., Syst.

31. 1864. LACAZE-DUTHIERS, H. Histoire naturelle du Corail.

32. 1816. LAMARCK, J. B. M. Chev. de. *Xenia purpurea*. Hist. natur. des Animaux sans vertèbres, vol. ii.

33. 1821. LAMOUROUX, J. V. F. *Xenia purpurea*. Exposition méthodique des genres de l'ordre des Polypiers.

34. 1834. LESSON, R. P. Illustr. de Zool.

35. 1898. MAY, W. Die von Dr. Stuhlmann im Jahre 1889 gesammelten ost-afrikanischen Alcyonaceen des Hamburger Museums. Mitth. naturh. Mus. Hamburg, vol. xv.

36. 1899. —— Beiträge zur Systematik und Chorologie der Alcyonaceen. Jenaische Zeitschr. Naturwiss. vol. xxxiii.

37. 1857. MILNE EDWARDS, H. Histoire naturelle des Coralliaires. 3 vols. 1857–1860.

38. 1900. PUTTER, A. Alcyonaceen des Breslauer Museums. Zool. Jahrb. vol. xiii., Syst.

39. 1834. QUOY, J. R. C., and GAIMARD, P. Voyage de l'Astrolabe. Zool. iv.

40. 1882. RIDLEY, S. O. Contributions to the Knowledge of the Alcyonaria, with Descriptions of new Species from the Indian Ocean and the Bay of Bengal. Ann. Mag. Nat. Hist. ser. 5, vol. ix.

41. 1884. —— Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H.M.S. 'Alert,' 1881–1882.

42. 1888. —— Report on the Alcyoniid and Gorgoniid Alcyonaria of the Mergui Archipelago. Journ. Linn. Soc., Zool. vol. xxi. pp. 223–247, pls. 17, 18.

43. 1817. SAVIGNY, J. G. Nephthée. Description de l'Egypte. Hist. nat. vol. ii.

44. 1856. STIMPSON, W. Description of some of the new Marine Invertebrata from the Chinese and Japanese Seas. Proc. Acad. Nat. Sc. Philadelphia, vol. vii.

45. 1878. STUDER, T. Uebersicht der Anthozoa Alcyonaria, welche während der Reise S.M.S. Gazelle um die Erde gesammelt wurden. Monatsber. (now Sitzungsber.) Akad. Wiss. Berlin.

46. 1887. —— Versuch eines Systems der Alcyonaria. Arch. f. Naturgesch. vol. liii.

47. 1888. —— On some new Species of the Genus *Spongodes* from the Philippine Islands and the Japanese Seas. Ann. Mag. Nat. Hist. ser. 6, vol. i.

48. 1889. —— Alcyonaria. Rep. Sc. Res. 'Challenger,' Suppl. vol. xxxii.

49. 1894. —— Alcyonarien aus der Sammlung des naturhistor. Museums in Lübeck. Mittheil. geogr. Ges. naturhist. Mus. Lübeck, (2) Heft. 7 u. 8.

50. 1873. TARGIONI-TOZZETTI, A. *Nephthya florida*. Nota intorno ad alcune forme di Alcionari e di Gorgonacei etc. Atti Soc. Ital. Sc. nat. vol. xv.

51. 1905. THOMSON, J. A., and HENDERSON, W. D., in Herdman, R. Soc. Report Pearl Oyster Fisheries, iii.

52. 1906. —— An Account of the Alcyonarians collected by the Royal Indian Marine Survey Ship 'Investigator' in the Indian Ocean.—I. The Alcyonarians of the Deep Sea.

53. 1906. —— The Marine Fauna of Zanzibar and British East Africa, from Collections made by Cyril Crossland, M.A., B.Sc., F.Z.S., 1901–1902. Alcyonaria, P. Z. S. 1906, vol. i.

54. 1864. VERRILL, A. E. Bull. Mus. Comp. Zool. Cambridge.

55. 1866. —— Synopsis of Polyps and Corals of the North Pacific Exploring Expedition.—Pt. 2. Proc. Essex Inst. vol. iv.

56. 1901. WHITELEGGE, T. The Alcyonaria of Funafuti.—Pt. I. Mem. Austral. Mus. vol. iii.

57. 1889. WRIGHT, E. P., and STUDER, T. Alcyonaria. Rep. Sc. Res. 'Challenger,' vol. xxxi.

EXPLANATION OF THE PLATES.

PLATE 3.

Fig. 1. *Spongodes rubescens*, sp. n. Complete colony. ($\frac{4}{5}$ nat. size.)

2. *Spongodes elegans*, sp. n. Complete colony. ($\frac{4}{5}$ nat. size.)

3. *Spongodes chimmöi*, sp. n. Complete colony. ($\frac{4}{5}$ nat. size.)

4. *Spongodes thomsoni*, sp. n. Complete colony. ($\times \frac{4}{7}$.)

5. *Spongodes biformata*, sp. n. Complete colony. ($\frac{4}{5}$ nat. size.)

6. *Chironephthya variabilis*, Hickson. Two fragments of a colony. Specimen A in text. ($\frac{4}{5}$ nat. size.)

7. *Chironephthya variabilis* (Hickson). Complete colony, but upper part somewhat broken. Specimen B in text. ($\frac{4}{5}$ nat. size.)

8. *Chironephthya pendula* (Studer), var. *bengalensis*, var. n. Three broken fragments of a colony. ($\frac{4}{5}$ nat. size.)

9. *Chironephthya siphonogorgica*, sp. n. One small complete colony, and one larger colony with basal attachment wanting. ($\frac{4}{5}$ nat. size.)

10. *Chironephthya planoramosa*, sp. n. The terminal portion of a single branch. ($\frac{4}{5}$ nat. size.)

11. *Chironephthya purpurea*, sp. n. Branch of a colony. ($\frac{4}{5}$ nat. size.)

12. *Chironephthya flavocapitata*, sp. n. Branch of a colony. ($\frac{4}{5}$ nat. size.)

13. *Siphonogorgia rotunda*, sp. n. Complete colony, but with basal attachment wanting. ($\times \frac{4}{9}$.)

14. *Solenocaulon tortuosum* (Gray). Colony broken at both ends. Specimen C in text. ($\times \frac{4}{9}$.)

15. *Solenocaulon tortuosum* (Gray). Lower portion of a colony. Specimen A in text. ($\times \frac{4}{9}$.)

16. *Solenocaulon ramosum* (Hickson). Three portions of a colony, showing the mode of formation of the belts (those in the figure are incomplete) and the grooved branches of the upper terminal twigs. ($\times \frac{4}{9}$.)

PLATE 4.

Fig. 17. *Spongodes thomsoni*, sp. n. Enlarged drawing of a single polyp.

18. *Spongodes thomsoni*, sp. n. Group of four spicules from the wall of the sterile stalk.

19. *Spongodes thomsoni*, sp. n. Group of spicules from the outer wall of a branch.

20. *Spongodes chimmöi*, sp. n. Enlarged drawing of a polyp.

21. *Spongodes chimmöi*, sp. n. Group of spicules from the outer wall of the sterile stalk.

22. *Spongodes chimmöi*, sp. n. Group of spicules from the outer wall of a branch.

Fig. 23. *Spongodes biformata*, sp. n. Drawing of a single polyp, showing the way in which the tentacles fold over the oral disc.

24. *Spongodes biformata*, sp. n. Drawing of a decalcified portion of a flattened leaf-like branch, showing the alternation of long stalked with short sessile polyps.

25. *Spongodes biformata*, sp. n. Single spicule from the outer wall of a branch.

26. *Spongodes elegans*, sp. n. Group of spicules from the outer wall of the sterile stalk.

27. *Spongodes elegans*, sp. n. Group of spicules from the outer wall of a branch.

28. *Spongodes rubescens*, sp. n. Spicules from the outer wall of the sterile stalk.

29. *Spongodes rubescens*, sp. n. A spicule from the outer wall of a branch.

Plate 5.

Fig 30. *Spongodes rubescens*, sp. n. Spicules from the partition-walls of a branch.

31. *Spongodes rubescens*, sp. n. Spicules from the partition-walls of the sterile stalk.

32. *Spongodes chimmöi*, sp. n. Spicules from the partition-walls of the sterile stalk. These spicules are drawn *in situ* to show the transverse arrangement.

33. *Spongodes chimmöi*, sp. n. Spicules from the partition-walls of a branch.

34. *Spongodes chimmöi*, sp. n. Two bright red spicules, somewhat broken, from the partition-walls of the branches. These two spicules were found in different branches, but they are the only two of the kind found. They are a very bright red, entirely different from the crimson-red of the branch-spicules of the outer wall.

35. *Spongodes thomsoni*, sp. n. Spicules from the partition-walls of the sterile stalk.

36. *Spongodes elegans*, sp. n. Spicules from the partition-walls of the sterile stalk.

37. *Spongodes elegans*, sp. n. Spicules from the partition-walls of a branch.

38. *Siphonogorgia rotunda*, sp. n. Spicule from the outer wall of the sterile stalk. Those from the outer walls of the branches are similar.

39. *Siphonogorgia rotunda*, sp. n. Spicules from the partition-walls. As in those of the outer walls, the spicules of stem and branches are similar.

40. *Chironephthya gracilis*, sp. n. Spicules from the outer wall.

41. *Chironephthya pendula*, var. *bengalensis*, var. n. Spicules from the outer wall.

42. *Chironephthya pendula*, var. *bengalensis*, var. n. Spicules from the partition-walls. The small spicules figured here are very characteristic of the genus *Chironephthya*. Spicules of the same form and size were found in every species (except *C. siphonogorgica*), the only variation being in the colour.

43. *Chironephthya siphonogorgica*, sp. n. *a*. Spicule from the outer wall; *b*. Spicule from the partition-walls.

44. *Chironephthya flavocapitata*, sp. n. Spicules from the outer wall. The large spicule is coloured pink.

45. *Chironephthya planoramosa*, sp. n. Spicules from the outer wall. The large opaque spicule is similar to those found in *C. hicksoni* and *C. annulata*.

46. *Chironephthya hicksoni*, sp. n. Spicule from the outer wall.

47. *Chironephthya annulata*, sp. n. Spicules from the outer wall. These are mostly coloured deep red, in the terminal twigs some are yellow.

Plate 6.

Polyp-heads of the Siphonogorgiidæ.

Fig. 48. *Chironephthya variabilis* (Hickson). Specimen A.

49. *Chironephthya variabilis* (Hickson). Specimen B.

Fig. 50. *Chironephthya variabilis* (Hickson). Specimen B.
These last two polyp-heads are from the same branch; they show the great variability of the species, and connect specimen C with the other forms.
51. *Chironephthya variabilis* (Hickson). Specimen C.
52. *Chironephthya flavocapitata*, sp. n.
53. *Chironephthya purpurea*, sp. n.
54. *Chironephthya planoramosa*, sp. n.
55. *Chironephthya retractilis*, sp. n.
56. *Chironephthya siphonogorgica*, sp. n.
57. *Chironephthya hicksoni*, sp. n.
58. *Chironephthya pendula* (Studer), var. *bengalensis*, var. n.
59. *Chironephthya annulata*, sp. n.
60. *Chironephthya gracilis*, sp. n.
61. *Chironephthya dipsacea*, Wright & Studer.
62. *Chironephthya scoparia*, Wright & Studer.
63. *Chironephthya crassa*, Wright & Studer.
64. *Siphonogorgia rotunda*, sp. n.
65. *Siphonogorgia pustulosa*, Studer.

Plate 7.

Solenocaulon tortuosum (Gray). Specimen A.

Fig. 66. Spicules of the outer bark.
67. Spicules of the inner bark.
68. Spicules of the axis.
69. Polyp.

Solenocaulon tortuosum (Gray). Specimen B.

70. Spicules of the outer bark.
71. Spicules of the inner bark.
72. Spicules of the axis.
73. Polyp.

Solenocaulon tortuosum (Gray). Specimen C.

74. Spicules of the outer bark.
75. Spicules of the inner bark.
76. Spicules of the axis.
77. Polyp.

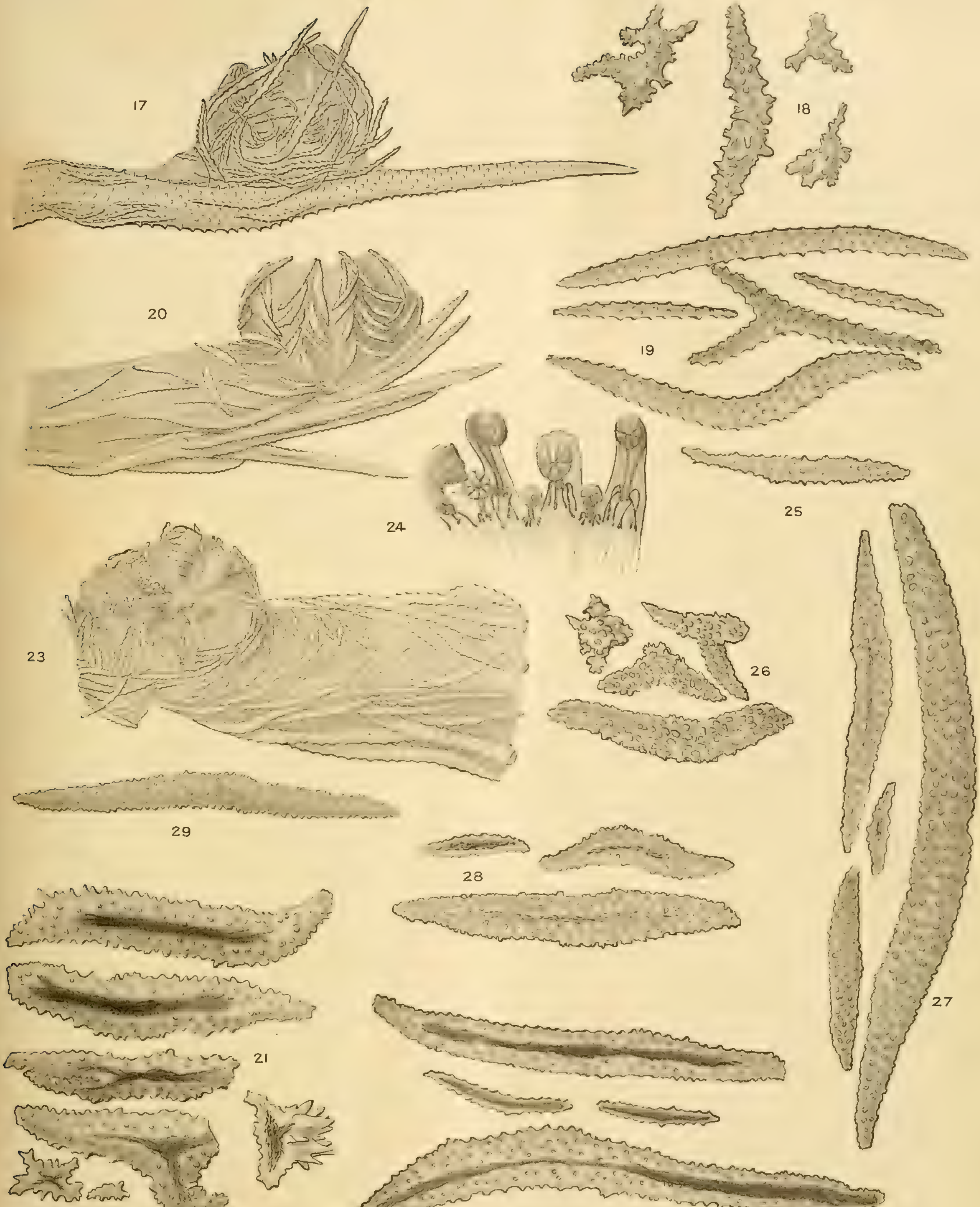
Solenocaulon ramosum (Hickson).

78. Bark-spicules.
79. Axis-spicules.
80. Polyp.
81. Polyp. This polyp is drawn on the same scale as all the figures of spicules. The scale is given on the left side of the Plate. The scale on the right side of the Plate is that on which the four polyp-heads (figs. 69, 73, 77, & 80) are drawn.

E. E. J. Schuster, del.

Huth, lith et imp

ALCYONARIA FROM THE INDIAN & PACIFIC OCEANS.



R.M.H del

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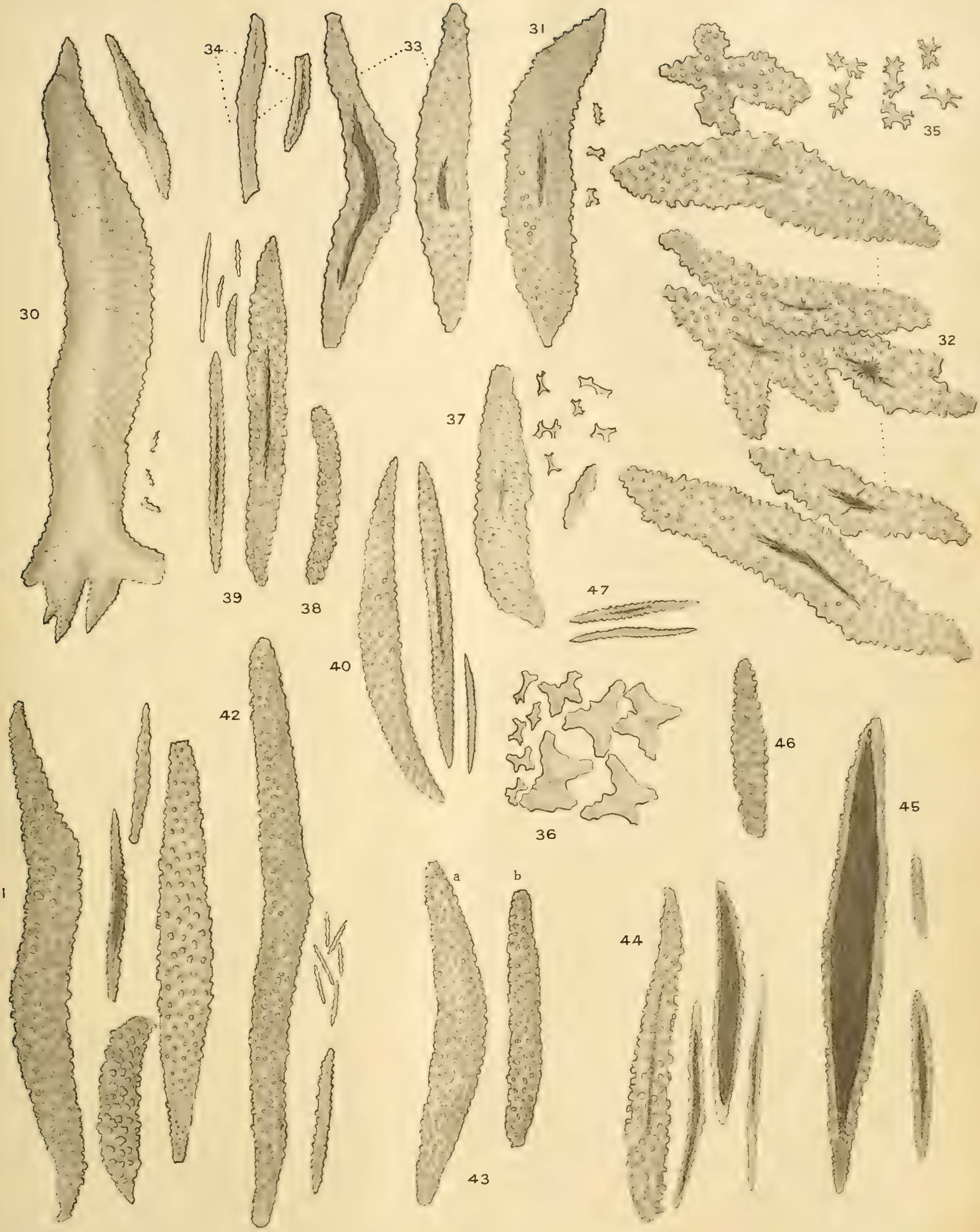

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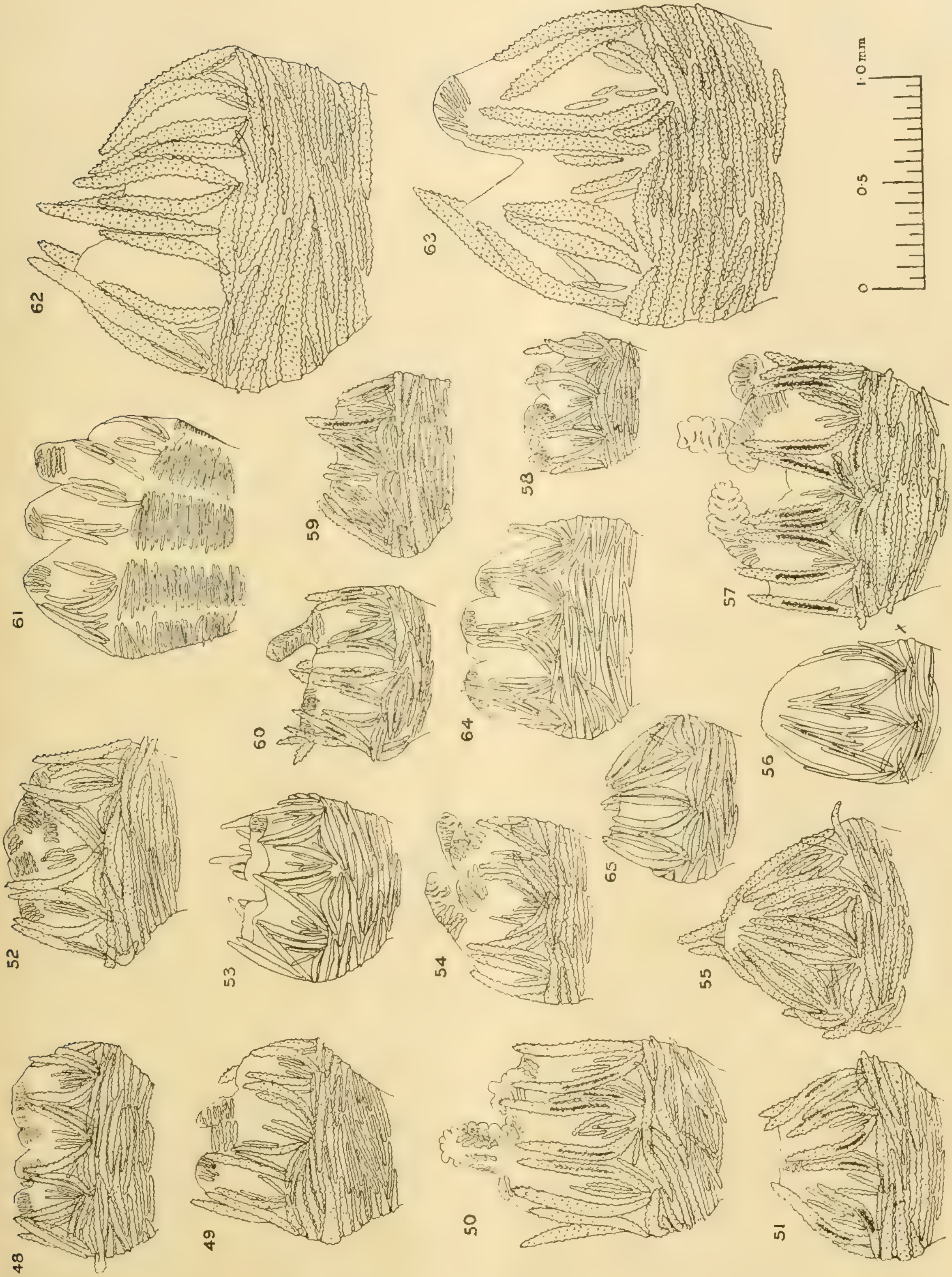

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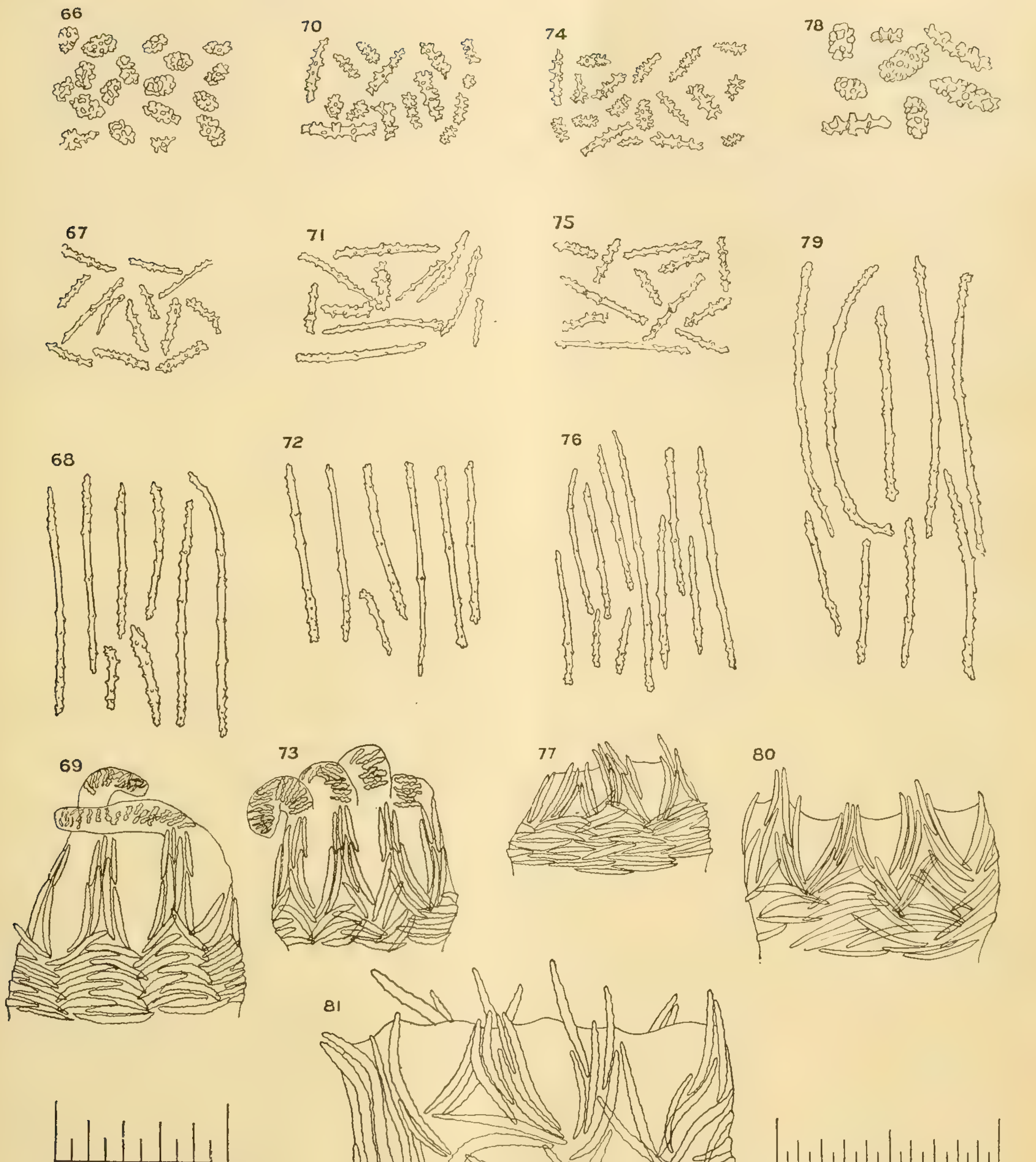


R. M. H. del.

ALCYONARIA FROM THE INDIAN AND PACIFIC OCEANS.

III. *Notes on some Parasitic Copepoda; with a Description of a new Species of* Chondracanthus. *By* May E. Bainbridge, *B.Sc., F.L.S.*

(Plates 8–11.)

Read 5th November, 1908.

ALL the species described in this paper, with one exception, were collected and sent to me by Miss Lebour, M.Sc. Durham, from fish brought in by the fishing-boats of North Shields, Northumberland. I am very much indebted to her for her kindness in sending them to me. *Anchorella stellata*, Kr., was found on a Hake (*Merluccius vulgaris*, Cuv.) bought at Sheringham, Norfolk. My work has been carried out in the Zoological Department of the Imperial College of Science and Technology (Royal College of Science), South Kensington. The classification is taken from Giesbrecht, but the position of some of the wholly parasitic families in his system seems still a matter of some doubt (*cf.* Dr. Calman *). Mr. Geoffrey Smith †, who has kindly given me permission to refer to his work which is still in the press, places these parasitic families (Caligidæ, Lernæidæ, Lernæopodidæ, Chondracanthidæ, Choniostomatidæ) in the Tribe Isokerandria, Giesbrecht, of the Suborder Podoplea, Giesbrecht. He has done this with Giesbrecht's consent and approval, and I have therefore adopted his system in the following paper. With regard to the nomenclature of the appendages I have followed Giesbrecht ‡ and Hansen §, who have independently arrived at the same conclusions.

Subclass **COPEPODA**, H. Milne-Edwards (1830).

Order I. EUCOPEPODA, Claus (1875).

Suborder II. PODOPLEA, Giesbrecht.

Tribe I. ISOKERANDRIA, Giesbrecht.

Fam. Bomolochidæ.

Genus Bomolochus, Nordm.

Bomolochus soleæ, Claus. (Plate 8. figs. 1–5.)

1864. *Bomolochus soleæ,* Claus, Zeitschrift für wissenschaftliche Zoologie, vol. xiv. p. 383, pl. 35. figs. 16–20, pl. 36. fig. 28.

1893. *Bomolochus soleæ,* T. Scott, 11th Ann. Report Fish. Board Scotland, pt. iii. p. 212, pl. 5. figs. 1–10.

* Ray Lankester's 'Zoology' (Crustacea).

† 'The Cambridge Natural History,' Crustacea, ch. iii. p. 69.

‡ "Mitth. über Copepoden," 6, p. 101, in Mitth. aus der Zool. Stat. Neapel, vol. xi. (1895).

§ "Zur Morph. der Gliedmassen u. Mundtheile bei Crust. u. Insecten," in Zool. Anz. 16 Jahrg. 1893, pp. 193–198, 201–212 (section 11).

1900. *Bomolochus soleæ,* T. Scott, ibid. 18th, p. 146.

1900. *Bomolochus soleæ,* A. Scott, 14th Ann. Rept. Liverpool Marine Biol. Com. Dec. p. 12.

1900. *Bomolochus soleæ,* A. Scott, Trans. Liverp. Biol. Soc. vol. xiv. p. 139.

1901. *Bomolochus soleæ,* T. Scott, 19th Ann. Rept. Fish. Board Scot. iii. p. 121.

1902. *Bomolochus soleæ,* T. Scott, ibid. 20th, p. 288.

1905. *Bomolochus soleæ,* T. Scott, ibid. 23rd, p. 108.

This parasite seems to be very common in the nostrils of the Cod (*Gadus morrhua*) (*cf.* A. Scott). T. Scott (1893) gives a short account and some figures of this species. His figure (pl. 5. fig: 3) of the second antenna does not seem to be quite correct. This appendage (Pl. 8. fig. 3, $A.^2$) is three-jointed. The basal joint articulates with a chitinous plate, with which the mandible and first maxilla are also articulated (fig. 3, *Ch.p.*). From the inner margin of this plate a chitinous rod springs which runs inwards and forwards and is united to the front lip, which is stiffened at this point by a chitinous knob. The second joint is quite short and forms the elbow of the appendage, which is doubled back on itself; it bears two small setæ. The terminal joint is nearly as long as the basal joint and is very elaborate. There is a broad portion, which ends in a sort of paddle and is covered with short spines. At the outer side of this, about the middle of its length, is a strong sword-shaped blade, the outer edge of which bears a fringe of thick pectinate setæ. Close to the base of the blade is a strong curved claw (?) or seta. Three longer and more slender setæ lie between the blade and paddle. There are also two finer setæ on the inner side of these. This appendage is the same in both sexes.

The Mandible (Pl. 8. fig. 4, *Md.*) has a long tooth and one much smaller at its side, and agrees closely with the mandible of a variety of this species found in the nostrils of the Ling, *Molva molva* (Linn.), which T. Scott describes and figures (*op. cit.* 1902, p. 288, pl. 22. fig. 16).

Behind the first maxilla and between it and the second maxilla is an oval chitinous structure with a stout base (fig. 4, *S.l.*); the oval portion is covered with fine hairs. Claus, in his account of this species (*op. cit.* 1864, p. 375), describes and figures (pl. 35. fig. 18 *d*) a chitinous plate to which he says the palp (maxilla) appears to belong; this figure does not agree with mine; but on the same plate (fig. 23 *b*) is a figure of the mouth-parts of *Bomolochus cornutus*, and in this he shows a structure very similar to that observed in *B. soleæ*. Claus describes it as "the maxilla-plate with palp." Giesbrecht, in his account of the "Paragnathe" of the Copepoda (*op. cit.* 4, p. 75), gives his reasons for regarding similar structures in the Hersiliidæ and other Copepoda as lateral outgrowths of the lower lip and he calls them, therefore, side lips (Seitenlippen). There can be no doubt, I think, that this is the true explanation of these structures in *Bomolochus soleæ*—i. e., they are outhrowths of the lower (hind) lip, and are morphologically quite distinct from the first maxilla. Giesbrecht considers that the correct terms to use for the parts of the mouth are fore lip (Vorderlippe), hind lip (Hinterlippe), and side lip (Seitenlippe). The specimen from which the drawings were made measured 1·53 mm.

The Male (Pl. 8. fig. 2) is much smaller, one specimen measured ·71 mm., another ·8 mm. As the male has apparently not been figured before, a drawing of it, enlarged to the same scale as the female, is given here. The abdomen is composed of three segments and the caudal furca. The first and second antennæ and the mouth-parts are the same as in the female. The first maxillipeds (fig. 5) are quite different; they are very conspicuous, and serve at once to distinguish the sexes. Claus describes them (*op. cit.* p. 377) and also the swimming-feet, the fourth pair of which differs somewhat from those of the female.

All the specimens examined were from the nostrils of the Cod (*Gadus morrhua*, Linn.).

Family Chondracanthidæ.

Genus Chondracanthus, De la Roche (1811).

Chondracanthus inflatus, sp. n. (Pl. 9. figs. 9–15.)

General Appearance (female).

In appearance the female is very stout and swollen, the body being curved slightly as shown in the figure (fig. 9). The head is separated from the body by a deep constriction, and bears a pair of strong curved hooks, the second antennæ; these project considerably beyond the ventral surface of the head, and by means of them the parasite is attached to its host. There are no traces of the first antennæ. The first thoracic segment is short and rounded dorsally, and bears a pair of blunt bilobed appendages. The constriction which separates this segment from the posterior one is less marked than the division between the head and the first thoracic segment. Traces of three more segments can be made out, the first of which is the shortest and bears another pair of bilobed appendages. The postabdomen is very short and projects beyond the genital segment; it is roughly pyramid-shaped with a blunt apex, and shows traces of two or perhaps three segments. On the last of these are a pair of small caudal furca. Just anterior to the furca are the openings of the oviducts. It is doubtful whether these are true segments or only secondary foldings. There are no lateral processes. Two transparent tubes run down each side of the genital segment beneath the dorsal surface. On the ventral side of the minute postabdomen the oviducts with narrow necks and wide ends can be seen (fig. 14, *Od.*). They open to the exterior on the sides of the abdomen, at a point a little posterior to the middle of its length. No ovisacs were present, and the ova inside the body were not fully developed. A minute male was attached to the female just above the abdomen on the ventral surface (fig. 9, ♂).

Appendages (female).

First Antennæ.—Not developed.

Second Antennæ.—A pair of stout hooks on a broad basal joint, very similar to these appendages in other species of *Chondracanthus.*

Mouth-parts (fig. 13).—Two pair of appendages (the second maxillæ and first maxillipeds) and part of a third pair (the first maxillæ) are situated posterior to the fore lip. This is long and curved, with two small prolongations at each side (*F.l.*), and completely covers the mandibles.

Mandibles (fig. 12, *Md.*).—Curved blades, the outer margin bearing sharply pointed teeth, the inner margin covered with much smaller teeth.

First Maxillæ (fig. 12, $Mx.^1$).—These are posterior to the mandibles, and are partly covered by the fore lip. They are flat ovate appendages, bearing each two small curved setæ.

Second Maxillæ (fig. 12, $Mx.^2$).—Apparently three-jointed. The last joint bearing a bluntly pointed blade with curved teeth on the outer margin: below the teeth is a delicate tongue-shaped seta.

First Maxillipeds (fig. 12, $Mxp.^1$).—Three-jointed, the terminal joint bears a strong short claw (there is no small tooth on the upper margin of the claw as on the same appendage of *C. cornutus*). The sheath of this claw is covered with fine bristles.

The hind lip, which is leaf-like in shape, hangs down dorsally to these appendages, the posterior margin reaching to about the level of the first maxillipeds. Two chitinous structures of unknown function can be seen near the lower edge of the lip (fig. 13, *H.l.*),

Thoracic Appendages (fig. 9, $F.^1$, $F.^2$).—Two pair. They are stout and project a short distance beyond the margin of the body. The ends are blunt and bilobed and are covered with fine bristles.

General Appearance (male).

Seven segments can be distinguished including the cephalothorax. The last abdominal segment bears the caudal furca. A wide intestine full of granules fills up a large portion of the body (fig. 10, *I.*). There is a large pigment-spot posterior to the second antennæ (*Pg.*). The mouth-parts are situated a considerable distance behind these appendages.

Appendages (male).

First Antennæ.—Four-jointed, slender. The terminal joint bearing three taste-hairs or setæ at its extremity and a tiny seta at its base. One seta on the third joint and one on the second joint above its junction with the basal joint, on which is a very small seta.

Second Antennæ.—Two-jointed, very stout with a strong terminal claw. The male is attached to the female by these appendages.

Mouth-parts.—The mandibles and first maxillæ are not visible, being covered by the fore lip.

Second Maxillæ.—Somewhat shorter than the maxillipeds. Three-jointed, the terminal joint bears a stout claw and a small seta.

First Maxillipeds (fig. 11).—Three-jointed, and similar to the second maxillæ.

Thoracic Appendages (fig. 15).—Two pairs; apparently biramose. Inner branch paddle-like, bearing a long slender seta and a very short one at its distal end. Outer branch club-shaped, more slender, bearing one short seta at the end. These limbs are very minute, measuring only ·04 mm.

	mm.
Length of female measured in the position as figured (fig. 9)	5
Width of genital segment	1·8
Length of male	0·6

Habitat. A single specimen of a female with a male attached was found on the gills of *Raia radiata.*

This *Chondracanthus* seems to be somewhat like Olsson's * *Chondracanthus annulatus*, and at first sight, in spite of the great differences in size (5 mm. *Ch. inflatus*, 10–12 mm. *Ch. annulatus*), I thought it might be a young female of Olsson's species. There are, however, two important points of difference. Olsson says both the first and second pair of antennæ are very minute, and he mentions and figures short posterior processes, which, however, he describes as shorter than the tail (abdomen). In the specimen from the Starry Ray (*Raia radiata*) the first antennæ are not developed, but the second antennæ are very large and strong, and there are no posterior processes. The male of *Ch. annulatus* (length 1·4 mm.), as far as can be made out from Olsson's description, would seem to be very similar except in size to the male described above. Although it is very unsatisfactory to establish a new species from a single specimen, it seems in this case necessary to do so. The complete absence of posterior processes is remarkable, these structures being usually developed in species of *Chondracanthus*. *Chondracanthus brevicollis*, Kllr., described and figured by Kröyer †, is the only species of this genus known to me which is without posterior processes, and indeed it seems somewhat doubtful if it should be placed in this genus at all. Kröyer himself remarks that this form seems somewhat aberrant, owing to the peculiar structure of the first thoracic limbs and the abdominal appendages (the caudal furca is well developed in *Ch. brevicollis*). The host of this species is not given; locality Moluccas, East Indies.

Family Lernæopodidæ.

Genus Lernæopoda, Kröyer (1837).

Lernæopoda cluthæ, T. Scott. (Pl. 10. figs. 21–27.)

1900. *Lernæopoda cluthæ,* T. Scott, 18th Ann. Rep. Fish. Board Scotl. iii. p. 173, pl. 8. figs. 27–37.

Lernæopoda cluthæ has been described and figured by T. Scott, but the following notes and a few more figures may be useful. This species seems to be very closely allied to *Lernæopoda longimana*, Olsson ‡, a species which the Swedish naturalist found in very large numbers (he mentions having more than 300 examples, and says he had seen ten times as many) on the gills of *Raia fullonica*, and at times very frequently on *Raia batis,* also from the Skager Rack. T. Scott's specimens of *L. cluthæ* were also taken from the gills of *Raia fullonica*, Firth of Clyde; but although closely allied it would seem that these two species are distinct. Olsson's specimens of *L. longimana*

* "Prodromus faunæ Copepodorum parasitantium Scandinaviæ," Acta Universitatis Lundensis, 1868; Lunds Univer. Årsskrift, iii. p. 30, pl. 2. figs. 13–15.

† 1863. "Bidrag til Kunds. om Snyltekrebsene," Naturh. Tidsskr. (3) ii. p. 320, pl. 13. figs. 3 *a–d*.

‡ *Op. cit.* p. 38, pl. 2. figs. 18–22.

measured from 7–8 mm.; the neck was not quite twice as long as the cephalothorax, and the egg-sacs equal to the neck in length. As already stated, Olsson examined a very large number of specimens, and he says that in all these the specific characters mentioned above were very constant. T. Scott's specimens measured 5 mm., and the neck appears to be decidedly shorter than in Olsson's specimens. Scott found and described the male; but Olsson, although he examined such large numbers, never saw a male. This point is interesting, as the simultaneous occurrence of the two sexes varies considerably in different species.

About twelve specimens of a *Lernæopoda*, all females, from the gills of *Raia radiata*, were examined by me. These agreed closely with Scott's specimens in size and other particulars, and are therefore placed under his species.

The measurements are given below.

The body of the female (fig. 24) was full of large ova. The ovaries (*Ov.*) are situated on either side of the genital segment where the body begins to widen out below the neck. The ovisacs are short, the ova being very large and apparently hexagonal in shape owing to pressure. Some ova found in a shrivelled ovisac, which had shed most of its contents, were found well-developed (January), the larva showing the abdomen already developed and two pair of swimming-feet. There is a wide intestine (*I.œs.*) full of granules which seems to run straight from the mouth-tube, widening out in the genital segment and narrowing again posteriorly. The genital openings are situated on the ventral surface on two slightly raised knobs, between which lies the minute postabdomen.

Mandibles (fig. 25).—Length ·13 mm. Slender, irregularly toothed. Four large teeth, between which are three very small ones. Following these seven teeth are four more, which are very thin and delicate. Eleven teeth in all.

The organ of attachment by which the parasite is joined to its host is most remarkable; it will be described in detail in another paper on the organ of attachment in the family of the Lernæopodidæ.

	mm.
Length of female (without posterior processes)	5
,, process	0·5
,, ovisacs	(1) 2·6, (2) 2·8
,, first maxillipeds and tenaculum	4

Genus Brachiella, Cuvier.

Brachiella pastinaca, Van Ben. (Pl. 8. figs. 6, 7; Pl. 9. fig. 8.)

1851. *Brachiella pastinaca*, Van Ben. Annales des Sci. Nat. 3 sér. vol. xvi. p. 118, pl. 4. figs. 8–9.

1877. *Brachiella pastinaca*, Kurz, Zeitschrift für wissenchaftliche Zoologie, Bd. xxix. p. 389, pls. 25, 26, 27. figs. 2, 3, 36, 45.

1880. *Brachiella pastinaca*, A. Valle, Bollet. d. Soc. Adriatica di Sci. Nat. in Trieste, vol. vi. fasc. 1, p. 77.

1904. *Brachiella pastinaca*, T. Scott, 22nd Ann. Rep. Fish. Board Scotland, iii. p. 278.

A single specimen of what I take to be this species was found in the spiracle of the Piked Dogfish (*Acanthias vulgaris*). P. J. Van Beneden's description and figures of this species, which he obtained from the nostrils of the Sting Ray (*Trygon pastinaca*), are not very satisfactory. He says the head passes insensibly into the thorax without narrowing to form a neck, so that at the first glance you do not know where the head is. This description certainly does not apply to the parasite from the Piked Dogfish; but after a careful comparison of my specimen with Kurz's figures and description (*op. cit.*) of *Brachiella pastinaca*, I think it is correct to identify it as that species. T. Scott obtained two specimens in the nasal fossæ of *Trygon pastinaca*, Linn., but unfortunately they were lost in the post and he was not able to give any figures (*op. cit.* p. 278). It would seem to be a somewhat rare species.

The curious position of this parasite (Pl. 8. fig. 6) is very remarkable. The head is thrown back, the arms (first maxillipeds) stretched out, and the posterior processes turned up almost at right angles to the body. Kurz's description of the general form of the body is accurate, but a short account of the appendages and some more figures may be useful. The cephalic shield which covers the dorsal surface of the head is made up of two plates, down the sides of which run strong chitinous rods of a yellow colour. There is a more slender rod of chitin between the two plates.

Appendages (female).

First Antennæ (Pl. 9. fig. 8, $A.^1$).—Slender, four-jointed, the terminal joint bearing three setæ of different shapes, and the second joint one small seta.

Second Antennæ.—Biramose, thick, and blunt; outer branch thicker than inner branch, bearing one or two small hooks and covered with fine bristles.

Mandibles (Pl. 8. fig. 7).—These lie inside the mouth-tube and are long and slender; they differ somewhat from Kurz's description and figure (p. 390, pl. xxvi. fig. 36). He mentions three principal teeth with three smaller teeth alternating with them, the five following teeth, with the exception of the first, being considerably smaller. In the specimen from *Acanthias vulgaris* there are three large curved teeth. Between the two first of these are two very small teeth (only one is shown in the figure). These five teeth are followed by two straight and sharply pointed teeth, and these again by two more, which are very slender and delicate. There are nine teeth in all. Beyond the teeth the inner margin is produced into a rounded cutting-edge.

At the sides of the mouth-tube, just anterior to the first maxillæ, are a pair of slender clawed appendages (Pl. 9. fig. 8, *p.*), each composed of a stout basal joint and a slender curved claw. Thompson *, in his description of *Brachiella parkeri*, mentions and figures somewhat similar structures; he calls them "maxillary palps."

First Maxillæ.—See Kurz (*op. cit.*).

Second Maxillæ (Pl. 9. fig. 8, $Mx.^2$).—Kurz does not describe these appendages, but his figure (pl. xxvii. fig. 45) corresponds fairly well with my drawing. They are two-jointed, the basal joint stout and bearing on the inner margin, just below the articulation of the terminal joint, a small pad covered with tiny bristles. About the middle of the inner margin is a small seta, and below this another small pad with bristles. The terminal joint is slender and curved, its edges having strong chitinous supports; at its end is a curved claw with a small tooth on its inner edge. At the base

* 1889. 'Transactions of the New Zealand Institute,' vol. xxii. (5th of new series) p. 374, pl. 28. fig. 8 *a* (*p.*).

of this claw is a small papilla with a single hair. Near the base of the terminal joint is a small seta.

First Maxillipeds.—Short and separate along their whole length. At the base of the cup-shaped organ of attachment they are united. The parasite was so firmly fastened to its host that it was necessary, in order to obtain the specimen undamaged, to cut away some of the tissue of the host. The structure of the tenaculum will be described in another paper.

	mm.
Length (without posterior process)	5·5
„ of posterior process	2

Kurz gives 8 mm. as the length of his specimen, but he does not say whether this measurement includes the posterior processes or not.

(?) BRACHIELLA PARKERI, Thompson. (Pl. 9. figs. 16–17; Pl. 10. figs. 18–23.)

1889. *Brachiella parkeri,* Thompson, Trans. New Zealand Inst. vol. xxii. p. 374, pl. 28. figs. 8 *a*, *b*.

One specimen of what I take to be this species, or one closely allied to it, was obtained from the gills of the Long-nosed Skate (*Raia oxyrhynchus*) in May. It was a female without ovisacs. The parasite was so firmly attached to its host that it was only dissected out with great difficulty.

General Appearance (female).

The position of this creature is very remarkable (Pl. 9. fig. 16), the head being bent backwards almost at a right angle with the body, so that the head and first maxillipeds are nearly in a straight line. The arms are very long and slender, almost the same thickness throughout their length, and only tapering slightly at the distal ends, where they are united in a disc-shaped tenaculum deeply imbedded in the tissue of the host. The head to the bend of the neck measures more than half the length of the neck and genital segment together. The neck is slender and short, passing gradually into the genital segment. From the ventral surface this portion of the body is somewhat bottle-shaped, widening posteriorly. Near the hinder margin the sides curve in, ending in two short lobes. The abdomen, which is roughly square, lies between these lobes and projects a short distance beyond the genital segment. On its dorsal surface near the sides are two stout processes borne on very short stalks. On the ventral surface of the abdomen two indistinct segments can be made out: the anterior is the shorter of the two and has a small thick-lipped slit down the centre. At the sides and slightly posterior to this slit are two knobs; between the raised folds of these lie the genital openings (Pl. 10. fig. 22, *G.O.*). The posterior segment is bluntly rounded and has a slit down the centre, the opening of the anus (Pl. 10. fig. 22, *a.*). In the preserved specimen it was not possible to determine with certainty whether the two slits were continuous or not.

The head is elongated, wider posteriorly, and becoming narrower towards the anterior end, where it is bent over so that the mouth-tube is on the ventral surface. The dorsal surface of the head is flattened. At the anterior end, where it is bent over, is a small prominence with uneven edges (Pl. 9. fig. 17, *x*); the first pair of antennæ, which are curved backwards, are borne near the base of this structure. Between the second antennæ, and making an angle of 45° with them, is the long mouth-tube, which hangs downwards. The upper and lower lips can be readily separated and the mandible is seen lying between them. Posterior to the mandibles at the base of the mouth-tube are the first pair of maxillæ. The second maxillæ are situated far behind the first pair, about half-way between the extremity of the head and the bend of the neck. Their ends are directed forwards and project considerably beyond the surface of the head. A constriction can be seen at the back of the head and another where the body is bent back; on this segment the arms are borne. Posterior to the bend is a narrow short portion passing gradually into the wide genital segment. Indistinct traces of four segments can be made out in this portion of the body. The first two subequal; the next about one and one-third longer, the fourth about three times as long as the first. It is doubtful if these are true segments. Two bands of muscle can be seen running down the centre of the genital segment; at a point which corresponds with the first constriction behind the neck their continuation seems interrupted: this is probably a true segment. These muscles run backwards almost to the base of the abdomen. On each side of them are two large masses of ova extending forwards into the first segment. There is another mass of ova beneath the ventral surface, and lying between these masses are a pair of thick-walled cement-glands (Pl. 9. fig. 16, *C.G.*), which extend forward to a point about the middle of the total length of the genital segment. From the side they can be seen curving round in the prominences at the posterior margin of the body just above the genital openings (fig. 16, *G.O.*).

Appendages (female).

First Antennæ (Pl. 10. fig. 23).—Two-jointed, basal joint one and a half times as long as the terminal joint, which is slender, bearing two delicate tapering setæ, one of which is thicker than the other, and two more very small setæ. Rather below the middle of this joint is another small seta.

Second Antennæ (Pl. 10. fig. 19).—Stout, biramous. The two branches are borne on a stout basal portion which is not distinctly segmented. The outer branch is about the same thickness throughout, with a blunt truncated extremity. This portion bears three rounded knobs, the two outer smaller and more raised than the median knob. All are covered with fine bristles and a few small hooks. The outer margin of this branch is also covered with bristles. The inner branch of the main stem is not so stout as the outer branch. The outer edge is covered with bristles, and above this part is a rounded knob on which is a slightly hollow disc full of bristles with a small seta at its base and another longer seta near the outer edge. On the inner side of this disc is a strong sharp claw with a small seta at its base. The segmentation of both branches is indistinct.

Mandibles (Pl. 10. fig. 20).—Four large teeth alternating with three small teeth: these seven are followed by four more, the first two of which are longer than the other two. Behind the teeth is a cutting-edge.

First Maxillæ (Pl. 10. fig. 21).—Biramous. The outer branch bearing three long tapering setæ. The inner branch small and stump-like, bearing two small setæ. The segmentation of this appendage is indistinct, but traces of two joints on the main stem below the inner branch can be seen.

Second Maxillæ (Pl. 10. fig. 18).—Very indistinctly segmented, traces of three joints can be made out, the last bearing a short simple claw ; below this on the inner margin of the same joint is a delicate short seta. Between the two appendages, at their base, are two small raised folds. The outer free margin is much longer than the inner, so that one appendage could not be dissected without tearing the other. The structure of these appendages is peculiar and unlike those of other species of *Brachiella*. There was no claw on the left appendage—it may, however, have been accidentally destroyed.

	mm.
Length from top of arms to end of abdomen	9·2
,, from end of head to extremity of attachment	19
,, of arms	14·5
,, of body from bend of neck to end of abdomen	8
,, of head to bend of neck	5·3
,, of process	4
Width of neck	1·5
,, of genital segment	5·2

This species seems to be nearly allied to, if not identical with, *Brachiella parkeri*, Thompson (*op. cit.*), from the gills of *Raia nasuta* and also a Stingaree (*Trygon* sp. ?), Otago Museum, but it differs from it in several particulars.

There is some difference in the size. The following are Thompson's measures of *Brachiella parkeri* :—

	mm.
Head and thorax	8
Length of arms	17
,, genital segment	11
Width	7
Length of process	10
Total length of animal from bend of thorax	12

On a comparison of these figures it will be seen that my specimen is considerably smaller, but it was without ovisacs and is probably a young female. Thompson, in his brief account of this parasite, mentions and figures a pair of "maxillary palps" at the base of the rostrum ; these appendages were not observed in the form now described. The great length of the posterior processes, 10 mm. as compared with 4 mm. in the British form, should also be noted. But, on the other hand, the position of the head in a "nearly continuous line with the arm-like appendages and bent at right angles to the genital segment" is very characteristic of my specimen. Also Thompson's description of the first maxillipeds (he calls these appendages "second maxillipeds"), as "conical protuberances which show no distinct segmentation" and which are situated "about three millimetres from the extremity of the cephalothorax," applies closely to the structure and position of these appendages in the form from the Long-nosed Skate. I have thought it better therefore provisionally to call this parasite *Brachiella parkeri*, Thompson.

The structure of the tenaculum with its remarkable sucker will be described in another paper.

Genus ANCHORELLA, Cuvier (1817).

ANCHORELLA RUGOSA, Kröyer. (Pl. 10. figs. 28–32 ; Pl. 11. figs. 33–37.)

1837. *Anchorella rugosa,* Kröyer, Naturh. Tidsskr. Række 1, Bd. i. p. 284, pl. 2. fig. 7, pl. 3. figs. 14 *a–e.*

1840. *Anchorella rugosa*, Milne-Edwards, Hist. Nat. Crust. iii. p. 519.

1851. *Anchorella rugosa*, p. 7, Van Beneden, Ann. Sci. Nat. 3me série, vol. xvi. p. 114, pl. 6. figs. 7–10.

1863. *Anchorella rugosa*, Kröyer, Naturh. Tidsskr. Række 3, Bd. ii. p. 383.

1879. *Anchorella rugosa*, C. Vogt, Recherches Côtières faites à Roskoff ; Genève.

1899. *Anchorella rugosa*, Bassett-Smith, " A Systematic Description of Parasitic Copepoda found on Fishes," Proc. Zool. Soc. London, April 1899, p. 503.

1900. *Anchorella rugosa*, T. Scott, 18th Ann. Rep. Fish. Board Scot. pt. iii. p. 176, pl. 8. figs. 45–48.

This species seems to be fairly common on the gills of the Catfish (*Anarrhichas lupus*, Linn.). There is considerable variation in the size of the female. One specimen measured 4 mm. from the base of the first maxillipeds to the end of the abdomen. The cephalothorax measured 6·5 mm. in length and the width of the genital segment was 3·6 mm. In another specimen these measures were respectively 2·3 mm., 4·4 mm., and 2·8 mm.

The Female.—Kröyer's description of this parasite is good, but his figures are poor. T. Scott (*op. cit.* 1900) also gives a short account and some figures of this species. The square outline of the genital segment and the stout wavy cephalothorax, which in life is doubled back and lies close to the dorsal surface, are very characteristic, as is also the jerky movement of the head from side to side and the slow movement up and down of the ovisacs. Kröyer mentions the peculiar movement of the end of the cephalothorax. Slighter movements of the antennæ and second maxillæ can be seen. In life the colour of the genital segment is yellowish and semi-transparent. A wide brown intestine with wavy borders runs down the cephalothorax and can be seen as a conspicuous brown mass on the ventral surface of the genital segment. The ova are paler in colour and each shows two specks of brown pigment (February). The chitinous structures are deep yellow. On the ventral surface (the side away from the cephalothorax), just anterior to the abdomen and between the ovisacs, are two yellow chitinous spots (the openings of the *receptacula seminis*) ; projecting from these in one specimen were two semi-transparent packets in shape like long narrow pods : these are probably spermatophores. On another female without ovisacs two globular semi-transparent bodies were observed projecting from the openings of the oviducts. They measured ·66 mm. in width and were ·8 mm. long. Possibly they are the commencement of the ovisacs? The muscular system will be described in another paper on the attachment of this parasite.

The Male.—Males are found attached to different parts of the female, sometimes on the cephalothorax or on the postabdomen, and in one case on the dorsal surface. They are minute and easily detached, holding on by means of the claws of the second maxillæ. In life they are semi-transparent and show no distinct segmentation. A wide coiled tube, the testis (Pl. 10. fig. 29, *T.*), fills up most of the body; there is also a broad intestine (fig. 28, *I.*) with sacculated walls which narrows posteriorly and opens where the carapace curves inwards (*a*). The intestine contains numbers of brownish-green cells; these are probably the excretory cells of Claus and are mentioned also by Wierzejski * in his description of the males of *Penella varians* (?). Clear oil or fat-globules are present in numbers in the digestive tube. Beneath the dorsal surface in the median line is a patch of red pigment (figs. 28, 29, *Pg.*), and there is a less conspicuous patch near the base of the first maxillipeds. At the base of these appendages on each side is a small coiled slightly raised structure, which looks like the opening of a gland (*P.*). Kurz †, in his description of the male of *Anchorella emarginata*, a species closely allied to *A. rugosa*, mentions two protrusible papillæ, at the extremities of which are the genital openings (fig. 11, *gp.*) and which are situated behind the "second maxillipeds" (first maxillipeds). It seems doubtful, however, from the position of these openings in *A. rugosa* whether they can be genital.

The description given by Kurz of the appendages of the male of *A. emarginata* (p. 401, figs. 11, 27, 28) seems to correspond closely with those of this species.

The Second Antennæ (fig. 31) are much like his figure (fig. 28, a^2), but he does not mention two delicate setæ on the paddle-shaped branch.

The Mandibles (Pl. 10. fig. 30).—The same as in the female, but much smaller and more slender; the teeth do not appear to be quite so sharply pointed as in Kurz's figure (fig. 31) of the mandible of *A. emarginata*.

The First Maxillæ (fig. 32).—See Kurz (figs. 27, 28, *mx.*).

The First Maxillipeds (Pl. 11. fig. 36).—Very stout and bearing strong claws. There is a small tooth on the claw, which is doubled in and seems to work on a pad covered with bristles. On the stout basal part of the appendage is a seta.

	mm.
Length of male of *A. rugosa*	·86
" " *A. emarginata*	·43

Mr. Bassett-Smith (*op. cit.* 1899) considers *A. emarginata* to be synonymous with *A. rugosa*, but the two species although closely allied seem to be quite distinct.

* "Ueber Schmarotzerkrebse von Cephalopoden," Zeit. wissen. Zool. Bd. xxix. 1877, 4 Heft, p. 567, pl. xxxii. fig. 1, K^2.

† "Studien über die Lernæopodiden," Zeit. wissen. Zool. Bd. xxix. 1877, p. 402, fig. 11, *g.p.*

Anchorella uncinata, Müller (variety from the fins of the Cod). (Pl. 11. figs. 43–46.)

(For synonymy and literature, see Bassett-Smith, *op. cit.* 1899, p. 505.)

Two females of what seems to be a variety of *Anchorella uncinata*, Müller, were obtained from the fin of a Cod (*Gadus morrhua*).

General Appearance (female).

The animal is somewhat flattened and is invested by a loose bag-like membrane (fig. 43). On the fin of the host where the parasite is attached is a large oval swelling (*s.*). The tenaculum is deeply imbedded in this swelling, only a small portion of the end of the chitinous stem being free. The two arms (first maxillipeds) are short but distinct, and are only united at the base of the stem of the tenaculum. Two glands open to the exterior on the transparent investing membrane close to the base of the arms. Similar glands are present in the common form of this species. The genital segment shows traces of three segments; the third is separated from the preceding segment by a deep indentation at the sides. From this segment the pear-shaped abdomen projects beyond the posterior margin of the body; it is borne on a stalk (*p.ab.*). The cephalothorax lies close to the genital segment and is moderately stout, increasing in thickness towards the head. In the larger of the two specimens it is a little longer than the genital segment, in the smaller considerably longer. On the sides at the end of the abdomen are two openings with thickened edges: two tubes can be seen running down the abdomen to open at these points.

The tenaculum will be described in another paper.

The appendages are the same as in *A. uncinata*, Müller. This variety differs considerably from the common form in its general appearance, being much flatter, and in the position of the cephalothorax. The curious pear-shaped swelling on the fin of the host is remarkable, as the common form of *Anchorella uncinata* does not seem to produce this swelling.

		mm.
(1) Length of female	. . . .	3
(2) ,, ,,	. . . .	2

Anchorella stellata, Kröyer. (Pl. 11. figs. 38–42.)

1838–39. *Anchorella stellata*, Kröyer, Naturh. Tidssk. Række 1, vol. ii. p. 142, pl. 3. fig. 5.
1864. *Anchorella stellata*, Kr. op. cit. Række 3, vol. ii. p. 383.
1900. *Anchorella stellata*, T. Scott, 18th Ann. Rep. F. B. Scot. iii. p. 178.
1901. *Anchorella stellata*, T. Scott, op. cit. 19th, p. 134, pl. 8. figs. 1, 2.

This species was first described by Kröyer, and T. Scott gives a description of it (1900) and some figures (1901). As the species is very interesting, I give a few more notes and some drawings.

Five specimens were found on the skin of a Hake (*Merluccius vulgaris*, Linn.) near the pectoral fin. They were all females and without ovisacs. The Hake was purchased at Sheringham, Norfolk.

General Appearance (female).

The genital segment and cephalothorax are much flattened and are invested by a loose bag-like membrane. The first maxillipeds (fig. 38, *Mxp.*[1]) are rather more than one-third of the length of the cephalothorax. They appear to be quite distinct, but the investing membrane seems to be fused along the median line, so that the two appendages cannot be separated. The ends are enlarged into two semicircular folds, between which the tenaculum lies. In the genital segment on either side are two large thick-walled cement-glands (*C.G.*). The relations of the genital apparatus were not easy to make out in preserved specimens, but the following points may be noticed :—The ends of the oviducts have thick chitinous walls (*Od.*); they open on the raised knobs on either side of the minute abdomen (*G.O.*). Two boat-shaped structures with chitinous walls lie at right angles and dorsally to them, and are probably the *receptaculum seminis* (*R.S.*). At the inner side of the thick wall of the oviduct is a smaller chitinous structure (x), lying apparently dorsal to the *receptaculum seminis.* Vejdowski *, in his paper on *Tracheliastes polycolpus*, Nordm., figures structures not unlike these, but the canals which he observed leading from either end of the *receptaculum seminis* to the external opening were not made out in *Anchorella stellata.*

On the abdomen are two minute chitinous structures; these are probably the external openings of ducts leading into the receptacula seminis.

The appendages are very similar to those of *Anchorella uncinata*, Müller.

The Mandible (fig. 42).—This is very irregularly toothed. The first tooth is large, followed by two smaller teeth, the fourth is very long and prominent, the fifth and sixth are smaller. Following these is a curved cutting-edge. There are six teeth in all.

In size these specimens corresponded very closely with those obtained on the Hake by T. Scott.

	mm.
Length of female	6
„ cephalothorax	3·5
Width of genital segment	2

* "Unters. über die Anatomie u. Metamorphose v. *Tracheliastes polycolpus*, Nordm.," 1877, Zeit. wissen. Zool. Heft. i. p. 32, pl. 3. fig. 4, *r.s.*

EXPLANATION OF THE PLATES.

The following letters apply to all the figures:—*A.*[1], first antenna; *A.*[2], second antenna; *a.*, anus; *C.th.*, cephalothorax; *C.F.*, caudal furca; *C.G.*, cement-gland; *E.c.*, excretory cells; *F.*[1], *F.*[2], *F.*[3], first, second, third thoracic foot or swimming-foot; *F.l.*, fore lip; *G.O.*, genital opening; *G.S.*, genital segment; *I.*, intestine; *I.B.*, inner branch of second antenna or first maxilla; *H.l.*, hind lip; *M.*, muscle, muscle-band; *m.*, mouth, mouth-tube; *Md.*, mandible; *Mx.*[1], first maxilla; *Mx.*[2], second maxilla; *Mxp.*[1], first maxilliped; *O.B.*, outer branch of second antenna, or first maxilla; *Od.*, oviduct; *Œs.*, œsophagus; *Ov.*, ovary; *Ovs.*, ovisac; *Pg.*, pigment; *P.*, papilla; *p.ab.*, postabdomen; *P.p.*, posterior process; *R.S.*, receptaculum seminis; *S.G.*, excretory gland; *S.l.*, side lip or lateral outgrowth of hind lip; *T.*, testis; *t.*, tenaculum.

Plate 8.

Bomolochus soleæ, Claus.

Fig. 1. Female. Length 1·53 mm. Ventral.
2. Male. Length ·83 mm. Ventral. Enlarged to the same scale as fig. 1.
3. Male. Second antenna, showing part of the upper lip, mandible, and first maxilla. The length AB=·1 mm. *Ch.p.*=chitinous plate.
4. Female. Mouth-parts. Cleared with potash. Length=·11 mm.
5. Males. First maxilliped. Length of AB=·14 mm., BC=·15 mm.

Brachiella pastinaca, Van Beneden.

6. Female. Length 5·5 mm.; length of head 2·4 mm. × 10.
7. Female. Mandible. Length ·18 mm.

Plate 9.

Brachiella pastinaca, Van Beneden.

Fig. 8. Female. Mouth-parts. The length AB=1·05 mm.

Chondracanthus inflatus, sp. n.

9. Female with ♂ attached to abdomen. Length of female 5 mm.
10. Male. Ventral. Length ·6 mm.
11. Male. First maxilliped. Length ·16 mm.
12. Female. Mouth-parts, upper lip removed.
13. Female. Mouth-parts. × 139 approx.
14. Female. Abdomen, ventral, showing oviducts. Length ·5 mm.
15. Male. Thoracic limbs. Length ·04 mm.

(?) *Brachiella parkeri*, Thompson.

16. Female. × 3·3.
17. Female. Mouth-parts. × 40.

Plate 10.

(?) *Brachiella parkeri,* Thompson (female).

Fig. 18. Second maxilla. AB=·41 mm.
19. Second antenna. AB=·3 mm.
20. Mandible. Length ·24 mm.
21. First maxilla. Length ·21 mm.
22. Abdomen, ventral.
23. First antenna. Length ·4 mm.

Lernæopoda cluthæ, T. Scott.

24. Length (including posterior processes) 5·5 mm.
25. Mandible. Length ·13 mm.
26. Second antenna.
27. First maxilla. Length ·16 mm.

Anchorella rugosa, Kr. (male).

28. Side view. *Pg.*=patch of red pigment. *E.c.*=excretory cells, brownish green in colour.
29. Length ·86 mm.
30. Mandible. Length ·07 mm.
31. Second antenna. Length ·1 mm.
32. First maxilla. Length ·1 mm.

Plate 11.

Anchorella rugosa, Kröyer.

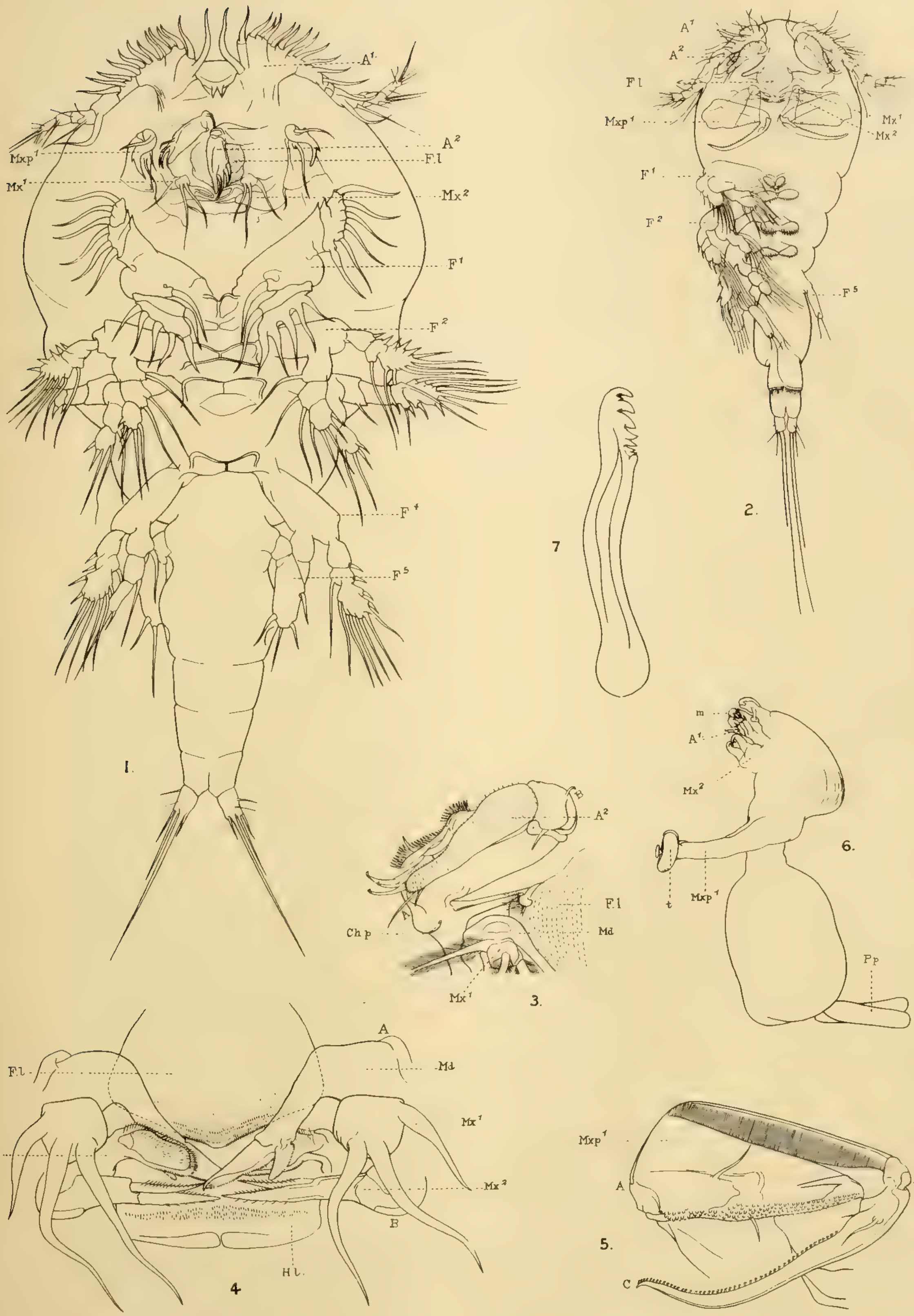
Fig. 33. Female. Mouth-parts. AB= ·8 mm. The second maxilla on the left is cut away to show the first maxilla.
34. Female. Second maxilla, terminal joint. Length ·17 mm.
35. Female. First maxilla. Length ·13 mm.
36. Male. First maxilliped. Length ·22 mm. Cleared with potash.
37. Female. Mandible. Length ·12 mm.

Anchorella stellata, Kröyer (female).

38. Length 6 mm. (including tenaculum to end of abdomen). *s.*=tissue of host; ×, part of genital apparatus.
39. First antenna. Length AB=·13 mm.
40. Second maxilla. AB=·17 mm.
41. First maxilla. Length ·1 mm.
42. Mandible. Length AB=·12 mm.

Anchorella uncinata, Müller, female (variety from the fins of *Gadus morrhua*).

43. Length 3 mm. (including tenaculum to end of adbomen). *s.*=swollen tissue of host.
44. Mouth-parts. × 147 approx. Slightly compressed.
45. Second maxilla. AB=·16 mm.
46. Mandible. Length ·09 mm.



M.E.B. del.

PARASITIC COPEPODA.

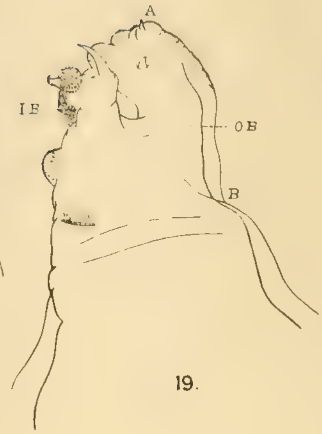
M.P Parker lith
Parker & West imp

M. E. B. del.

PARASITIC COPEPODA.

M. P. Parker lith.
Parker & West imp.

18.



19.


20.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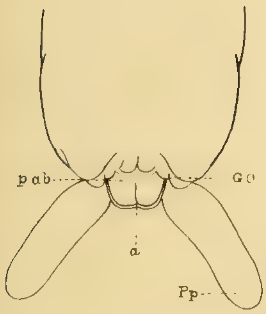

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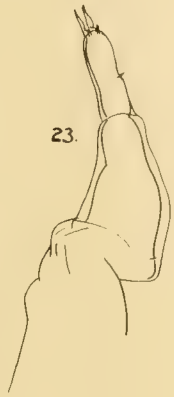
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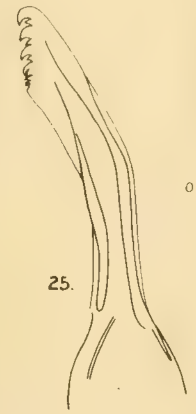
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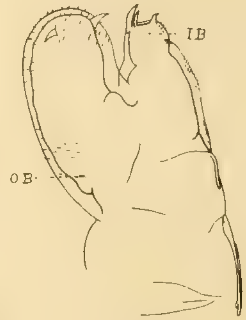

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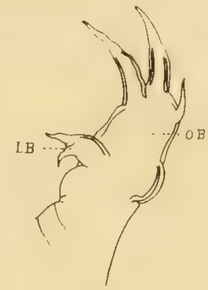

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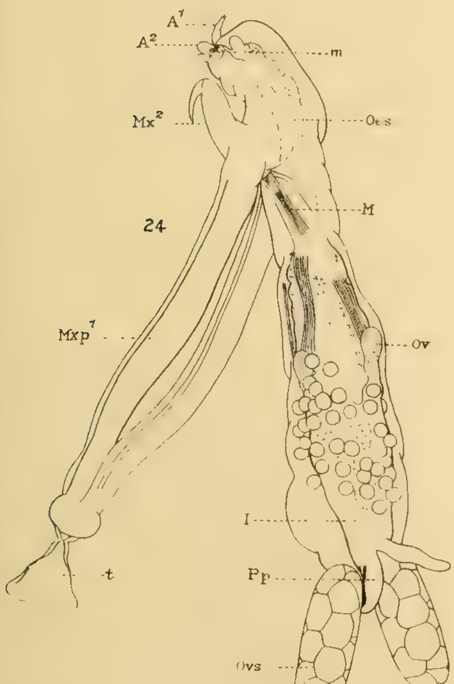
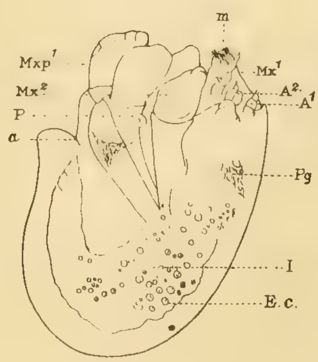


24.



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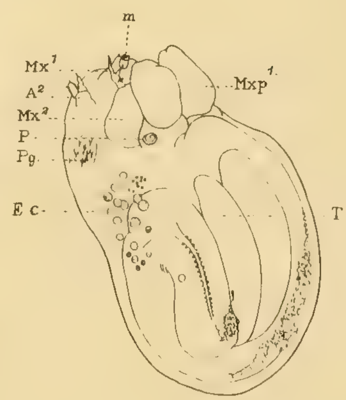

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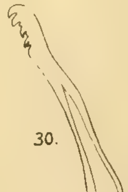
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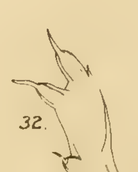

32.

M. E. B. del.

PARASITIC COPEPODA.

M. P. Parker lith.
Parker & West imp.

M.E.B. del.

PARASITIC COPEPODA.

M P Parker lith.
Parker & West imp

IV. *The Freshwater Crustacea of Tasmania, with Remarks on their Geographical Distribution.* *By* GEOFFREY WATKIN SMITH, *M.A., F.L.S., Fellow of New College, Oxford.*

(Plates 12–18 and Map.)

Read 19th November, 1908.

PART I.—GENERAL.

HISTORICAL.

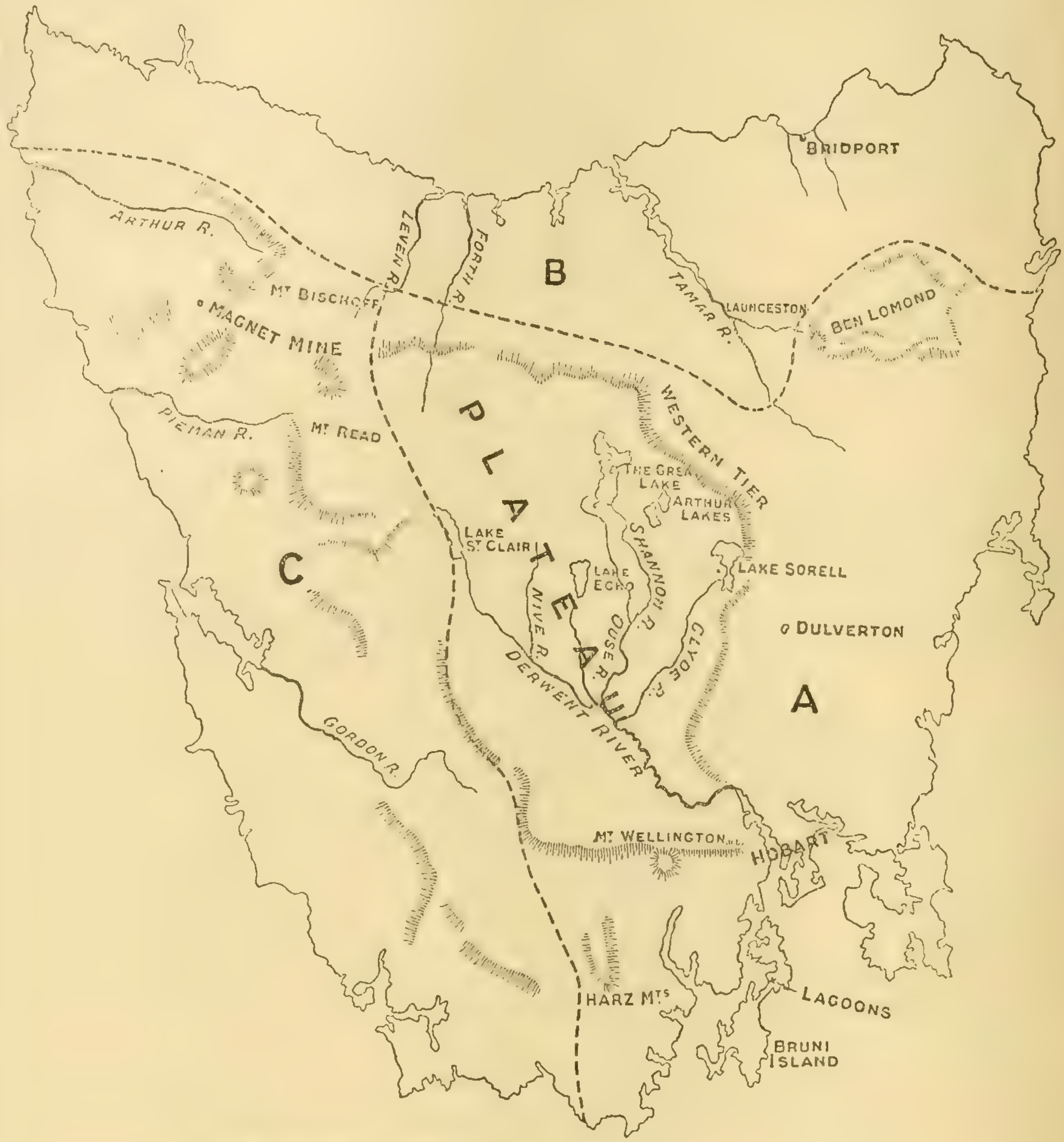
DURING a six months' stay in Tasmania (October 1907 to March 1908), undertaken at the suggestion and through the assistance of Prof. G. C. Bourne of Oxford, I visited a great number of freshwater localities in the island with the object of making a collection and study of the Crustacea. Tasmania is a particularly favourable place for studying the Australian freshwater fauna, as its highlands are covered with numerous large lakes and tarns, and the country everywhere is watered by large rivers and streams.

Previous to my visit, the only naturalist who had made a study of the Crustacea was G. M. Thomson, F.L.S. (Proc. Roy. Soc. Tasmania, 1892, p. 51), who confined himself to the Malacostraca from a few localities. Most of the Tasmanian genera are, however, common to Victoria and New South Wales, so that the works of Sars and Sayce (see Systematic Part) have been of great use to me in assigning species to their proper systematic positions. Besides the discovery of several new forms of interest, I believe that my collections are sufficiently thorough and cover a wide enough area to establish clearly not only what are the dominant genera in Tasmanian freshwaters, but also what genera characteristic of other countries are absent.

In the account of the localities visited and the nature of their Crustacean fauna I confine myself to stating the most important physical characters; but if the reader is desirous of knowing more about the nature of the country and the means of transit I may refer him to my book, 'A Naturalist in Tasmania' (Clarendon Press).

LOCALITIES; WITH THEIR CRUSTACEA.

Tasmania falls naturally into three chief regions:—(1) The Greenstone Plateau. The plateau itself, formed of igneous dolerite or diabase, occupies the centre of the island, the various large lakes being situated on the tableland at an elevation of 2000–3000 ft. above sea-level. The diabase plateau is everywhere flanked by Permo-Carboniferous sand- and mud-stones, beneath which the diabase was originally thrust upwards. To



SKETCH MAP OF TASMANIA

A. Greenstone & Palaeozoic Sandstones.
B. Northern Region.
C. West Coast Region.

Scale 30 Miles to the inch

0 15 30 60 M.

the east and south the plateau is broken up and irregular, with extensive undulating plains in the lowlands formed chiefly of the sandstones, but with occasional high upstanding mountains of diabase, *e. g.* Ben Lomond in the north-east, Mt. Wellington and the Harz Mountains in the south. The waters in this region, where they flow chiefly over the diabase, are very pure and unclouded; but where they flow over the sandstones, especially in the valleys, they are yellow and cloudy.—(2) The North Coast. The strip of the north coast is very varied geologically, with outcrops of granite and basalt and rather extensive tertiary estuarine deposits, especially round the Tamar.—(3) The West Coast. The west coast is a very mountainous and rugged district, the mountains being formed of schists, and other metamorphic rocks of Archæan, Cambrian, and Silurian age. The rainfall here is excessive (about 100 inches per annum) and the mountains are clothed with forests of the evergreen beech (*Fagus Cunninghami*), which replaces Eucalypts, characteristic of the other districts.

1. *The Greenstone Plateau.*

The Great Lake.—At about 3000 ft. above sea-level is an extensive sheet of water, 90 miles in circumference, but nowhere deeper than 20 ft. The water is always somewhat discoloured by the sand stirred up by the waves. Round the edges are blocks of greenstone with a good deal of weedy growth. The Crustacean fauna is very rich both in point of variety of species and in number of individuals representing them. Almost all the species are confined to the shallow littoral zone, the dredge in the deeper zones bringing up nothing but fine mud without any life. In the littoral zone I found a new genus of the Anaspidacea, named *Paranaspides lacustris* (Proc. R. S. ser. B, vol. 80, p. 470, 1908), a transparent green *Mysis*-like shrimp attaining an inch in length. Crawling about in the weeds the very handsome *Phreatoicus spinosus* (Pl. 12. fig. 7), a new species, was abundant, and also the common *P. australis* (Pl. 12. fig. 1). In the deeper muddier zone the straw-coloured *P. brevicaudatus*, sp. n. (Pl. 12. fig. 5), was especially common. These three very distinct species were perhaps the commonest Crustacea in the lake. Together with these were two abundant species of Amphipod, *Neoniphargus tasmanicus*, sp. n., and *Gammarus ripensis*, sp. n. (Pl. 14. figs. 5–8 and Pl. 14. figs. 23–26).

The only native fish which inhabit the Great Lake are the little Galaxias, or native "trout," *G. auratus* and *G. truttaceus*, which can never have been formidable enemies. In the last 50 years the English Brown Trout has been introduced here and grows to an enormous size in the lake (up to 25 lbs.). The trout examined by me all had very deep pink flesh, and their stomachs were full of the above-mentioned Malacostraca, so there is no doubt that they chiefly feed upon the Crustacea of the lake. Tow-netting during the daytime produced very little result, but at night a rather poor quantity of plankton was obtained consisting of the Cladoceran *Bosmina brevirostris*, sp. n. (Pl. 16. fig. 1), the first *Bosmina* to be taken in Australasia, and the common *Cyclops albicans*, sp. n. (Pl. 16. fig. 8).

Lake Sorell.—This lake, at a rather lower elevation than the Great Lake, is of a similar shallow type with discoloured water. Owing to the absence of a boat I was unable to explore it thoroughly. The littoral region of the lake seemed destitute of Amphipods or *Phreatoicus*, but there were numerous prawns of the widely distributed *Xiphocaris compressa*. The plankton was well-developed and consisted of the two Cladocera *Bosmina sorelli*, sp. n. (Pl. 16. fig. 2), and *Ceriodaphnia planifrons*, sp. n. (Pl. 15. fig. 17), and the Copepod *Boeckella longisetosa*, sp. n. (Pl. 17. fig. 13), belonging to the Diaptomidæ.

Lake St. Clair is very different in type to the other Tasmanian lakes, being exceedingly deep (in places 600 ft.) and the water absolutely clear and ice-cold. The elevation is about 2500 ft. The dredge from the deep holes brought up absolutely nothing but fine mud. Round the sandy margins the widely distributed Amphipod *Chiltonia australis* was common. The plankton, which was exceedingly rich, consisted of *Bosmina rotunda*, sp. n. (Pl. 15. fig. 18), *Ceriodaphnia hakea*, sp. n. (Pl. 15. fig. 10), and the Copepod *Boeckella longisetosa*.

Mt. Wellington.—On the flat top of this mountain, at about 4000 ft., are numerous small pools of clear water which never completely dry up, with blackish mud at the bottom of them. In these pools the common *Phreatoicus australis* is abundant and with it the little yellow Amphipod *Neoniphargus montanus* (Thomson).

In a few of the deeper pools the mountain shrimp *Anaspides tasmaniæ* is met with, but this species is found in greater abundance in the deep pools of the mountain torrent which rises on the top of Mt. Wellington and flows down into the North-West Bay River. It does not occur, however, in this river below the Wellington Falls at about 2000 ft. In the little rivulets which everywhere course down the sides of Mt. Wellington several Amphipods are found under the stones, viz. *Neoniphargus wellingtoni* and *Gammarus mortoni*.

Round the base of the mountain in the smaller branches of the streams the smaller species of crayfish or freshwater lobster, *Astacopsis tasmanicus*, is found, though not so abundantly as formerly.

Harz Mountains.—These mountains lie at the extreme edge of the greenstone country bordering on the West Coast Mountains. Near the top are several large and very deep tarns of clear water: in them *Anaspides tasmaniæ* is very abundant, and round the edge a little black Amphipod, *Neoniphargus niger*, sp. n. (Pl. 15. figs. 1–4). The plankton consists of a very numerous bright red Copepod, *Boeckella rubra*, sp. n. (Pl. 18. fig. 1), only found in these tarns and in similar tarns on the West Coast (Mt. Read).

Mt. Field has similar tarns to the above, which, however, I did not visit. *Anaspides tasmaniæ* is found here.

Ben Lomond.—On the top of this mountain, at an elevation of about 4000 ft., is a shallow lake, Yule's Lake, in which are very numerous *Phreatoicus australis* and *Neoniphargus yuli* (Pl. 13. fig. 1).

Adventure Bay Lagoon, Bruni Island.—This is a large shallow freshwater lagoon, only separated from the sea by a line of sand hummocks. The water is, however, perfectly fresh, and the water-weeds and fauna are typical of freshwater. *Phreatoicus australis* was abundant here—a curious fact, since otherwise the genus is found only at high elevations. Among the weeds the Copepod *Brunella tasmanica* (Pl. 18. fig. 6), representing a new genus of the Diaptomidæ, was very abundant. This genus was not met with elsewhere.

Small Ponds &c. round Hobart.—As was to be expected, the Entomostraca from the small ponds and puddles did not yield anything of particular interest, some of the species being identical with Australian forms, while all the genera, except *Boeckella*, are of world-wide distribution. The large *Boeckella robusta* was common in small ponds round Hobart. In a very small rivulet at Huntingfields, at sea-level, I again met with *Phreatoicus australis* and a *Neoniphargus*, *N. exiguus*, sp. n. (Pl. 14. figs. 1–12).

Lake Dulverton really belongs to this category, as, although it is of a large size, it is entirely overgrown with weed. It was found to harbour only those Entomostraca, such as *Alonella*, *Macrothrix*, *Cyclops*, &c., characteristic of small weedy ponds. It had besides a *Boeckella*, *B. insignis* (Pl. 17. fig. 4), and the widely distributed *Chiltonia australis*. It may be mentioned here that the Prawn *Xiphocaris compressa* is found all over Tasmania in streams and lakes where the water is cloudy and there is a great deal of weed, and the same is true of *Chiltonia australis*. The only Phyllopod obtained was the common *Lepidurus viridis*.

2. *The North Coast.*

In this district all the streams and rivers tend to be rather discoloured and there are no extensive lakes. The rivers are characterised by certain fish which are entirely absent from the rivers of the south, east, or centre of the island. These are the Blackfish (*Gadopsis marmoratus*), the Cucumber Herring (*Prototroctes maræna*), and the Freshwater Flathead (*Aphritis*).

The Anaspidacea appear to be entirely absent from this region and also the genus *Phreatoicus*. I also failed to find any *Neoniphargus*. *Gammarus antipodeus* (Pl. 14. figs. 17–22) was found in a little limestone stream (Mole Creek) near Chudleigh. The small Crayfish *Astacopsis tasmanicus* appears to be entirely absent, its place being taken by the gigantic *A. franklinii*, which may scale 8 or 9 lbs. This huge species is found in the rivers and even in the smallest rivulets along the north coast and on to the west coast, but it is nowhere very abundant. On the north coast upon mud-flats and swamps the Land-Crab or Crayfish, *Engæus fossor*, is fairly frequent, though nowhere so abundant as on the West Coast Mountains.

3. *The West Coast.*

The mountainous and forest-clad region is only opened up to the traveller in the mining districts, where tracks have been cleared through the forest. The south-western corner of Tasmania, where no mines have been hitherto opened, is uninhabited, and the forests can only be penetrated by the traveller cutting a track in front of him.

Two localities were visited on the West Coast:—(1) The beech forest round the Magnet Mine. Here the burrows of the land-crab, *Engæus fossor*, were present in all the moist gullies, and in one place, where a dam was being constructed for mining purposes, the banks were absolutely riddled by these creatures, which seriously interfered with the construction of the dam. Under logs and the fallen leaves of the beeches, the Hopper (*Talitrus sylvaticus*) was very abundant. In a little rivulet I collected some specimens of the Amphipod *Gammarus australis*.—(2) Near the top of Mt. Read, at an elevation of about 3000 ft., I visited a tarn of exceedingly deep and clear water. In this tarn *Anaspides tasmaniæ* was fairly abundant and a species of *Neoniphargus*, *N. alpinus*, sp. n. (Pl. 14. figs. 13–16). The water swarmed with the little red Copepod *Boeckella rubra* (Pl. 18. fig. 1), so that the fauna of this tarn closely resembled that of the tarns on the Harz Mountains. I was surprised here by the quantity and tameness of the *Platypus*, which swam round our raft with the greater part of their bodies exposed to view—no doubt owing to their little acquaintance with human beings, as the tarn had only been visited at long intervals on two or three occasions by miners.

General Remarks on Geographical Distribution.

From a zoological and botanical standpoint Tasmania belongs to what Professor Baldwin Spencer ('Narrative of the Horn Expedition to Central Australia,' 1895) has called the Bassian Subregion of Australia, which includes Tasmania and Victoria south of the Dividing Range of mountains. This subregion is characterised by a moderate or great rainfall and a temperate climate.

The freshwater Crustacea of Tasmania are for the most part represented by closely allied or, in some cases, identical species on the mainland of Victoria, and very few of the commonest and most typical forms (e. g. *Anaspides, Phreatoicus, Chiltonia, Neoniphargus, Gammarus, Boeckella*) range north of the Dividing Range into tropical or subtropical Australia. These characteristic genera of Southern Australia belong, in fact, to an essentially temperate fauna, by far the greater number of species being found on the high alpine ranges of Tasmania and on the slopes of the Dividing Range of Victoria and New South Wales. They are, however, again represented by closely allied species in the temperate climate of New Zealand, especially in the subterranean waters of that island (Chilton, Trans. Linn. Soc. London, ser. 2, Zool. vol. vi. pt. 2, p. 163). These facts are of the greatest importance in considering the probable derivation of this fauna.

Two of the most characteristic genera of the Tasmanian freshwaters, viz. the Amphipod *Chiltonia* and the Copepod *Boeckella*, which also occur in the temperate parts of Southern Australia, are represented not only in New Zealand but also in temperate South America, where *Boeckella* has been several times recorded (see Daday, Termés. Füzetek, Bd. xxi. 1902, p. 201) and *Chiltonia* is replaced by the closely allied *Hyalella* of Lake Titicaca and the southern ranges of the Andes. These two genera (*Chiltonia* and *Boeckella*) are therefore confined in their distribution to the temperate parts of the Southern Hemisphere, with the exception of S. Africa. The Copepod *Boeckella* occupies the same position in the Southern Hemisphere as *Diaptomus* in the Northern, which in the south it almost entirely replaces. Although some of the species occur in small ponds, the majority live in lakes and are particularly characteristic of the cold highland tarns of Tasmania. The Parastacine group of Crayfishes has a similar distribution, being found in New Zealand (*Paranephrops*), Tasmania and Southern

Australia (*Astacopsis* and *Engæus*), South America (*Parastacus*), and an isolated form in Madagascar (*Astacoides*).

There is, therefore, a strong presumption in favour of the view that at any rate these elements in the temperate Crustacean fauna of Southern Australasia have reached their present range by means of an Antarctic connection between the southernmost projections of Australia, S. America, and New Zealand—a connection which is now more than ever postulated to account for the presence of common elements in the temperate fauna and flora of these countries.

Starting with this strong presumption in favour of an antarctic derivation of certain of the Tasmanian and Southern Australian Crustacea, it is interesting to examine another element which has evidently been derived primarily from the Northern Hemisphere. This element consists of the Amphipodan genera *Gammarus* and *Neoniphargus*, the Cladoceran *Bosmina*, and probably the Anaspidacea.

The genus *Neoniphargus*, the members of which form so dominant a feature in the Crustacean fauna of Tasmania, is very closely related to *Gammarus*, but it shows an approach to the subterranean European genus *Niphargus*, especially in the form of the first maxilla (Pl. **13**. fig. 5), the inner plate of which is narrow and bears only two or three plumed setæ at its apex, in the small number of joints composing the secondary appendage of the first antenna (Pl. **13**. fig. 2), and in the greatly reduced endopodites of the last pair of uropods (Pl. **13**. fig. 13).

Undoubted representatives of the genus *Gammarus* also occur in Tasmania (e. g. *G. australis*), and certain species (e. g. *G. ripensis* and *G. antipodeus*) are almost exactly intermediate between the genera *Neoniphargus* and *Gammarus* (see Pl. **14**. fig. 27) in the structure of the maxilla and of the first antenna (Pl. **14**. figs. 17, 22, 23). The special resemblance of *Neoniphargus* to the European *Niphargus* may therefore be due to convergence. However this may be, the occurrence of *Gammarus* and the closely related *Neoniphargus* in the temperate region of Southern Australasia and in New Zealand affords a peculiar instance of discontinuous distribution, because *Gammarus* and its close allies are otherwise confined to the north temperate hemisphere, being absolutely unknown from the tropics of either hemisphere. In enquiring how they have reached their present position in Southern Australasia we must bear in mind that temperature in this case, as in the case of all Crustacea, whether freshwater or marine, is the chief condition determining the dispersal of these forms. There are two routes by which they could have reached Southern Australasia, either through the tropics of Asia and Northern Australia or else through South America and the lost Antarctic connection. It is extremely difficult to see how an animal apparently incapable of living in a tropical climate could have followed the first-named route, as there is no range of mountains in the Eastern Hemisphere running north and south which could be used by such an animal as a bridge to pass through the tropics; but in America there is the range of the Andes to permit this migration. It may therefore be suggested that the Tasmanian and Southern Australian *Gammarus* and *Neoniphargus* reached these countries from the Northern Hemisphere through S. America and Antarctica, and it is reasonable to suppose that some of their representatives will still be found in the Andes.

The same theory applies with even more force to the Cladoceran *Bosmina*, which was found by me as one of the chief constituents of the plankton in the highland lakes of Tasmania, though this is the first record of its occurrence in Australasia. This genus ranges all over the Northern Hemisphere, but is apparently absent from the tropics of the Old World. In America, however, it follows the route of the Andes right down into Patagonia, and, as we have said, turns up again in the extreme southern corner of Australasia. It may be objected that it is not legitimate to use an animal of this kind as an argument in a discussion on geographical distribution, because it is easily distributed by means of birds transporting its resting-eggs to great distances. We must remark, however, that *Bosmina* only inhabits large pieces of water not liable to dry up, and that its propagation is chiefly parthenogenetic, the resting-eggs being produced in any quantities only once a year, and then falling to the bottom of the lake or tarn out of reach of any water-bird. Moreover, it does not appear that even those Cladocera which inhabit small ponds and puddles liable to desiccation are distributed haphazard all over the world by wind or water-birds. It is true that practically all the genera are cosmopolitan, but the fact that each country has for the most part its well-marked and distinct specific forms shows clearly that the wide distribution of the genera has taken place by a gradual extension of range, facilitated no doubt by their special adaptation for transport.

In the case of the Anaspidacea, which are at the present time represented by three distinct forms (*Anaspides*, *Paranaspides*, and *Koonunga*—the first two being confined to the highlands of Tasmania and the last to Western Victoria), the fact that in Permian and Carboniferous times closely related marine forms (*Gampsonyx*, *Palæocaris*, &c.) existed in the Northern Hemisphere suggests that these animals have followed a similar route to *Gammarus* and *Bosmina* and have reached temperate Australia through Antarctica.

The Phreatoicidea, constituting an isolated suborder of Isopods, are at the present time confined to the freshwaters of temperate Australia and New Zealand, and we know nothing about their geological history. They are, however, so characteristically a part of the temperate Australian fauna, for the most part being inhabitants, like the Anaspidacea, of alpine stations, that they probably also belong to the same element of Antarctic derivation as all the above-mentioned Crustacea. Leaving aside the small Entomostraca of world-wide distribution, the only freshwater Crustacean in Tasmania which has clearly been derived from the Asiatic tropics is the prawn *Xiphocaris compressa*, which at the present day ranges into Queensland and whose near allies extend through the East Indies into China.

The distribution of the two common genera of Phyllopods, *Lepidurus* and *Apus*, is of interest. Both these genera occur in the Northern Hemisphere, and of the two *Lepidurus* is the more characteristic of cold alpine stations. Now *Lepidurus* has a representative in temperate South America (*L. patagonicus*), and another in Tasmania and the temperate parts of Australia (*L. viridis*), but it is entirely absent from central and tropical Australia, where it is replaced by *Apus*. The latter genus, on the other hand, is not known in the temperate parts of Australia or S. America. It would appear therefore that *Lepidurus* has reached Australia by way of S. America and Antarctica, while *Apus* entered by way of the Asiatic tropics.

The evidence of an Antarctic connection between New Zealand, Southern Australia, and South America, derived from a consideration of the freshwater Crustacea of Tasmania, is thus particularly cogent, because we are dealing with a group of animals whose distribution is closely dependent on temperature, and unless we are to suppose that tropical Asia and Australia have in the not very distant past possessed a totally different climate and physical character from their present condition, it is impossible to conceive that these essentially temperate and for the most part alpine creatures have reached their present isolated position in Tasmania by this route.

And when we take into consideration the fact that the freshwater fish of Tasmania (*Galaxias*, *Prototroctes*, and *Aphritis*), the Mollusca for the most part, and the most typical of the Alpine trees (*e. g.* the two species of *Fagus*, *F. Cunninghamii* and *F. Gunnii*) have their closest allies in one or more of the countries of the temperate Southern Hemisphere, we are forced back on the existence in the past of a land-connection, probably, as Mr. C. Hedley originally suggested (Ann. Mag. Nat. Hist. (6) xvii. 1896, p. 113), by means of rays of land passing southwards to meet an antarctic continent, uniting these southern lands, which at the present time are separated by so vast and so deep stretches of ocean.

Part II.—SYSTEMATIC.

Subclass *MALACOSTRACA*.

With the exception of the Isopods and Amphipods, it is not proposed here to give a systematic description of the Malacostraca, as they have either been described elsewhere or else will form the subject of future memoirs ("A Monograph of the Anaspidacea," in preparation for the Quarterly Journal of Microscopical Science; and "The Crayfishes of Australia and Tasmania," in preparation for the Memoirs of the Melbourne Museum). A sufficient account of them will be given, however, to facilitate their recognition.

Order DECAPODA.

Family Atyidæ.

Genus Xiphocaris.

Xiphocaris compressa, v. Mart.

This freshwater prawn is very abundant in those streams of Tasmania which are discoloured by flowing over the sandstones, *e. g.* the Clyde and Jordan Rivers, and also in some of the lakes with similar cloudy water, *e. g.* Lakes Sorell and Crescent and Tiberias Swamp. It is a widely ranging species, extending into Victoria, New South Wales, and Queensland. As no other prawn occurs in the freshwaters of Tasmania, it is unnecessary to give a description of this species.

Family Parastacidæ.

The classification of the Australian and Tasmanian Crayfishes is at present in the greatest confusion, owing to the imperfect descriptions given by the earlier observers. I must postpone a detailed account of the Tasmanian species until the large collection now in my hands, from all parts of Australia, has been carefully examined.

Four distinct members of the family, and possibly more, exist in Tasmania.

There is, first of all, the very large Crayfish found in the cloudy streams and rivers of the north coast, and on the west coast as far south as the Gordon River. This species may attain to the weight of 8 or 9 lbs. and exceed in size our marine lobster. The name *Astacopsis franklinii* (Gray) should be reserved for this species. There is another much smaller, but closely allied, species, to which the name *A. tasmanicus* (Erichson) will be applied. This species is never, when adult, more than six or seven inches long, and it inhabits the small mountain-streams of Southern Tasmania, *e. g.* the streams round the base of Mt. Wellington. It is distinguished from the large species by a number of small constant characters: *e. g.*, the pincers of the great chela in *A. franklinii* have two enlarged tubercles on their internal edges, while there is only one in *A. tasmanicus*; the wrist in *A. franklinii* has only two spines on its upper internal border, while *A. tasmanicus* has three or more; the branchiostegites in *A. tasmanicus* are uniformly rugose, while those of *A. franklinii* are smooth with a few enlarged rounded tubercles.

The Land-Crayfish, known locally as the Land-Crab, occurs all over the northern and western parts of Tasmania, from sea-level to the tops of the mountains at 4000 ft., on marshy plains or in damp situations in the "myrtle" forests (*Fagus Cunninghamii*, Hook.) of the West Coast. It belongs to Erichson's species *Engæus cunicularis*.

There also appears to be a very interesting form in Tasmania intermediate both in structure and habits between *Engæus* and *Astacopsis*. I did not myself meet with this form, but Prof. Haswell, Sydney, has given me some which were collected in the western Lake District of Tasmania, and there are some very similar specimens from Victoria in the large collection entrusted to me by Professor Spencer of Melbourne.

Order ANASPIDACEA.

Family Anaspididæ.

Thomson, Proc. Roy. Soc. Tasmania, 1892, p. 51; id. Trans. Linn. Soc. Lond. ser. 2, Zool. vol. vi. (1894) p. 285; Calman, Trans. Roy. Soc. Edinburgh, vol. xxxviii. p. 787; Smith, Proc. Roy. Soc. London, ser. B, vol. lxxx. (1908) p. 465.

Genus Anaspides, Thomson.

Anaspides tasmaniæ.

This species occurs in isolated pools and in the pools of the North-West Bay River on the top of Mt. Wellington, in the tarns on the top of the Harz Mountains and on Mt. Field, and in the tarns on Mt. Read, and probably other mountains on the West

Coast. The water in all these localities is very clear and cold. The species is at once distinguished by its straight, unbent body and the dark brown pigmentation with yellow markings.

Genus PARANASPIDES, Smith.

PARANASPIDES LACUSTRIS.

This species occurs only, so far as is known, in the littoral region of the Great Lake; the waters of this lake are never very clear, but always discoloured to a certain extent with sand. *P. lacustris* is distinguished by its pale green transparent colour, finely powdered with black dots, by its sharply bent body, and by the great size of the antennal scales and tail-fan.

Order ISOPODA.

Family PHREATOICIDÆ.

Genus PHREATOICUS.

Chilton, Trans. Linn. Soc. Lond. ser. 2, Zool. vol. vi. (1894) p. 185.

Remarks.—Besides the New Zealand species *P. typicus* and *assimilis*, *P. australis* has been described (Chilton, Records of the Australian Museum, 1 & 2, 1890–95, p. 149) from Mt. Kosciusko in Victoria and also recorded by Thomson (Proc. Roy. Soc. Tasmania, 1892, p. 76) from Mt. Wellington. Besides this a blind species, *P. shephardi*, has been described by Sayce (Proc. Roy. Soc. Victoria, vol. xiii. 1900, p. 25) from Victoria.

The other genera are *Phreatoicoides* (Sayce, Proc. Roy. Soc. Victoria, vol. xii. 1900, p. 122) from Gippsland, *Hypsometopus* (Sayce, *loc. cit.* vol. xiv. p. 218) from burrows of the land-crayfish *Engæus* in Tasmania, and *Phreatoicopsis* (Spencer & Hall, *loc. cit.* vol. xix. 1896, p. 14), a large terrestrial form from Gippsland.

As very little has been recorded of the habits or internal structure of these animals, the following notes may be given:—Their movements are exceedingly sluggish, so that when alive they are easily distinguished from the rapidly moving Amphipods, which in external structure they so closely resemble. They appear to be entirely vegetable-feeders, and subsist by passing a great quantity of vegetable mud, &c., through their intestine, much in the same manner as an earthworm. This also appears to be the habit in the land-form *Phreatoicopsis*. In specimens of this form which I dissected I first noticed that the gut, which was full of earth, was provided with a highly developed typhlosole or double fold, running its whole length, and quite unlike any structure met with elsewhere among the Crustacea. The anterior portion of the gut, slit open along the dorsal surface and displaying the gastric mill and the beginning of the double typhlosole, is shown on Pl. 12. fig. 13, while a diagrammatic transverse section (Pl. 12. fig. 12) shows the relation of the typhlosole to the wall of the alimentary canal. It is evident that the vegetable mould, after being pounded up by the action of the ridges and pads of the gastric mill, is passed underneath the typhlosolar flaps, which enormously increase the area for absorption. A similar typhlosole was found to exist in the various species of *Phreatoicus*, so that it is probably a characteristic of the whole suborder. The alimentary canal is supplied with four hepatic cæca, which lie ventrally and open at the base of the gastric mill.

A pair of very large maxillary glands are present.

The above points in the internal anatomy of the Phreatoicidea confirm the opinion that they constitute a rather isolated suborder of the Isopoda, but does not lend support to the view that they are related to the Amphipoda.

Phreatoicus australis, Chilton, Records of the Australian Museum, 1 & 2, 1890–95, p. 149. (Pl. 12. fig. 1.)

The thoracic segments are not much sculptured or tuberculated, and carry very few spines dorsally.

The head is as long as the two following segments.

The second antenna has the peduncle and flagellum rather short, and the former has the margin of only the first two joints serrated (Pl. 12. fig. 9).

The telson and uropod have the forms shown in Pl. 12. fig. 2.

The colour is uniformly black and the length about 10 mm. Occasionally yellowish specimens occur.

Occurrence. Recorded by Chilton from Mt. Kosciusko and Thomson from Mt. Wellington. I have taken it in the small pools on the top of Mt. Wellington, in a small stream at sea-level at Huntingfields, and in a lagoon at sea-level on Bruni Island. Also in Yule's Lake on the top of Ben Lomond and in the littoral region of the Great Lake. The uropod differs slightly in the arrangement of the spines from the various localities. The Ben Lomond (Pl. 12. fig. 3), Great Lake (Pl. 12. fig. 2), and the specimens from the other localities (Pl. 12. fig. 4) form three different varieties.

Phreatoicus spinosus, sp. n. (Pl. 12. fig. 7.)

The head is shorter than the two following segments.

The body is markedly sculptured, and the thoracic segments bear two distinct tubercular ridges dorsally with a concavity between them; the abdominal segments are also ridged. All the segments are furnished very richly with long and conspicuous spines dorsally, and the legs are also covered with long spines.

The second antenna (Pl. 12. fig. 11) has the peduncle and flagellum very long, only the first two joints of the peduncle having a serrated margin.

The telson ends in a long projection and the uropods are also very long (Pl. 12. fig. 8).

The colour is blackish grey, with the extremities of the antennæ and often of the limbs bright orange.

Length up to 25 mm., but also adult at 15 mm.

Occurrence. Among weeds in the littoral region of the Great Lake.

PHREATOICUS BREVICAUDATUS, sp. n. (Pl. 12. fig. 5.)

The head is shorter than the two following segments.

The body is markedly sculptured as in *P. spinosus*, but is not spinous, only a few inconspicuous setæ being present on the dorsum. The segments of the pleon are rather broader than usual.

The second antennæ are not very long; the whole of the peduncle and most of the flagellum has a serrated margin (Pl. 12. fig. 10).

The telson has the form shown in Pl. 12. fig. 6; the uropods do not project much beyond the end of the telson and are poorly furnished with stout spines.

The colour is straw-yellow.

Length 15 mm.

Occurrence. In the deeper littoral of the Great Lake, where the bottom is chiefly composed of a fine yellowish mud.

Order AMPHIPODA.

Family GAMMARIDÆ.

Genus NEONIPHARGUS.

Neoniphargus, Stebbing, Trans. Linn. Soc. Lond. ser. 2, vol. vii. (1899) p. 424.
Niphargus, Thomson, Proc. Roy. Soc. Tasmania, 1892 (1893), p. 67.
Unimelita, Sayce, Proc. Roy. Soc. Victoria, vol. xiii. (1901) p. 238.

Diagnosis (see also Pl. 13).—Body much compressed, without dorsal projections and with few setæ. Coxal plates wide and deep, the fifth very wide and emarginated.

First antennæ longer than second, with a small secondary appendage of one or two joints.

Inner plate of first maxillæ very narrow, bearing apically two or three plumose setæ (Pl. 13. fig. 5). Outer plate of maxillipeds with stout spine-teeth (Pl. 13. fig. 8).

Gnathopoda subequal; hands small, quadrate, and subchelate, with no conspicuous sexual differences. Pereiopods normal, the three posterior pairs with coxal joints much expanded. The two anterior pairs of uropoda with rami subequal; the third pair only just projects beyond the others posteriorly and has the inner ramus very small and scale-like tipped with a single seta, the outer ramus one-jointed or with an additional rudimentary joint at tip. Telson cleft, but not entirely to the base.

NEONIPHARGUS YULI, sp. n. (Pl. 13. fig. 1.)

Head not longer than first segment. Eyes large, crescent-shaped.

First antennæ not half as long as body, the three segments of the peduncle subequal, with a few bunches of setæ; secondary appendage two-jointed, not distinctly longer than first joint of flagellum (Pl. 13. fig. 2).

Pereiopods armed with bunches of very stout setæ; terminal joint not much elongated (Pl. 13. fig. 10).

The three pairs of uropods reach to approximately the same point posteriorly and do not project one beyond the other. All are armed with very prominent spines. In uropod 3 the outer ramus is short, and bears a rudimentary terminal joint; no plumose setæ (Pl. 13. figs. 12 & 13).

The telson is obtusely cleft rather less than halfway to the base; the lobes carry about six stout spines apiece (Pl. 13. fig. 14).

The metasome is devoid of spines or setæ, except on the last two segments, which bear a few spines dorsally.

Length 10 mm.

Colour. Dark blackish green to pale yellow.

Occurrence. In Yule's Lake on the top of Ben Lomond, at about 4000 ft.

Neoniphargus exiguus, sp. n.

Head longer than first segment. Eyes large, irregularly crescentic.

First antennæ not long; segments of peduncle stout, the third distinctly shorter than second, with bunches of setæ. Secondary appendage two-jointed, distinctly longer than first joint of flagellum (Pl. 14. fig. 1).

Pereiopods thickly clothed with rather stout setæ; terminal joint elongated (Pl. 14. fig. 4).

The third pair of uropods project slightly beyond the other two pairs, which carry the normal spines.

In uropod 3 the outer ramus is fairly long and stout, well armed with spines, with a terminal joint and without plumose setæ (Pl. 14. fig. 2).

The telson is acutely cleft rather more than halfway to the base; the lobes are slightly concave at the end, carry three terminal spines and a few lateral ones (Pl. 14. fig. 3).

The segments of the metasome carry a few long spinules.

Length 6 mm.

Colour. Dirty yellow.

Occurrence. In weed and mud in small stream near Huntingfields.

Neoniphargus tasmanicus, sp. n.

Head slightly longer than first segment. Eyes large, crescent-shaped.

First antennæ more than half as long as body, the third segment of peduncle distinctly shorter than second; a few bunches of setæ on peduncle; secondary appendage two-jointed, distinctly longer than first joint of flagellum (Pl. 14. fig. 5).

Pereiopods armed with setæ, which are not very stout or conspicuous; terminal joint elongated (Pl. 14. fig. 8).

The third pair of uropods project distinctly beyond the second and first; the uropods are armed with not very strong spines.

In uropod 3 the outer ramus is long, bears a rudimentary terminal joint, is feebly armed with spines, and carries three plumose setæ (Pl. 14. fig. 6).

The telson is acutely cleft more than halfway to the base; the lobes have a pointed angle and carry a single stout spine each (Pl. 14. fig. 11).

The metasome is devoid of spines, except on the last two segments as in *N. yuli.*

Length 8 mm.

Colour. Dark brown.

Occurrence. In the littoral zone of the Great Lake.

NEONIPHARGUS WELLINGTONI, sp. n.

Head as long as two succeeding segments. Eyes small, oval.

First antennæ stout, not long, the third segment of peduncle subequal to second; peduncle with a continuous row of long simple setæ, the whole of antennæ having very setose appearance.

Secondary appendage single-jointed, very short, much shorter than first joint of flagellum (Pl. 14. fig. 9).

Pereiopods armed with long but slender setæ; terminal joint short, stout, with recurved claw (Pl. 14. fig. 12).

The first pair of uropods project slightly beyond the other two pairs; all are armed with very long but not stout spines.

In uropod 3 the outer ramus is short and without rudimentary terminal joint, bearing at the end four or five spines instead. No plumose setæ (Pl. 14. fig. 10).

The telson is rather acutely cleft more than halfway to the base; the lobes are blunt at the end and carry five stout spines (Pl. 14. fig. 11).

The metasome has all the segments spiny dorsally, especially the posterior ones.

Length 7 mm.

Colour. Very dark greenish.

Occurrence. Under stones &c. in small streams on eastern face of Mt. Wellington, about 3000 ft.

NEONIPHARGUS ALPINUS, sp. n.

Head slightly longer than first segment. Eyes small, crescentic.

First antennæ not long; segments of peduncle stout, the third slightly shorter than second, with bunches of setæ. Secondary appendage two-jointed, distinctly longer than first joint of flagellum (Pl. 14. fig. 13).

Pereiopods not very thickly clothed with long and rather fine setæ; terminal joint much elongated. Joints of pereiopods, as a whole, longer and thinner than in *N. exiguus*, which this species closely resembles (Pl. 14. fig. 16).

The third pair of uropods project slightly beyond the other two pairs.

Uropod 3 has the outer ramus long and rather slender, with a terminal joint and without plumose setæ (Pl. 14. fig. 14).

The telson is acutely cleft more than halfway to the base; the lobes are slightly concave at the end, carry two terminal spines and no lateral ones (Pl. 14. fig. 15).

The segments of the metasome are smooth and without spines, except the last two.

Length 8 mm.

Colour. Olivaceous grey.

Occurrence. In mountain tarns on the West Coast (Mt. Read) at about 3000 ft.

NEONIPHARGUS NIGER, sp. n.

Head as long as two following segments. Eyes small, oval.

First antennæ very long; the third segment of peduncle not so long as second; bunches of slender setæ; secondary appendage with three short joints, the whole not as long as first segment of flagellum (Pl. 15. fig. 1).

Pereiopods armed with slender numerous setæ; terminal joint not slender or elongated.

Uropod 3 extends a great way behind the other two pairs; its outer ramus is long, armed with long and rather slender setæ, without a small terminal joint; the inner ramus is minute and normal (Pl. 15. fig. 2).

The telson is acutely cleft for about three-fourths to the base; the lobes carry three stout spines apiece and several slender long setæ (Pl. 15. fig. 4).

The segments of the metasome are furnished dorsally and dorso-ventrally with bunches of exceedingly long and conspicuous setæ.

The gnathopods (Pl. 15. fig. 3), of which the second pair is distinctly the larger, have the two penultimate joints more elongated than is usual in this genus, and more heavily armed with setæ. They resemble rather more the gnathopods of *Gammarus*.

Length 8 mm.

Colour. Black.

Occurrence. Under stones in Lake Perry, Harz Mountains.

NEONIPHARGUS MONTANUS, Thomson, Proc. Roy. Soc. Tasmania, 1892 (1893), p. 70.

This species agrees very closely with *N. yuli*, but differs in the absence of a rudimentary terminal joint to uropod 3, in the fewer setæ on the lobes of the telson, and in the less spinose pereiopods.

I have been unable to examine this species closely, as the tube in which I had collected some was broken.

From pools on the top of Mt. Wellington.

NEONIPHARGUS SPENCERI.

Unimelita spenceri, Sayce, Proc. Roy. Soc. Victoria, vol. xiii. (1900) p. 238.

This species agrees most closely with *N. tasmanicus* from the Great Lake. It differs, however, in a number of essential points—*e. g.*, shape of telson, great length of uropod 3, shortness of secondary appendage, &c.

From Lake Petrarch.

Genus GAMMARUS, Fabr.

Remarks.—The genus *Gammarus* as restricted by Stebbing (Das Tierreich, Crustacea, Amphipoda Gammaridea, 1906) is confined chiefly to the freshwaters of the Northern Hemisphere. It is absent from the tropics and the Southern Hemisphere. Sayce has, however, described two species, *G. australis* and *G. haasei*, from Victoria, which clearly belong to this genus, and he has suggested that *Niphargus mortoni* described by Thomson also belongs to *Gammarus*.

The two species described below, *G. ripensis* and *antipodeus*, are evidently closely allied to Thomson's *N. mortoni*, and a careful examination of their characters has shown that they are exactly intermediate in structure between the genera *Neoniphargus* and *Gammarus*.

Thus the telson (Pl. 14. figs. 19 & 25) cleft to the base and the form of the gnathopods (Pl. 14. figs. 20 & 26) are Gammarid, while the three-jointed secondary appendage of the 1st antennæ (Pl. 14. figs. 17 & 23), the inner ramus of uropod 3 (Pl. 14. fig. 18), the condition of the inner plate of the maxilla (Pl. 14. fig. 22) are very close to *Neoniphargus*, but with distinct Gammarid tendencies. With regard to the first maxilla especially, it is to be noted that of *G. antipodeus* (Pl. 14. fig. 22) is exactly intermediate between that of *Neoniphargus* (Pl. 13. fig. 5) and *Gammarus* (Pl. 14. fig. 27). It is, in fact, very difficult to say to which genus they are more nearly allied, and it would perhaps be permissible to erect a new genus to receive these three species. The occurrence of these intermediate forms between *Gammarus* and *Neoniphargus* certainly suggests that *Neoniphargus* has been derived independently from *Gammarus* in the Southern Hemisphere and that it is not genetically related to the *Niphargus* of the Northern Hemisphere. In this case, the species described by Sayce as *Niphargus pulchellus* from Victoria (Proc. Roy. Soc. Victoria, 1899, vol. xii.) should not be placed in *Niphargus*, with which, indeed, it does not closely agree, but in a separate genus. The resemblance of this species and of the numerous species of *Neoniphargus* to the European *Niphargus* must then be looked upon as a remarkable case of convergence.

Gammarus mortoni.

Niphargus mortoni, Thomson, Proc. Roy. Soc. Tasmania, 1892 (1893), p. 68.

This species is evidently closely related to the two described below, but probably not identical with either. Thomson's figures do not give quite the requisite details. The form of the telson is, however, different to that in the two following species.

Occurrence. In a small stream above Franklin on the Huon River and on Mt. Wellington.

Gammarus ripensis, sp. n.

The coxal plates of the fourth pair are normally quadrate in shape. The eyes are oval.

The first antennæ have the peduncle of three subequal joints, clothed with a continuous row of fairly long setæ. The secondary appendage consists of three joints (Pl. 14. fig. 23).

The gnathopods have the two penultimate joints normal in shape, longer than broad, with the inner surface provided with rows of stout bristles (Pl. 14. fig. 20).

The perciopods are armed with fairly numerous and long setæ; the terminal joint with its claw is slender and rather elongated.

The third pair of uropods projects distinctly behind the outer two pairs.

The outer ramus of uropod 3 has a minute terminal joint, and there are three groups of spines, with one plumose seta. The inner ramus is small and scale-like with a single terminal seta (Pl. 14. fig. 24).

The telson is cleft to the base; the lobes are slightly concave posteriorly and carry two stout spines (Pl. 14. fig. 25).

The segments of the abdomen are very spinous.

Length 13 mm.

Colour. Dark greenish brown.

Occurrence. Among weed and under stones in the littoral region of the Great Lake.

GAMMARUS ANTIPODEUS.

The coxal plates of the fourth pair have the hind margin produced to form a triangular lobe (Pl. 14. fig. 21). The eyes are narrow and elongately oval.

The first antennæ have the third joint of the peduncle shorter than the second; clothed with a continuous row of short setæ. The secondary appendage is of three joints (Pl. 14. fig. 17).

The gnathopods are similar to those of *G. ripensis*, but the distal outline of the carpopodite is more sinuous (Pl. 14. fig. 20).

The pereiopods are feebly armed with very short setæ; the terminal joint with its claw is stout and not long.

The third pair of uropods project distinctly behind the other two pairs.

The outer ramus of uropod 3 is without a terminal joint, and there are more than three groups of stout spines with several plumose setæ. The inner ramus is rather large and has four terminal setæ (Pl. 14. fig. 18).

The telson is cleft to the base; the lobes are concave posteriorly and carry a single stout spine and several small ones (Pl. 14. fig. 19).

The segments of the abdomen are quite smooth.

Length 20 mm.

Colour. Dark greenish brown.

Occurrence. In Mole Creek, just after issuing from a number of large limestone caves. In the caves themselves, which are quite dark, a colourless specimen was found with very much reduced eyes, and more numerous plumose setæ on uropod 3. Otherwise it agrees exactly with the species described.

GAMMARUS AUSTRALIS, Sayce, Proc. Roy. Soc. Victoria, vol. xiii. (1901) p. 233, & ibid. vol. xv. (1902) p. 51.

This species shows more clearly than the above-described the true characteristics of the genus *Gammarus*. Thus, besides the cleft telson and the broad internal plate of the 1st maxilla (Pl. 14. fig. 27), there are distinct sexual differences in the gnathopods, the inner ramus of uropod 3 is quite long, and the secondary appendage of the first antenna has six or seven joints.

Occurrence. In a small stream near the Magnet Mine on the west coast of Tasmania. Also in Victoria, Dandenong Creek; and a blind species, *G. haasei* (Sayce), also from Victoria.

Genus Chiltonia.

Stebbing, Trans. Linn. Soc. Lond. ser. 2, Zool. vol. vii. (1899) p. 408.

The type species of this genus was described as *Hyalella mihiwaka* by Dr. Chilton from New Zealand. Subsequently Sayce described *H. australis* from numerous localities in Victoria and from Lake Petrarch in Tasmania. The genus *Hyalella* is otherwise confined to S. America. Stebbing pointed out some differences between the New Zealand species and the S. American *Hyalella* and proposed a new genus *Chiltonia.* The chief differences between *Hyalella* and *Chiltonia* are the presence in the former of a minute rudimentary palp to the first maxillæ, and also the presence of a lobe on the wrist of the second gnathopoda in the male. Evidently the two genera are closely allied, and can hardly have been independently derived.

Chiltonia australis (Sayce).

This species can be at once distinguished from the other freshwater Gammarids in Tasmania by the short first antennæ and the entire absence of a secondary appendage, by the pronounced sexual difference in the gnathopods (the second pair in the male being greatly enlarged), by the absence of a palp on the first maxillæ, and by the undivided telson. The colour is pale green and the length about 8 mm.

Occurrence. Southern Victoria (*Sayce*); in Tasmania the localities are Lake St. Clair, the Great Lake, Lagoons on Bruni Island, Clyde River near Bothwell; in fact, it is the most widely distributed species in Tasmania.

Genus Talitrus, Latr.

Talitrus sylvaticus, Haswell, Proc. Linn. Soc. N.S.W. vol. iv. (1880) p. 246; also see Thomson, Proc. Roy. Soc. Tasmania, 1892 (1893), p. 15.

This species of land-hopper is widely distributed in the highlands of Tasmania, being found under logs and leaves in the forests on Mt. Wellington and in very great abundance in the beech-forests on the mountains of the West Coast. It also occurs in Victoria (Mt. Kosciusko).

Subclass *ENTOMOSTRACA.*

Order PHYLLOPODA.

Family Apodidæ.

Genus Lepidurus.

Large numbers of the common *L. viridis*, Baird (see also Sayce, Proc. Roy. Soc. Victoria, xv. 1903, p. 242), were taken in a small roadside pond near Bridgewater, on the Derwent.

Only the genus *Lepidurus* is represented in Tasmania and Southern Australia, *Apus* being entirely absent. *Lepidurus*, on the other hand, is altogether absent from Northern, Central, and Western Australia, where it is replaced by *Apus*.

Family Daphnidæ.

Genus Ceriodaphnia (Dana).

The species described below agree with the northern *Ceriodaphnia* closely in their appendages, but differ considerably in the general form of the body. *C. cornuta* (Sars, Forhand. Videns. Selsk. Christiania, 1885), the only other Ceriodaphnid from Australia, seems to be closer to the northern species.

Ceriodaphnia hakea, sp. n. (Pl. **15**. figs. 10–16.)

Female.—The form of the carapace is rounded, and there is no posterior spine, only a slight angle. The constriction between the thorax and the head is not very sharply marked. The head bears dorsally a remarkable recurved hook, a character not known in any other member of the genus. The outline of the head is regularly curved and not in the least sinuous. There is no spine or tumescence on the head in front of where the first antennæ spring from.

The ocellus is very clearly marked.

The first antennæ carry very short terminal setæ, and a fairly long single seta on a ridge some distance away from the apex.

The distal joint of the second antennæ bears only two compound plumose setæ (Pl. **15**. fig. 15).

The anal claws are long and are not furnished with any small spines; behind the claws the telson bears laterally five large spines decreasing in size anteriorly. Between the anal claws and the two plumose setæ on the back, the hind end of the body is regularly arched without any distinct angulation or sinuosity (Pl. **15**. fig. 14).

Length 1 mm.

Colour. Green.

Occurrence. In the plankton of Lake St. Clair. No males were observed.

CERIODAPHNIA PLANIFRONS, sp. n. (Pl. 15. fig. 17.)

This small species has the carapace more elongated than *C. hakea*, and has the posterior angle of the carapace clearly marked and almost forming a distinct spine. The constriction between the thorax and the head is not very clearly marked. The head is not furnished with any spines, and its outline is regularly curved without any distinct sinuosity; nor is there any spine or turgescence in front of the insertion of the first antennæ.

The first antennæ have short terminal setæ, and one rather long seta on a ridge close to the apex.

The ocellus is clearly marked.

The second antennæ are similar to those of *C. hakea*. The anal claws are long and unarmed, and there are five lateral spines behind them. These spines nearly reach to a fairly distinct angle, which is not marked in *C. hakea*.

Length ·9 mm.

Colour. Green.

Occurrence. In the plankton of Lake Sorell. No males observed.

Genus SIMOCEPHALUS (Schœdler).

Four species have been described from Australia by Sars (Archiv for Math. og Naturvid. vol. xviii. (1896); and Forhand. Vidensk. Selsk. Christiania, 1885), agreeing fairly closely with northern members of the genus. The species described below does not offer any marked characters.

SIMOCEPHALUS DULVERTONENSIS, sp. n. (Pl. 15. figs. 5–7.)

The carapace is rather quadrate in form; the posterior angle is rounded and dorsal in position, with its margin carrying a few short spines. The ventral margin is uniformly clothed with setæ, which towards the posterior end are stout and spiniform. The under surface of the head is greatly elongated, and there is a small projection just in front of the insertion of the first antennæ.

The first antennæ have their sides hollowed out; they carry about ten hollow setæ, and a single small seta on a projection about halfway down the stem (Pl. 15. fig. 6).

The second antennæ have the structure characteristic of the genus; the tops of the segments are very distinctly serrated.

The anal claws are long and without any additional spines at their base. Behind the claws are about eight strong spines, the anterior ones being very small. The angle behind these spines is fairly prominent and carries several rows of small bristles (Pl. 15. fig. 7). The hind part of the body between this angle and the two dorsal setæ is also slightly angular.

Length 2 mm.

Colour. Green.

Occurrence. Among thick weed in Lake Dulverton. No males. Also among weed in Great Lake.

Simocephalus australiensis, Dana, United States Exploring Expedition, Crustacea, ii. p. 1271; also Sars, Forhandlinger, Christiania, 1888, p. 15.

This species can be readily distinguished from the foregoing by the distinct projection on the underside of the head just in front of the insertion of the first antennæ (Pl. 15. fig. 8), and also by the form of the telson, which has the anal claws armed with a conspicuous row of spines at their bases (Pl. 15. fig. 9). There is a good deal of variation in the shape of the hind part of the carapace, the posterior angle being sometimes pronounced and sometimes almost absent.

The species occurs in quite small puddles and ponds, and is evidently universally distributed in Tasmania. Dana and Sars report it from near Sydney.

Genus Daphnia, O. F. Müller.

Daphnia carinata, King, Proc. Roy. Soc. Tasmania, 1853, p. 253.

This species was found by Mr. King in the neighbourhood of Sydney.

I found some very large specimens, measuring 3 millimetres in length, in a few cupfuls of water in a cart-rut near Plenty, Tasmania. These specimens were among the tubes in my collection that were destroyed, so that I cannot give a full description of them. They agree, however, with King's figure of *D. carinata*, variety C, in having the spine at the back of the carapace very short.

Family Bosminidæ (Sars).

Genus Bosmina (Baird).

The three species described below, which are the only Bosminidæ hitherto found in Australasia, are closely related to the common northern *B. longirostris*. They possibly only represent varieties of one species.

Bosmina rotunda, sp. n. (Pl. 15. fig. 18.)

Female.—Form of the carapace very round, with the posterior angle not distinctly marked. A seta is present on each valve close to the posterior spine. There is a slight projection where the forehead passes into the first antennæ.

The first antennæ are long, slightly curved, and with about eleven joints below the antennal spine and sensory setæ.

The second antennæ are short and do not project as far as the anterior angles of the valves of the carapace; their structure is normal.

The anal claws are long, and carry about four small spines near their base; the telsonic angle is furnished with about three rows of small bristles.

Length ·9 mm.

Colour. Green.

Occurrence. In the plankton of Lake St. Clair. Males were not observed.

Bosmina brevirostris, sp. n. (Pl. 16. fig. 1.)

Female.—The carapace is more elongated than in *B. rotunda* and the posterior angle is distinctly marked. A seta is present on each valve close to the posterior spine.

There is a slight projection where the forehead passes into the first antennæ.

The first antennæ are short, slightly curved, and with about 8 joints below the antennal spine and sensory setæ.

The second antennæ are short and do not project as far as the anterior angle of the valves of the carapace.

The anal claws are rather short and carry about six small spines, which extend nearly to the tip of the claws.

Length ·5 mm.

Colour. Green.

Occurrence. In the plankton of the Great Lake. No males were observed.

Bosmina sorelli. (Pl. 16. fig. 2.)

Female.—This very small species has the carapace elongated and sloping rather suddenly to the posterior angle from the dorsal surface; the angle is well marked.

There is practically no projection where the forehead passes into the first antennæ.

The first antennæ are long with about 11 joints below the antennal spine and sensory setæ.

The second antennæ are short and do not project as far as the anterior angle of the valves of the carapace.

The anal claws are long, with about 4 spines near their base.

Length ·35 mm.

Colour. Green.

Occurrence. In the plankton of Lake Sorell. No males were observed.

Family Lyncodaphnidæ.

Genus Macrothrix (Baird).

Sars (Forhand. Christiania, 1885) has described *M. spinosa* from Australia.

Macrothrix burstalis, sp. n. (Pl. 16. fig. 3.)

The carapace is oval in shape, with the posterior angle rounded and situated rather dorsally.

The ventral margin of the carapace is fringed with exceedingly long and conspicuous setæ.

There is practically no constriction between head and thorax.

The first antennæ are not dilated at the end, are tipped with a few very long setæ, and carry about 8 short spines on their stems interiorly.

The second antennæ have the normal structure; the compound setæ are very long and all subequal in length.

The anal claws are rather small and simple, without spines; behind them is a continuous row of bristles fringing the whole posterior region of the body; posteriorly in the neighbourhood of the dorsal setæ these bristles become strong and spiniform. There is a distinct indentation in the contour of the hind region of the body.

The dorsal setæ are unique in structure, in that they end in a bunch of simple non-plumose bristles.

Length ·4 mm.

Colour. Green.

Occurrence. Among weed in Lake Dulverton. No males observed.

Family Lynceidæ.

Genus Alonella (Sars).

This genus and the related *Alona* and *Dunhevedia* appear to be abundantly represented in Southern Australian waters.

Alonella nasuta, sp. n. (Pl. 16. fig. 4.)

Form of the carapace is regularly oval without any marked angles. The usual striations and ventral fringe of setæ are present.

The head is drawn out into an exceedingly long and tapering nose, which projects far beyond the end of the first antennæ.

The first and second antennæ are normal in structure and do not call for any special remark.

The anal spines are long and furnished at the base with one strong spine and several bristles. On the telson are four stout short spines, and then follow about five groups of bristles. Beyond these bristles comes a marked concavity, and the margin is continued rather sinuously to the dorsal setæ (Pl. 16. fig. 5).

Length ·5 mm.

Colour. Yellow.

Occurrence. Among thick weed in Lake Dulverton. No males observed.

Alonella propinqua, sp. n. (Pl. 16. fig. 6.)

The carapace is rather square-shaped, but without any distinctly marked angles. It is fringed ventrally with setæ, and the striæ on the carapace are densely broken up into roughly quadrangular blocks.

The head is drawn out into a moderately long proboscis; but both the first and second antennæ project nearly as far as the proboscis, thus differing from *A. nasuta.*

The appendages do not offer any characters of specific importance.

The anal claws are long and furnished each with a single strong spine at its base.

The telson rises abruptly above the anal claws and is furnished with a row of 9 lateral fairly stout spines, behind which are one or two very small bristles of insignificant appearance. Between the end of the spine-row and the dorsal setæ the back is smooth and rises to a prominence about midway (Pl. 16. fig. 7).

Length ·35 mm.

Colour. Yellow.

Occurrence. Among thick weed in freshwater lagoon near Adventure Bay.

Order COPEPODA.

Family Diaptomidæ.

Genus Boeckella.

Boeckella, Guerne & Richard, Mémoires de la Société Zool. France, vol. ii. (1888) p. 151; Davay, Termész. Füzetek, Bd. xxiv. p. 1, and Bd. xxv. pp. 101, 436; Mrázek, Ergeb. Hamburg. Magalh. Sammel. Lief. 6 (1902).

This genus hitherto consists of several species from Patagonia and temperate S. America, *B. triarticulata*, Thomson, from New Zealand, *B. robusta*, Sars (Archiv for Math. og Naturvid. Christiania, xviii.), and *B. minuta*, Sars (*loc. cit.*), from S. Australia. It differs from *Diaptomus* in several quite constant characters, especially in the conformation of the last pair of limbs in the male. The antennæ, mouth-parts, and other limbs are built very much on the *Diaptomus* plan.

The genus appears to be entirely confined to the temperate Southern Hemisphere.

Boeckella insignis, sp. n. (Pl. 17. figs. 4–12.)

Female.—The anterior portion of the body is cylindrical; the head and first segment fused with it are equal to the succeeding anterior segments. The fifth segment is small, with inconspicuous lateral prolongations which do not project far over the abdominal segments.

The first abdominal segment is not swollen in the middle. The abdomen consists of 3 segments.

The first antenna consists of 24 joints. The second antenna, mandible, maxilla, and first maxillipede have the form shown in Pl. 17. figs. 7–10.

The last leg has the form shown in Pl. 17. fig. 11. It closely resembles that of *B. robusta*, Sars.

The uropods bear 5 setæ each, exceeding in length the uropods and the last two abdominal segments (Pl. 17. fig. 5).

Length 2 mm.

Colour. Green.

Male.—The male is a good deal smaller and has a narrower body. The fifth segment has very small lateral projections. The abdomen consists of 5 distinct segments, not counting the uropods (Pl. 17. fig. 5). The last pair of legs have the form shown in Pl. 17. fig. 12. The right limb has the external ramus biarticulate, with rather a short claw. The left limb has the external ramus uniarticulate, with a longer claw. They resemble closely those of the male *B. robusta*, Sars.

The first antenna, which is distinctly geniculated, has 23 joints (Pl. 17. fig. 6).

Occurrence. Among weed in Lake Dulverton.

Boeckella longisetosa, sp. n. (Pl. 17. figs. 13–17.)

Female.—The head and first segment fused with it are shorter than succeeding anterior segments. The fifth segment is fairly large, with fairly conspicuous lateral projections which are distinctly bilobed, the outer lobe being spiniform, the inner rounded.

The first abdominal segment is rather swollen in the middle, and the abdomen consists of 3 distinct segments, and also the uropods are rather distinctly segmented off, making a fourth indistinct segment (Pl. 17. fig. 14).

The first antenna has 21 joints and the other limbs are similar to *B. insignis*.

The last leg is slender and feebly armed with setæ, the internal ramus being tipped terminally with 3 setæ, but otherwise unarmed (Pl. 17. fig. 16).

The uropods bear five compound setæ, which are exceedingly long, equalling in length the whole abdomen.

Length 1·5 mm.

Colour. Green.

Male.—Agrees with the male of *B. insignis* in having a five-segmented abdomen, a more slender body, and no conspicuous projections on the fifth thoracic segment.

The first antenna, which is geniculated, has 22 joints (Pl. 17. fig. 15).

The fifth pair of limbs have the form shown in Pl. 17. fig. 17. The internal ramus of the right limb is two-jointed and bilobed at the end.

Occurrence. In the plankton of Lake St. Clair and Lake Sorell.

BOECKELLA RUBRA, sp. n. (Pl. 18. figs. 1–5.)

Female.—Anterior portion of body narrow and cylindrical; the head and anterior segment fused with it are about equal to the two succeeding segments.

The fifth segment is large, with very conspicuous lateral projections, consisting of two lobes, the external lobe being very long and spiniform and nearly as long as the first abdominal segment, the internal lobe being smaller and rounded at the end. The first abdominal segment is distinctly swollen in the middle. The abdomen consists of three segments.

The first antenna consists of 25 joints.

The last leg has the form shown in Pl. 18. fig. 3, from which it is seen that the setæ on the inner margin of the terminal joint of the external ramus are smaller than in *B. insignis*, while the inner ramus is well armed with small setæ and thus differs from that of *B. longisetosa*.

The uropods have five simple setæ apiece, about equal in length to the abdomen, thus intermediate in length between those of *B. insignis* and *B. longisetosa*.

Length ·7 mm.

Colour. Bright red.

Male.—Similar in form to the female, save that the lateral projections are absent on the fifth segment, and the abdomen consists of 5 segments.

The first antenna, which is geniculated, has 23 joints, and the penultimate joint has a very marked projection at its end (Pl. 18. fig. 2).

The fifth pair of legs have the form shown in Pl. 18. figs. 4 & 5. They differ from the legs of the other species in the presence of an extra seta near the internal ramus of the left limb, and in the presence of an extra seta on the claw of the external ramus of the right limb.

Occurrence. This species occurs in vast swarms in the very old and deep tarns on the Harz Mountains and on Mt. Read. It was never met with in small bodies of water or at lower levels than about 3000 ft.

Boeckella robusta, Sars, Archiv for Math. og Naturvid. xviii.

This large and handsome species was found in great abundance in several small muddy ponds near Hobart (in a pond near the road at Sandy Bay and in a small pond near the Cascade Brewery). Sars describes it from the neighbourhood of Sydney, so that it is evidently a widely distributed form in Southern Australia. It can at once be distinguished from the other species by its great size, by the comparative shortness of the setæ on the uropods, by its pale livid colour, and by the great length of the lateral projections on the fifth segment.

Genus Brunella, gen. n.

I have made this new genus of the Diaptomidæ to include a species found in a large weedy freshwater lagoon near Adventure Bay, Bruni Island. It was present in great quantities, but I did not meet with it anywhere else. It is impossible to include it in any existing genus, as the structure of the thoracic limbs, and especially of the fifth pair in the male, is quite peculiar. In its other characters (*e. g.* structure of antennæ and mouth-parts) it agrees very well with *Diaptomus* or *Boeckella.*

The diagnostic characters which concern the thoracic limbs are:—

1. The first thoracic limb has the external ramus biarticulate and the internal ramus uniarticulate (Pl. 18. fig. 12).
2. The second, third, and fourth limbs have the external ramus triarticulate and the internal ramus biarticulate (Pl. 18. fig. 13).
3. The fifth thoracic limbs in the male differ on the right and left side. The right limb has the external ramus 2-jointed, the last joint being spatulate and carrying a very small terminal spine; the internal ramus of this limb is 2-jointed with an extra internal lobe. The left limb has the external ramus 3-jointed and ending in a greatly elongated claw; the internal ramus of this limb is 3-jointed (Pl. 18. figs. 15 & 16).
4. The fifth thoracic limbs of the female have the external ramus 3-jointed and the internal ramus 2-jointed (Pl. 18. fig. 14).

This combination of characters is very peculiar. Thus the first two characters point to affinities with *Eurytemora*, but the character no. 4 is unparalleled in any freshwater Diaptomid, and one has to go to some marine genus (e. g. *Centropages*) for comparison. Character 3 shows some agreement with *Parabroteas michaelseni*, described by Mrázek from S. America, but in its other characters it differs widely from that genus.

Brunella tasmanica, sp. n. (Pl. 18. figs. 6–16.)

Female.—The fore-body is narrow and cylindrical; the head-segment tapers anteriorly and has a slight depression laterally near the anterior end; this segment exceeds in length the two following segments.

The fifth segment has small lateral projections, which are bilobed, the external lobe being the larger and rounded at the end; the internal lobe is small and more acute. The first abdominal segment is rather tumid; the abdomen has three distinct segments, not counting the segmented bases of the uropods.

The uropods are long, equalling in length the first abdominal segment. They are furnished each with four terminal plumose setæ and one lateral; these setæ are not quite half as long again as the uropods.

The first antennæ are long, equalling the length of the body; they consist of 27 joints.

The second antennæ are similar in structure to those of *Boeckella*, and so are the mandibular palps; the biting-edge of the mandible has the form shown in Pl. 18. fig. 8.

The maxilla (Pl. 18. fig. 9) resembles that of *Boeckella* very closely, but has rather fewer setæ. The same applies to the first maxillipede (Pl. 18. fig. 10).

The second maxillipede (Pl. 18. fig. 11) closely resembles that of *Boeckella*, but the internal lobe on the first joint is more prominent.

The first thoracic limb (Pl. 18. fig. 12) has the external ramus 2-jointed and the internal ramus 1-jointed.

The third limb (which resembles closely the second and fourth) has the form shown in Pl. 18. fig. 13. The external ramus is 3-jointed; the internal is 2-jointed. The arrangement of the spines and setæ is always constant as in the figure.

The fifth leg of the female (Pl. 18. fig. 14) has the external ramus 3-jointed and the internal 2-jointed. The stout spine on the penultimate joint of the external ramus is not plumose.

Length ·7 mm.

Colour. Green.

Occurrence. In great numbers in a weedy freshwater lagoon near Adventure Bay, Bruni Island.

Male.—The male differs from the female in having the first antenna normally geniculated (Pl. 18. fig. 8) and in having five distinct segments in the abdomen.

The last pair of legs are very peculiar.

The right leg (Pl. 18. fig. 16) has the external ramus 2-jointed; the joints are flattened and expanded, and there is a short stout spine on the terminal joint. Otherwise setæ are absent. The internal ramus is 2-jointed, the terminal joint bearing four long setæ. The other joint has a peculiar lobe upon it, and also another internal lobe springs from its base.

The left leg (Pl. 18. fig. 15) has the external ramus 3-jointed, if we count the terminal claw as a joint. There is a small spine at the top of the first joint and another small spine on the base of the claw. The internal ramus is 3-jointed, the terminal joint carrying four setæ.

Family CYCLOPIDÆ.

Genus CYCLOPS, O. F. Müller.

Besides one species, *C. australis*, King, characterised by Sars as peculiar to Australia (Archiv for Math. og Naturvid. xviii.), the latter author reports (*loc. cit.*) several common European species from small pools in and around Sydney (e. g., *C. albidus*, *C. serrulatus*, *C. affinis*, &c.). This occurrence of species identical with those found in Europe is a little suspicious, as nothing of the sort occurs among the other groups of Entomostraca, almost all the species of Cladocera being peculiar. The species found in Tasmania, although very closely related to European forms, are distinguishable as separate species.

CYCLOPS ALBICANS, sp. n. (Pl. 16. figs. 8–12.)

The head-segment is broad and blunt; the succeeding segments have rounded edges, which do not project laterally to any extent.

The uropods are about as long as the last two abdominal segments. They are furnished each with four terminally placed setæ, of which the innermost is much longer than the outermost, but none of them are as long as the abdomen (Pl. 16. fig. 12).

The first antenna, which is as long as the first two segments of the cephalothorax, consists of 17 joints. The terminal segments are without a row of spines or hyaline membrane (Pl. 16. fig. 12).

The first swimming-leg (Pl. 16. fig. 9) has both branches consisting of three joints, and so have the succeeding swimming-legs. The last two joints of the inner ramus of all but the first pair have their internal margin serrated (Pl. 16. fig. 10).

The rudimentary fifth pair of limbs consist of two distinct joints; the terminal joint carries a plumose seta at its tip, and on its inner margin a serrated spine nearly as long as the seta and situated on the inner margin near the tip. The basal joint carries a fairly long seta on its external border (Pl. 16. fig. 11).

Length ·8 mm.

Colour. Very pale green or white.

Occurrence. In the plankton of the Great Lake, and also in many small ponds, widely distributed.

CYCLOPS DULVERTONENSIS, sp. n. (Pl. 17. figs. 1–3.)

The head-segment is broad and blunt, but equal in length to the rest of the thorax. The thoracic segments have their hinder edges distinctly produced and overlapping the segments behind them.

The uropods are rather longer than the last two abdominal segments. They are furnished each with four terminal setæ, the innermost being very slightly longer than the outermost, and the longest is as long or longer than the abdomen (Pl. 17. fig. 3).

The first antenna (♀), which consists of 12 joints, is about as long as the head-segment. The terminal segments are without a row of spines or hyaline membrane.

The first swimming-leg has the inner ramus 2-jointed and the outer 3-jointed, the basal joint being rudimentary. The succeeding legs have both rami 3-jointed, but without any serration on the inner ramus.

The rudimentary fifth pair resemble closely that of the foregoing species.

Length ·5 mm.

Colour. Dark green.

Occurrence. Among thick weed in Lake Dulverton.

EXPLANATION OF THE PLATES.

Plate 12.

Fig. 1. *Phreatoicus australis* (Chilton).
2. Lateral view of telson and uropod, *P. australis,* from the Great Lake.
3. Uropod of *P. australis* from Ben Lomond.
4. Uropod of *P. australis* from Mt. Wellington.
5. *Phreatoicus brevicaudatus,* sp. n.
6. Lateral view of telson and uropod, *P. brevicaudatus.*
7. *Phreatoicus spinosus,* sp. n.
8. Lateral view of telson and uropod, *P. spinosus.*
9. Second antenna of *P. australis.*
10. Ditto of *P. brevicaudatus.*
11. Ditto of *P. spinosus.*
12. Alimentary canal of *Phreatoicopsis terricola* (Spencer). Diagrammatic transverse section.
13. Anterior part of alimentary canal of above, opened to show structure of stomach and typhlosole.

Plate 13.

All figures of *Neoniphargus yuli,* sp. n.

Fig. 1. The animal in lateral view.
2. First antenna. *Sec.app.*, secondary appendage.
3. Second antenna.
4. Right mandible.
5. Left first maxilla.
6. Palp of right first maxilla.
7. Second maxilla.
8. Maxillipede.
9. First gnathopod.
10. Third pereiopod.
11. Terminal claw of first pereiopod.
12. Second uropod.
13. Third uropod.
14. Telson.

Plate 14.

Fig. 1. First antenna of *Neoniphargus exiguus.*
2. Third uropod of ditto.
3. Telson of ditto.
4. Terminal joint of 3rd pereiopod of ditto.
5. First antenna of *N. tasmanicus.*
6. Third uropod of ditto.
7. Telson of ditto.
8. Terminal joint of 3rd pereiopod of ditto.
9. First antenna of *N. wellingtoni.*

Fig. 10. Third uropod of *Neoniphargus wellingtoni.*
11. Telson of ditto.
12. Terminal joint of 3rd pereiopod of ditto.
13. First antenna of *N. alpinus.*
14. Third uropod of ditto.
15. Telson of ditto.
16. Terminal joint of 3rd pereiopod of ditto.
17. First antenna of *Gammarus antipodeus.*
18. Third uropod of ditto.
19. Telson of ditto.
20. Gnathopod of 2nd pair of ditto.
21. Fourth coxal plate of ditto.
22. First maxilla (left) of ditto.
23. First antenna of *G. ripensis.*
24. Third uropod of ditto.
25. Telson of ditto.
26. Gnathopod of 2nd pair of ditto.
27. First maxilla (left) of *G. australis.*

Plate 15.

Fig. 1. First antenna of *N. niger.*
2. Third uropod of ditto.
3. Second gnathopod of ditto.
4. Telson of ditto.
5. *Simocephalus dulvertonensis.* × 56.
6. First antenna of ditto.
7. Telson of ditto.
8. Head of first antenna of *S. australiensis.*
9. Telson of ditto.
10. *Ceriodaphnia hakea.* × 92.
11. First thoracic limb of ditto.
12. Second thoracic limb of ditto.
13. Third thoracic limb of ditto.
14. Telson of ditto.
15. Second antenna of ditto.
16. Mandible of ditto.
17. *Ceriodaphnia planifrons.* × 92.
18. *Bosmina rotunda.* × 90.

Plate 16.

Fig. 1. *Bosmina brevirostris,* ♀. × 125.
2. *Bosmina sorelli,* ♀. × 125.
3. *Macrothrix burstalis,* ♀. × 125.
4. *Alonella nasuta,* ♀. × 125.
5. Telson of ditto.
6. *Alonella propinqua,* ♀. × 125.

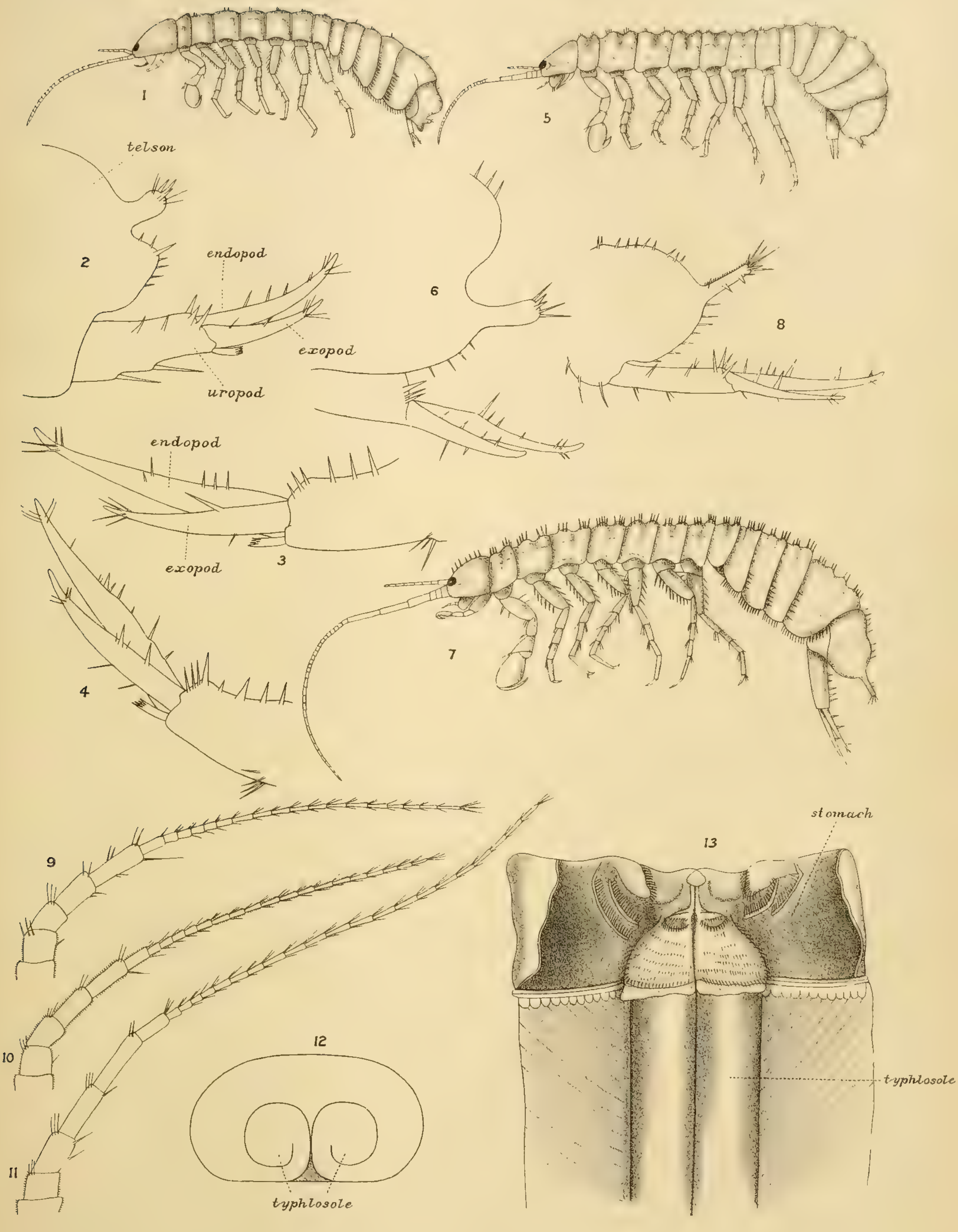
Fig. 7. Telson of *Allonella propinqua*, ♀.
8. *Cyclops albicans*, ♀. × 80.
9. First leg of ditto.
10. Second leg of ditto.
11. Last leg of ditto.
12. First antenna of ditto.

Plate 17.

Fig. 1. *Cyclops dulvertonensis*, ♀. × 86.
2. First pair of legs of ditto.
3. Hind body of ditto.
4. *Boeckella insignis*, ♀. × 50.
5. Hind body of ditto, ♂.
6. First antenna of ditto, ♂.
7. Second antenna of ditto, ♀.
8. Mandible of ditto.
9. Maxilla of ditto.
10. First maxillipede of ditto.
11. Last leg of ditto (♀).
12. Last legs of ditto (♂). R, right limb. L, left limb.
13. *Boeckella longisetosa*, ♀. × 50.
14. Hind body of ditto.
15. First antenna of ditto, ♂.
16. Last leg of ditto, ♀.
17. Last legs of ditto, ♂.

Plate 18.

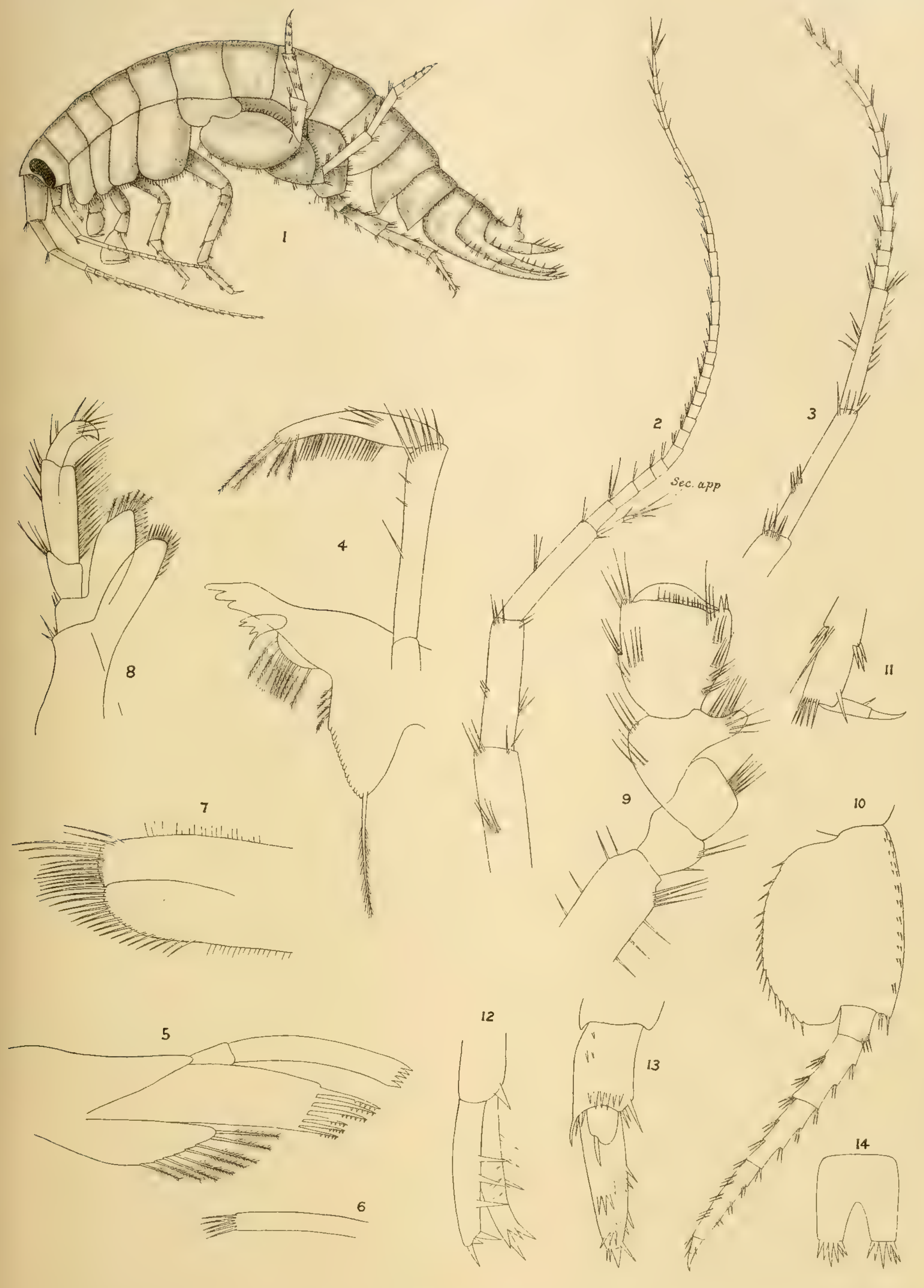
Fig. 1. *Boeckella rubra*, ♀. × 86.
2. Terminal joints of first antenna of ditto, ♂.
3. Last leg of ditto, ♀.
4. Last right leg of ditto, ♂.
5. Last left leg of ditto, ♂.
6. *Brunella tasmanica*, ♀. × 86.
7. Terminal joints of first antenna of ditto, ♂.
8. Biting-edge of mandible of ditto. Right.
9. Maxilla of ditto.
10. First maxillipede of ditto.
11. Second maxillipede of ditto.
12. First limb of ditto, ♀.
13. Third limb of ditto, ♀.
14. Last limb of ditto, ♀.
15. Last left limb of ditto, ♂.
16. Last right limb of ditto, ♂.



G. W. S. del.

TASMANIAN CRUSTACEA

M. P. Parker lith.
Parker & West imp.



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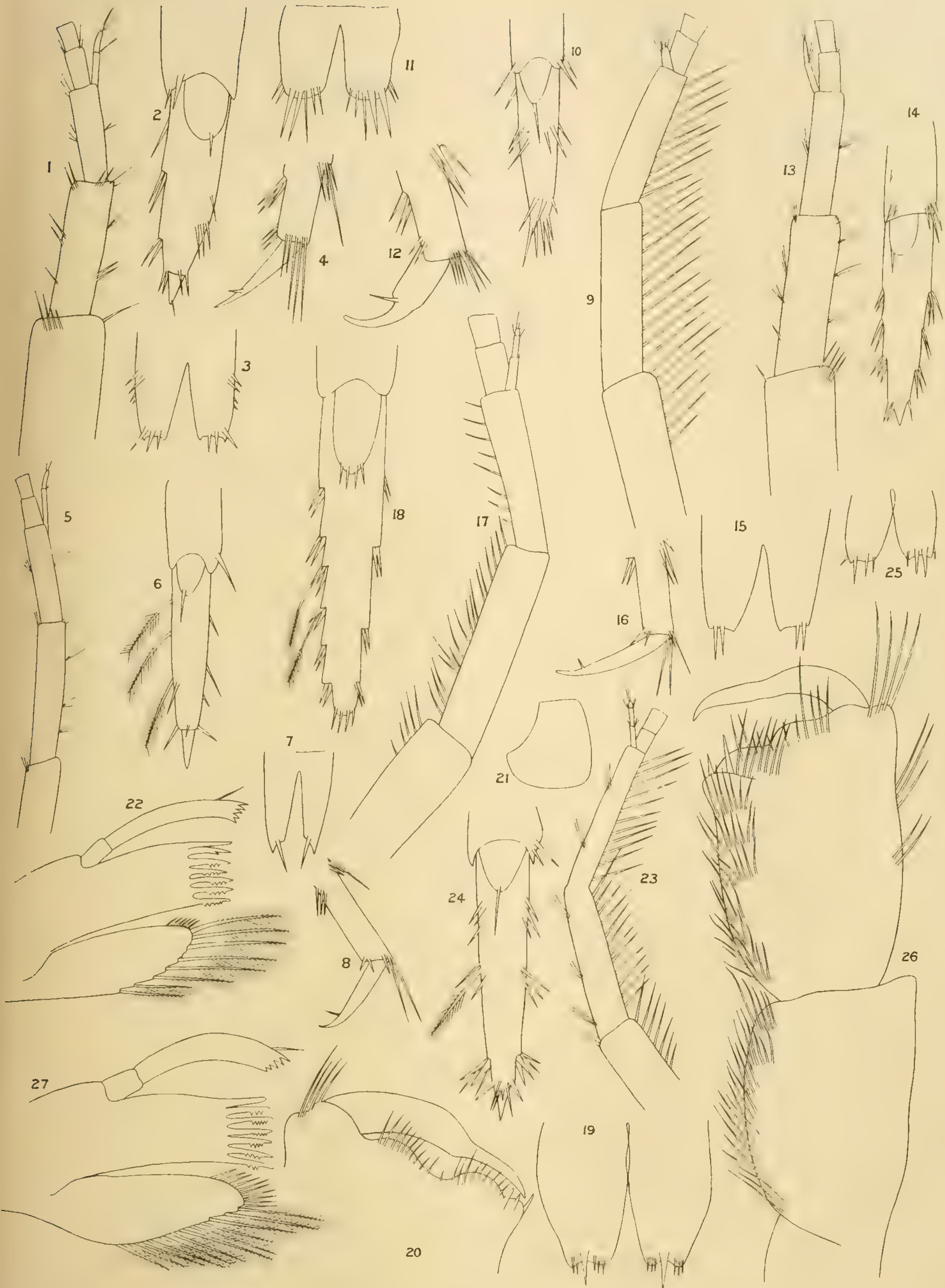
Parker & West imp.



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TASMANIAN CRUSTACEA.

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Parker & West imp

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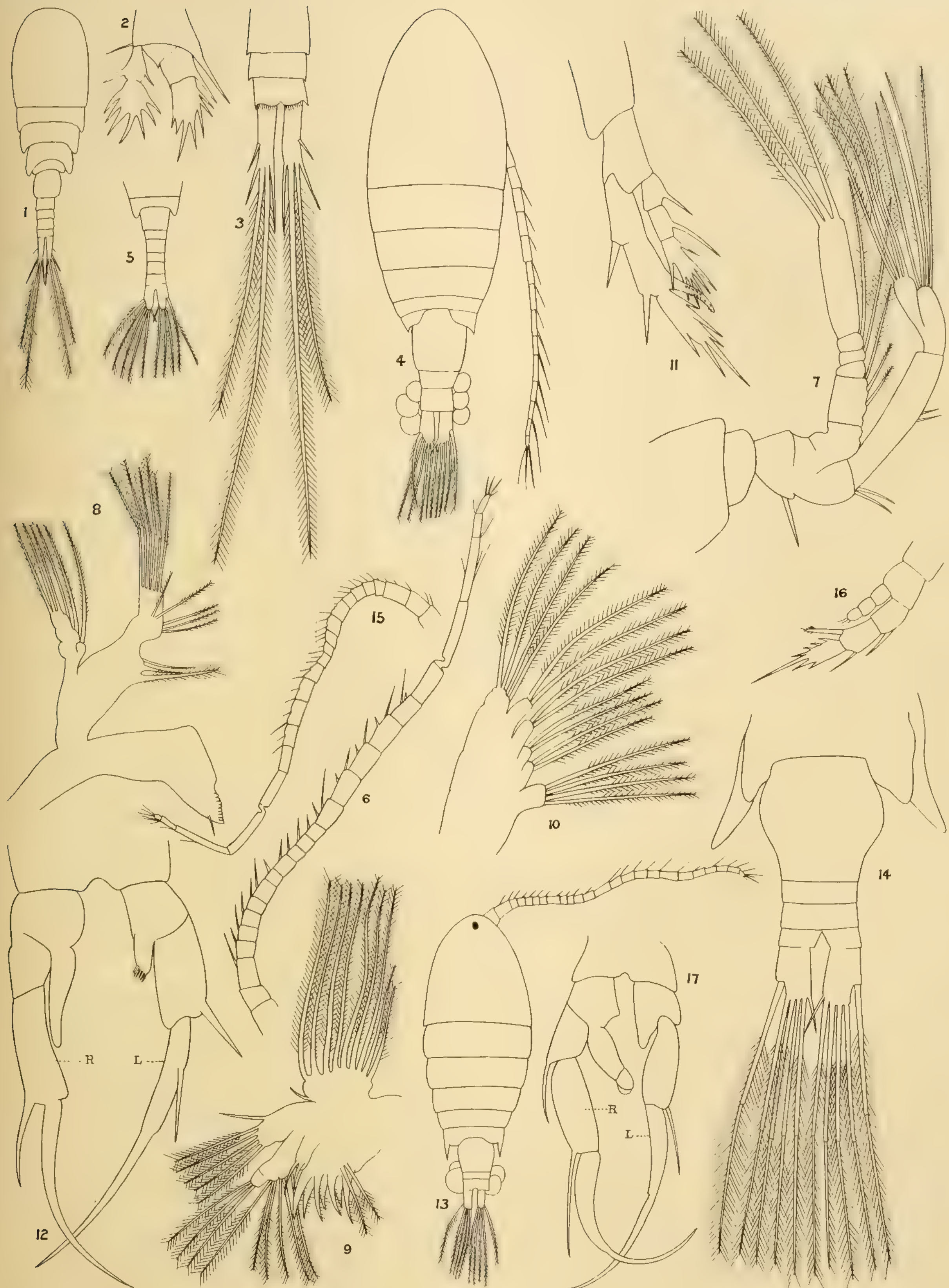


G. W. S. del.

TASMANIAN CRUSTACEA.

M. P. Parker lith.
Parker & West imp.

G. W. S. del.

TASMANIAN CRUSTACEA.

M P Parker lith.
Parker & West imp

V. *On a Blind Prawn from the Sea of Galilee* (Typhlocaris galilea, g. et sp. n.). *By* W. T. Calman, *D.Sc.*, *F.L.S.* (*Communicated by permission of the Trustees of the British Museum.*)

(Plate 19.)

Read 1st April, 1909.

THE British Museum has recently received from Mr. R. Grossmann, of Tiberias, two specimens of a blind Crustacean, which differs in some remarkable characters from any species at present known. The specimens, I understand, were not actually taken in the Sea of Galilee itself, but from a small pond near the town of Tiberias communicating with the lake and fed by a mineral spring. From the fact that the animal is without any organs of sight (so far as can be ascertained by external examination), it seems most probable that it is a species of subterranean habitat, brought to the surface by the waters of the spring. It is much less probable that the specimens entered the pond from the lake, although this is no doubt the origin of some small fish, taken along with the prawns, which have been identified by my colleague Mr. C. Tate Regan as *Discognathus lamta*, a common Syrian species.

Among the numerous species of subterranean Crustacea which have been described, only a small number belong to Decapoda. The following list includes all the truly subterranean species of which I can find record :—

Astacidæ.

Cambarus pellucidus (Tellkampf) *.
„ *hamulatus*, Cope & Packard *.
„ *setosus*, Faxon †.
„ *acherontis*, Lönnberg ‡.

Palæmonidæ.

Palæmonetes antrorum, Benedict §.
„ *eigenmanni*, Hay ||.

Atyidæ.

Troglocaris schmidtii, Dormitzer ¶.
Palæmonias ganteri, Hay **.

From this list have been omitted species like those of *Euryrhynchus* and some of the species of *Cambarus*, which, while known or suspected to have a subterranean habitat, have well-developed eyes, and may therefore be assumed sometimes to frequent the surface-waters.

* See Faxon, "Revision of the Astacidæ," Mem. Mus. Comp. Zool. Harvard, x. (4) pp. 40 & 81 (1885).
† Faxon, in Garman, Bull. Mus. Comp. Zool. Harvard, xvii. (6) p. 237 (1889).
‡ Lönnberg, Bih. Svenska Vet.-Akad. Handl. xx. Afd. 4, no. 1, p. 6 (1894).
§ Benedict, Proc. U.S. Nat. Mus. xviii. p. 615 (1896).
|| Hay, Proc. U.S. Nat. Mus. xxvi. p. 431 (1903).
¶ Dormitzer, Lotos, iii. p. 85 (1853).
** Hay, Proc. U.S. Nat. Mus. xxv. p. 226 (1902).

The blind marine cavernicolous species *Munidopsis polymorpha*, which I have discussed elsewhere *, belongs to a somewhat different category as regards habitat.

According to Barrois †, the only Decapod Crustacea recorded from the Sea of Galilee are the Crab *Telphusa fluviatilis* (or more correctly, according to Miss Rathbun, *Potamon potamios*) and the Atyid *Hemicaridina* (= *Atyaëphyra*) *desmarestii.*

Family PALÆMONIDÆ.

TYPHLOCARIS, gen. nov.

Rostrum very short, flattened, without teeth. Carapace without antennal, hepatic, or other spines, but with a longitudinal suture-line on each side. Outer flagellum of antennule with a minute vestige of an inner branch. Mandible without a palp. Maxilla with the distal endite undivided. Third maxilliped slender. Second peræopods much larger than the first.

Type species, *T. galilea*, sp. n.

The affinities and systematic place of the genus are discussed below.

TYPHLOCARIS GALILEA, sp. n. (Plate 19. figs. 1–13.)

Description of Male.—The carapace is smooth, its surface beset with very minute, widely-scattered setæ. In front it is produced in a minute triangular rostrum, flattened and without any median keel, not extending beyond half the length of the ocular peduncles. The orbital notch is defined below by a very slight convexity, but there are no antennal, hepatic, or other teeth on the antero-lateral margin, and the antero-lateral corner is broadly rounded. On each side the carapace is traversed by a longitudinal suture-line or fine groove which runs, nearly straight, from a point opposite the base of the antenna to the posterior margin. This suture has very nearly the position of the *linea thalassinica* of certain Thalassinidea and of a similar line found in certain Penæidæ (*Parapenæus*, *Parapenæopsis*), but I cannot find mention of any comparable structure in the Caridea. Towards its lower edge the carapace becomes membranous.

The abdomen has little of the "humped" form supposed to be characteristic of the Caridea (*Eukyphotes* of Boas), but this feature is ill-defined in many other Caridea. The pleural plates of the second somite are comparatively little expanded. The abdomen is about the same width throughout its length, the sixth somite being broad and depressed, hardly longer than the preceding somite, and much broader than long. The telson (fig. 3) is longer by one-half than the sixth somite, and has a broadly triangular or rounded tip, extending well beyond a pair of stout subapical spines and fringed with spinules and setæ; there are two pairs of spinules on the upper surface.

The ocular peduncles (fig. 4) have the form of flattened scales, lying horizontally and nearly touching each other in the middle line. On the upper surface of each are a

* Ann. Mag. Nat. Hist. (7) xiv. p. 213 (1904).

† Th. Barrois, "Liste des Décapodes fluviatiles recueillis en Syrie," Rev. Biol. Nord France, v. pp. 125–134 (1893); also "Contribution à l'étude de quelques lacs de Syrie : IV. Lac de Tibériade," *op. cit.* vi. pp. 250–293 (1894).

few setæ. I could detect no trace of pigment or of ocular structure. The antennules (fig. 2) have the stylocerite of the first segment blunt, closely applied to the side of the segment, and not reaching its distal end. There are two long flagella (incomplete in both specimens), the outer of which bears, at about the 52nd articulation in one specimen and at the 25th in the other, a small biarticulate appendage (fig. 5); in other words, the bifurcation of the outer flagellum is reduced to a minimum. I have been unable to detect a statocyst in the basal segment of the antennule, but I am not confident that it is absent.

The antenna (fig. 2) has a flagellum longer than the body. The scale is about two-thirds as broad as long, with the spine on the outer edge a little beyond the middle of its length.

The mandibles (fig. 6) have well developed incisor and molar processes but no palp. The maxillulæ resemble those of *Palæmon*. The maxillæ (fig. 7) have a very unusual form; the proximal endite is obsolete (as in *Palæmon* and many other Caridea) and the distal endite is undivided, perhaps owing to the suppression of its proximal lobe.

The first maxilliped (fig. 8) has the lobe of the exopodite very large and pointed. The second maxilliped (fig. 9) has a large epipodite, but the podobranchia appears to be represented only by a small fleshy lobe on the anterior surface of the epipodite.

The third maxillipeds (fig. 10) are stout, and extend forwards well beyond the scales of the antennæ. The terminal segment is considerably longer than the penultimate. The epipodite is represented by a small fleshy lobe which bears a group of yellow spines, each very stout in the proximal half and tapering to a very slender tip. The first legs are slender and, when extended forwards, the distal end of the merus reaches to the tip of the antennal scale. The carpus is about equal to the merus and longer by one-half than the chela. The fingers are nearly twice as long as the palm.

The second legs (fig. 11) are large and subequal, and the merus extends beyond the antennal scale. The carpus is about two-thirds as long as the merus. The palm is inflated and slightly compressed laterally. In two of the chelæ examined the palm is about two-thirds as long as the fingers; the third, which may be abnormal, has the immovable finger much shorter than the dactylus, which is about equal to the palm. The fingers have a thin smooth cutting-edge, which forms a low tooth near the base of each, and internally to this edge they have a series of widely-spaced teeth. The whole limb is clothed with long and soft hairs.

The walking-legs are moderately stout. The dactyli are not toothed on the lower (concave) edge, but have some stout spines on the upper surface. The pleopods (fig. 12) have broad protopodites, on the posterior face of each of which, near the outer edge, is a patch of stout yellow spines with filiform tips. Some of these spines (fig. 13) are irregularly thickened or distorted. In the first pair of pleopods the endopodite is about half as long as the exopodite, and has near its distal end on the inner side a clavate process bearing a group of coupling-hooks. In the second pair the *appendix masculina* is shorter than the *appendix interna*.

The uropods have both rami very broad and pointed, instead of rounded, distally. The exopodite extends beyond the telson for half its length. The tooth on the outer margin is about the middle of its length, and an oblique ridge runs inwards from it. The endopodite possesses a suture-line running inwards from the outer margin in a corresponding position, which looks as though it might be produced by the pressure of the endopodite against the ridge of the exopodite. It is very rare for the endopod of the uropods to show any trace of division into two segments by a suture-line, and I do not know of any other case among the Caridea.

The branchial apparatus comprises five pleurobranchiæ on the somites of the peræopods, an arthrobranchia on the third maxilliped, mastigobranchiæ (epipodites) on the first and second maxillipeds and possibly also on the third (if this be the value of the spinose lobe described above), and a vestigial podobranch, represented by the simple lobe on the epipodite of the second maxilliped. The branchial formula of *Palæmon* differs from this by the presence of a pleurobranchia above the third maxilliped and a distinct podobranchia on the second.

The colour in life is stated to be white.

Measurements in millimetres:—

	♂.	♂.
Total length	51	42·5
Length of carapace and rostrum	20	17·5
Inner flagellum of antennule (incomplete)	28	—
Second leg	—	48·5
„ „ merus	—	11·0
„ „ carpus	—	7·5
„ „ palm	—	10·0
„ „ fingers	—	13·0

The characters of this species, as described above, show that it must be referred to the family Palæmonidæ as defined by Borradaile *, but its exact position within the family is not so easy to define. Borradaile includes as a subfamily of the Palæmonidæ, the *Pontoniinæ* (formerly ranked as a distinct family), which are distinguished from most of the *Palæmoninæ* by having, among other characters, the rostrum often small and not serrated, the bifurcation of the outer antennular flagellum reduced to a minimum, and the mandible without a palp. In these points the present species agrees, but I do not think that it can be regarded on that account as having any special affinities with the exclusively marine *Pontoniinæ*. As a matter of fact, the *Palæmoninæ* already include one genus, *Euryrhynchus*, Miers †, which agrees with that here described in the three points of palpless mandibles, reduced and non-serrated rostrum, and freshwater (possibly also subterranean) habitat. From *Euryrhynchus* and all the other *Palæmoninæ*, however, *Typhlocaris* differs not only in the suppression of all spines or teeth on the antero-lateral margin of the carapace, but in other characters so important as to suggest that it may be necessary to establish at least a new subfamily for its reception. Chief among these characters are the presence of a pair of suture-lines on the carapace and the undivided distal endite of the maxilla. I am not aware that these characters are paralleled in any of the Caridea, and if, as seems possible, the suture of the carapace be homologous with

* Ann. Mag. Nat. Hist. (7) xix. p. 472 (1907).

† See Calman, Ann. Mag. Nat. Hist. (7) xix. p. 295 (1907).

that of some Penæidæ and with the *linea thalassinica*, it may indicate that *Typhlocaris* has been derived from some very ancient and primitive Caridean type. The resemblance to the Thalassinidea in this character adds another to the indications already existing (phyllobranchiæ, appendix interna, larval development) that that group has some affinity with the Caridea.

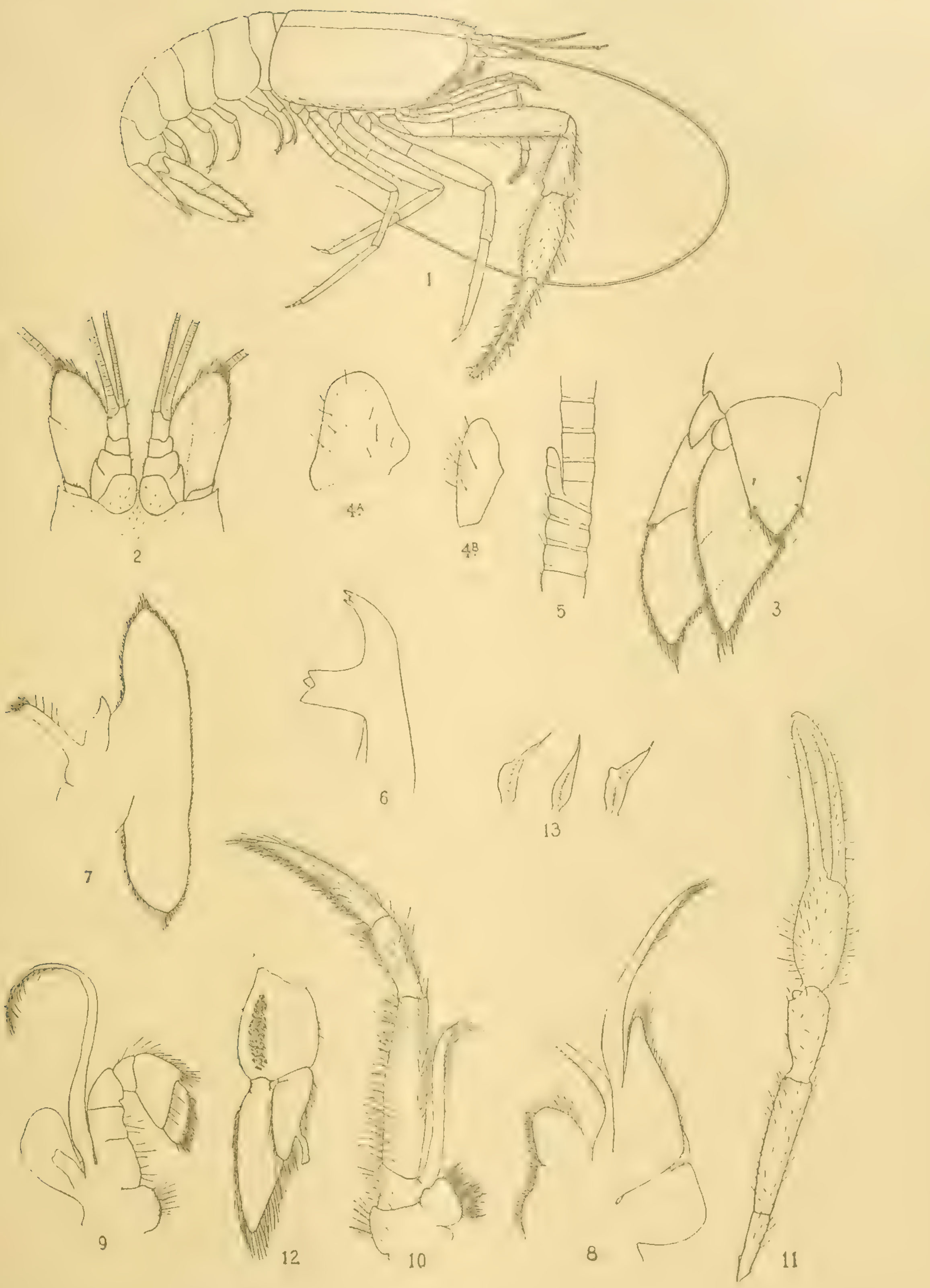
As indicated above, the only blind subterranean Palæmonidæ known are two species referred to *Palæmonetes* occurring in Texas and Cuba respectively. Both have been described only in a very summary fashion, but so far as their characters are known they indicate no special affinity with the present species *.

According to information supplied by the collector, the species would appear to be very rare. Repeated searches in the same locality over a period of two years only resulted in the discovery of three specimens, one of which was afterwards lost by accident. The other two specimens, which are males, are now in the British Museum, and form the types of the species.

EXPLANATION OF PLATE 19.

Fig. 1.	*Typhlocaris galilea*,	g. et	sp. n.	Male, from the side. $\times \frac{7}{4}$.
2.	,,	,,	,,	Head, from above.
3.	,,	,,	,,	Telson and uropod, from above.
4.	,,	,,	,,	Ocular peduncle: *a*, from above; *b*, from the side.
5.	,,	,,	,,	Portion of outer flagellum of antennule, showing the secondary appendage.
6.	,,	,,	,,	Mandible.
7.	,,	,,	,,	Maxilla.
8.	,,	,,	,,	First maxilliped.
9.	,,	,,	,,	Second maxilliped (anterior surface), showing vestigial podobranchial lobe on the epipodite.
10.	,,	,,	,,	Third maxilliped.
11.	,,	,,	,,	Second leg.
12.	,,	,,	,,	Pleopod of first pair (posterior surface), showing patch of modified spines on protopodite.
13.	,,	,,	,,	Spines from protopodite of pleopod.

* Since this was written I have been enabled, by the courtesy of Miss M. J. Rathbun and of the authorities of the United States National Museum, to examine specimens of these two species. They differ widely from the species here described.



W. T. C. del. Grout sc.

TYPHLOCARIS GALILEA.

VI. *On the Life-History of* Chermes himalayensis, *Steb., on the Spruce* (Picea Morinda) *and Silver Fir* (Abies Webbiana). *By* E. P. Stebbing, *F.L.S., F.Z.S., F.R.G.S., F.E.S., Imperial Forest Zoologist to the Government of India.*

(Plates 20–23.)

Read 17th March, 1910.

I. *Chermes himalayensis*, Steb., on the Spruce (*Picea Morinda*) and Silver Fir (*Abies Webbiana*).

References: *Chermes abietis*, Buck. Ind. Mus. Not. iii. pp. 5, 54.
Chermes abietis-piceæ, Steb. Jour. As. Soc. Bengal, lxxii. pt. ii. pp. 37, 229.

General Remarks.

In April 1892 some galls found on Spruce trees (*Picea Morinda*) near Chakrata, in the North-West Himalaya, were sent to the Indian Museum, Calcutta, by Mr. J. S. Gamble, F.R.S., the Director of the Imperial Forest School, Dehra Dun. The galls were found to contain insects, but these latter were too immature at this period to render identification possible. In July 1893 further specimens were sent from the same locality by Mr. A. Smythies, Deputy Director of the School and late Conservator of Forests, Central Provinces. Mr. Smythies procured some mature flies from the galls, which were identified by the late Mr. Buckton as *Chermes abietis*, Kalt., the well-known Spruce gall Aphis of Europe *.

In May 1901 and June and July 1902 the writer had an opportunity of visiting the forest from which the above-mentioned specimens were sent, and neighbouring areas, and made a study of this *Chermes*. As is well known, *Chermes viridis*, Ratz., lives in Europe upon the Spruce and Larch, series of agamic generations alternating between these two trees, a sexual generation occurring but once a year in the autumn and then always upon the Spruce, whilst another species, *Chermes abietis*, Kalt., lives only on the Spruce.

In 'Injurious Insects' (1899), in quoting the discovery † of *Chermes abietis* in the North-West Himalaya, a locality I had not at the time visited, I pointed out that it would be interesting to know whether the Spruce grew pure in that locality, and if so whether the insect existed on that tree alone.

My investigations during 1901 and 1902 led me to the discovery that the *Chermes* lived in a somewhat similar manner in the Himalaya to its European confrère, *C. abietis*, but that in the absence of the Larch the second host plant was the Silver Fir

* Ind. Mus. Notes, vol. iii. no. 5, p. 54.

† Injur. Ins. Ind. For. p. 23 (1899).

(*Abies Webbiana*). I further came to the conclusion that the Himalayan species was distinct from the European species *Chermes viridis* and *C. abietis*.

In two papers read before the Members of the Asiatic Society of Bengal in 1903 *, I gave a brief account of the life-history of this *Chermes*, which I named *Chermes abietis-piceæ*, on the Spruce and Silver Fir so far as it was then known to me.

I have now abandoned the specific name of *abietis-piceæ* in favour of *himalayensis*, since the former would give rise to considerable confusion should Cholodkovsky's opinion that *C. abietis* and *C. piceæ* are true species stand the test of careful breeding-experiments.

The first paper treated of the mode of development of the alar appendages of the Spruce form of the insect on its issue from the gall or pseudo-cone, whilst in the second a general account was given of some of the stages of the parallel series passed by the insect on the two trees, so far as was then known to me.

Whilst on furlough in England in 1904 I paid a visit to St. Petersburg, where I had the pleasure of meeting Professor Cholodkovsky, the well-known eminent authority on the genera *Chermes*, *Lachnus*, &c. I was thus afforded an opportunity of a full discussion on this subject with the able Doctor. He fully confirmed my views as to the *Chermes* of the Himalaya being an undescribed species, and expressed the greatest interest in the marked differences in the life-history as then known.

Subsequent investigations—as yet, I am fully aware, by far from complete—have enabled me to throw some further light on the existence of this remarkable insect and to correct some of the data given by me in my papers read before the Asiatic Society.

I am also able, owing to the talent and assiduity of my wife, to supplement this account with some valuable and interesting coloured plates drawn on the spot from living specimens collected during a recent tour in Chamba State in the Himalaya.

The general Life-History of the Insect on the Spruce and Silver Fir.

Chermes himalayensis, as the Indian species is named, closely resembles the European *Chermes viridis*, Ratz., in that the individuals of one generation may assume different habits at different stages of their existence and so set up the phenomenon known as "parallel series." Also the apterous forms of the insect are parthenogenetic, and, as we shall see, several generations of these parthenogenetic females may be passed through on one host plant. The insect lives on two host plants, the Spruce and Silver Fir, and different stages in the life-history may be passed on either the one or other of the two.

Blochman and Dreyfus in Germany, Cholodkovsky in Russia, and, more recently, E. R. Burdon, of Cambridge, in the 'Proceedings of the Cambridge Philosophical Society,' have made a series of most important and interesting observations on the habits of the European *Chermes*—Cholodkovsky in his erudite "Monographie der Coniferen-Lause" †

* Jour. As. Soc. Bengal, vol. lxxii. pt. ii. pp. 57, 229.

† Cholodkovsky: "Beiträge zu einer Monographie der Coniferen-Lause," Horæ Societatis Entomologicæ Rossicæ, t. xxxi., July 1896.

treating of the subject in a most able manner. Burdon's interesting papers * will be alluded to later on.

As has been stated, the fact that the Himalayan form lives upon two host-plants was unknown before 1901.

In order to present the somewhat complicated stages of life passed through by this insect in a form intelligible to the reader, I propose to give a brief description of the various generations at present known to live upon the two trees and which give rise to the parallel series.

To the generations of the European forms of *Chermes* the names I. FUNDATRICES, II. ALATÆ, III. COLONICI, IV. SEXUPARÆ, and V. SEXUALES have been given †, and I propose, as far as possible, to retain these names in the following account.

In the early spring dead apterous females, "stem-mothers" (Generation I. FUNDATRICES), are to be found upon the Spruce trees, these having most probably hibernated through the winter. These females are merely shrivelled skins covering the masses of eggs similar to those shown in Pl. 22. fig. 5. These dead females are found at the base of small pinkish cone-shaped swellings which are galled buds, the females by their sucking-operations having already caused the tissues of the stem in their close neighbourhood to swell to an appreciable extent.

The larvæ hatching out from these eggs (Generation II. ALATÆ) feed at the base of the young developing Spruce-needles, the part of the stem below and the needles gradually swelling up and coalescing into a gall within which the young Aphids become enclosed (*cf.* Pl. 20. fig. 1).

This gall resembles a small fir-cone and gradually increases in size, until during July it opens by a contraction of its parts (*cf.* Pl. 21. fig. 1) and the now mature larvæ or nymphs crawl out, moult their skins, and appear as winged insects.

A portion of these winged insects remain upon the Spruce, and lay the eggs from which the stem-mothers of Generation I. FUNDATRICES develop, whilst the others fly to the Silver Fir, where they may be found upon the needles of the tree. These are the MIGRANTES-ALATÆ of Burdon (see Table, p. 120). They there secrete a cottony mass, which wholly or partially covers them, and lay eggs upon the needles. Some of these eggs at least give rise to apterous parthenogenetic females, forming Generation III. COLONICI.

In the case of the Silver Fir an examination of the branches of old trees and the masses of saplings and poles in the early spring (May) will show minute white cottony specks on the bark. These cottony masses at times may be seen thickly dotting the whole of

* Burdon: "The Pine-apple Gall of the Spruce.—A Note on the Early Stages of its Development," Proc. Camb. Phil. Soc. xiii. pt. 1 (1906), p. 12; "The Spruce Gall and Larch Blight Diseases caused by *Chermes* and Suggestions for their Prevention," Journ. Econ. Biol. Lond. vol. ii. (1907) pt. 1, p. 1; "Some Critical Observations on the European Species of the Genus *Chermes*," ibid. pt. 4 (1908), p. 119.

† Cholodkovsky, *op. cit.*; Burdon, "Spruce Gall and Larch Blight Diseases," Journ. Econ. Biol. Lond. vol. ii. pt. 1, p. 5.

the bark of the stem of young saplings. The cottony masses contain a number of egg-bunches, having the appearance under the lens of bunches of yellow and brown grapes, as shown in Pl. 22. fig. 5. These eggs are those laid by the COLONICI. From these eggs hatch out in the early spring little larvæ, which crawl on to the newly-developed young Silver Fir needles, insert their proboscides into the tissue of the under surface and suck out the sap. These larvæ reach full growth as apterous females, EXSULES (fig. 2), in about three weeks, and these apterous females secrete cottony filaments, under which they lay bunches of eggs on the needles, similar in appearance to the spring ones, and die (figs. 3, 4). A portion of this generation is winged (fig. 7) and would seem to represent a part of Burdon's Generation IV. SEXUPARÆ. From the eggs laid on the Silver Fir needles hatch out in a few days small red grubs (see fig. 8), which in their turn become full-grown and lay similar eggs (EXSULES). A portion of these latter generations collect and feed down at the base of the needles and stem, and cause the needles to contort and twist and curl inwards, forming a corkscrew termination to the shoot towards the end of June (*cf.* Pl. 23. fig. 1). This corkscrew would almost seem to be of the nature of a rudimentary gall structure, and thus this species differs fundamentally from the European *Chermes* on the Larch, which forms nothing in the shape of a gall-like structure. In this corkscrew both apterous (EXSULES) and winged (SEXUPARÆ) insects are to be found. In the latter part of June and first part of July the twisted-up needles are found to contain numerous eggs covered by the usual dead mother skin and white cottony substance. These egg-masses are also to be found on the twigs and stem of the tree and are very visible.

These eggs hatch out into grubs, which grow into minute apterous female insects furnished with very long proboscides (Pl. 23. fig. 3). These insects, if not already there, crawl down on to the bark of the branch, insert their proboscides down a crevice into the bast and remain feeding there (*cf.* Pl. 23. figs. 2, 3) throughout the rains, and, I think, probably through a part of the winter, when they secrete the cottony material, lay eggs, and die.

The winged forms (SEXUPARÆ), or a portion of them, migrate to the Spruce, as I have found living specimens on the old needles of the tree, as also dead insects stuck to the needles. These insects presumably lay eggs upon the needles and give rise to the fifth generation, the SEXUALES. I have not found this generation on the Spruce. It would presumably consist of wingless males and females, and give rise to the first generation, the FUNDATRICES.

From what has been said, it thus becomes obvious that one important factor governs the appearance and duration of the various generations passed through upon the Spruce and Silver Fir, and that is the monsoon. The rains burst in the Outer Himalayan Region we are considering early in July and bring to an end Generations I. and II. upon the Spruce and Generation IV. on the Silver Fir.

With this brief review of the various phases of the life-history we will now proceed to consider in fuller detail the life-stages passed respectively on the Spruce and Silver Fir.

For convenience of comparison, I give below the Table drawn up for the various generations of the European insect, *Chermes viridis*. It is taken from Burdon's paper on the "Pine-apple Gall of the Spruce":—

	PRIMARY HOST: *Picea.*	INTERMEDIATE HOST: *Larix* (or *Pinus*, or *Abies*).
1st year.	I. FUNDATRICES .. Hibernate. Cause galls. Wingless. All ♀. II. ALATÆ ...... Larvæ inhabit galls. Adults winged. All ♀. Non-Migrantes. Migrantes.	
2nd year.	I. FUNDATRICES (as before). V. SEXUALES .. Wingless. Cause no gall. ♂ & ♀. II. ALATÆ (as before). Non-Migrantes. Migrantes. —To *Larix* as before.	III. COLONICI ...... Hibernate. Cause no gall. Wingless. All ♀. Larvæ live on the needles. Cause no gall. All ♀. IV. SEXUPARÆ. Adults winged. EXSULES. Adults wingless. EXSULES.
	I. FUNDATRICES. I. FUNDATRICES.	?

II. *CHERMES HIMALAYENSIS* ON THE SPRUCE.

Nature of Attack.

The *Chermes* feeds on the sap of the twigs and new buds of the year, preventing the development of the needles of the latter, which coalesce and form a small fir-cone-like gall or pseudo-cone. These galls are at times exceedingly numerous on the trees and not unlikely account for the scraggy appearance of many young trees, whose crown and branches have a thin and open appearance, and are seen to contain numerous old and new galls upon them (*cf.* Pl. 20. fig. 1).

Distribution.

I have noted the presence of this insect in Jaunsar, Tehri Garhwal, Simla Hill States, Bashahr, and Chamba States. It is doubtless distributed throughout the Western Himalaya Region wherever the Spruce and Silver Fir are associated together in mixture.

Description.

Stem-Mother (FUNDATRICES).—The skin of the dead insect is a dark brown madder to black in colour. The insect is furnished with a very long proboscis, which is found fixed in the tissues of the shoot.

Egg-Mass.—The egg-mass consists of a cluster of brown-yellow or brown-madder eggs placed close together in such a manner as to resemble a rather open bunch of grapes. This bunch is covered, and to some extent probably protected, by the dried skin of the stem-mother.

Egg.—Small, ovate-elliptical, almost hen-egg-shaped, shining yellow to yellow-brown or brown-madder in colour. Length 0·5 millim.

Young Larva from Spring Eggs (ALATÆ).—As seen under the microscope this is small, a brown-madder in colour; antennæ consist of two large basal joints, followed by a narrower longer one which is surmounted by a hair. The proboscis is short. Three pairs of short legs are present, and the body is simply segmented and not as yet much corrugated and crenulated.

Half-grown Larva.—Brown-madder in colour, the legs and antennæ bright yellow. No indications of wings are yet visible on the dorsal surface of the thorax. The abdomen is slightly more ridged and corrugated than in the newly hatched larva (*vide* Pl. 20. figs. 3, 4). Figure 4 is about three-quarters grown and shows the first commencement of the wing-protuberances on either side behind the head.

Fully-grown Larva.—Small, thick, puffy, wingless, dull purple-brown in colour, much ridged and corrugated dorsally, the lateral edges crenulate, and the anterior coxæ greatly enlarged and globose. Beneath the skin on each side of the mesothorax a small dull yellow excrescence can be seen, and posteriorly to this on the metathorax, also at the side, a longish dark flatter protuberance. These protuberances are the new fully-developing wings. Legs and antennæ yellowish green. Antennæ six-jointed. No wool is secreted by the insect at this stage. Length 1·14 to 1·35 millim. (Pl. 21. fig. 2.)

Winged Insect (ALATÆ).—After the last moult of the larval or nymph skin the Aphid is very brightly coloured. Head and prothorax black and shining, mesothorax and metathorax both dorsally and ventrally dark orange-brown. Wings pale apple-green with yellow nervures. Abdomen shining black. Legs and antennæ bright canary-yellow. Short, thick-set, almost squarish, the body flatter than before the nymph's final moult. Head small; antennæ six-jointed, the first joint very small, second and third small, fourth longest; prothorax broad and much channelled, the rest of thorax also broad, the metathorax sessile on the abdomen. The wings project beyond the posterior part of the body almost $1\frac{1}{4}$ times the total length of the Aphid. Length with wings 2·25 to 2·68 millim. Pl. 21. fig. 5 shows the fly newly issued from its last larval skin with wings still rolled up; fig. 6 the perfect fly with wings fully developed; and fig. 7 the fly developing the white cottony material on head, thorax, and body.

Life-History.

An examination of the branches of the Spruce at the beginning of May will show small pinkish-white cone-shaped masses appearing here and there. At the bases of these, in the axil between the branch and cone (which is really an unopened bud), masses of elliptical reddish-yellow eggs are to be found, sometimes very abundantly, at others in much scarcer numbers. These egg-masses are partially covered by the dried skin of what was the stem-mother, who dies after laying them. At the beginning of May these egg-masses are in the majority, few of them having hatched out, and the bud above them having only just commenced to increase in size. I have not as yet definitely ascertained whether these eggs are laid in the spring or in the late autumn by the stem-mother. A careful search for eggs in October and November, 1906, in Jaunsar failed to disclose any on the Spruce, even on trees bearing numerous old galls from which winged insects had emerged the previous July. This would seem to point to the fact that the stem-females (FUNDATRICES) on the Spruce hibernate through the winter with their long proboscides fixed in the bast-layer of the stem just below a bud and lay the eggs very early in the spring in April—in fact, before the first warmth of spring has made itself really felt and whilst snow is still lying on the ground. This is what I think myself actually takes place.

According to Burdon, it is the lengthy feeding of the mother by suction which originates the gall-growth on the stem, the growth gradually spreading to and enveloping portions of the needles in the European form.

In the first week in May small larvæ hatch out from the eggs, and sections cut across any of the small cones, which have swollen to a slight extent, will disclose numerous young larvæ between the bases of the young needles. These larvæ are engaged in feeding upon the sap of a part of the stem and the young undeveloped needles of which the pink cone or gall consists. The irritation set up by the stem-mother feeding at the base of the bud and perhaps by the young larvæ feeding at the base of the young needles soon causes the bud to swell, but instead of opening out into a short stiff brush of needles it develops into a green cone-shaped mass or gall. When this gall is quite young there is no partitioning off into distinct cells to be observed within it; but as the swelling under the constant irritation set up by the larvæ and due to the growth of the needles themselves continues, the interior gradually becomes divided off into distinct compartments, in each of which numbers of the young larvæ are to be found engaged in sucking the sap from the walls of the compartment. Pl. 20. fig. 2 shows a section across a partially-grown gall with five compartments in it.

In the third week of May this partitioning is already distinct, and a section of a small gall—which is by then bright green externally and pyramidal or pear-shaped in form, from which the European gall gets its name of Pine-apple Gall—will show a number of chambers situated on either side of a central axis (*cf.* Pl. 20. fig. 2).

The young larvæ are still a bright madder-brown in colour, with legs and antennæ light yellow. No indications of wings have yet made their appearance (*cf.* Pl. 20. fig. 3).

As the gall becomes partitioned off inside distinct diamond-shaped areas make their appearance on the external surface, each of which serves as a cover to the chamber below it. It will be noted that the galls terminate the shoots, being sessile at the top of last year's woody shoot (*cf.* Pl. 20. fig. 1). It would almost appear therefore as if the gall was a stem-growth, and to some extent it must be so looked upon, for it is made up of the young needles whose growth in length has been arrested and also of the tissues which would have gone to make the new stem-growth of the year. If the centre of each diamond-shaped cover be examined it will be seen that a central spot on the surface is lighter-coloured than the rest and usually forms a small projection which is longer and more apparent in the young gall than in the old one (*cf.* Pl. 20. fig. 1 and Pl. 21. fig. 1). This projection would appear to represent the tip of the swollen-up and absorbed needle. It is rarely more than an eighth of an inch in length and in this totally differs from the European Spruce and Larch *Chermes* gall, in which only the lower portions of the needles and shoot of the year swell up and coalesce to form the gall, the upper part of the needles projecting to some distance beyond the gall-surface and being obviously the true upper portion of the needle, whilst the upper portion of the shoot continues its normal growth above the gall.

Mr. E. R. Burdon's recent investigations from a botanical point of view on the origin and development of the European gall * are of such interest that I feel no apology is required for reproducing them here:—

"As soon as the insect begins to suck in the spring, the cells in the region of the cambium where the apex of the proboscis lies are forced into precocious growth. They at once increase rapidly in size and undergo active division. The protoplasm becomes filled with large vacuoles and the nuclei enlarge in about the same proportion. The daughter cells repeat the process and the swelling and growth radiate outwards in every direction from this centre.

"At first the formation proceeds symmetrically and both the pith and the cortex are invaded to an equal extent. Very soon, however, a limitation is imposed on the growth of the pith-cells by the lignified vessels of the protoxylem, and the cells of this region do not continue to respond so readily to the stimulus. The growth then takes the line of least resistance, and extending rapidly outwards through the cortex becomes excentric. . . .

"The net result of these various changes is that almost all previous differentiation of the stem has been obliterated, and in its place a parenchymatous tissue, consisting of abnormally swollen cells with extremely thin walls, has been formed. The cortex on the galled side of the stem has become two to three times as thick as the cortex on the other side which is still normal, and the symmetry of the stem has thus been destroyed.

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* "The Pine-apple Gall of the Spruce: a Note on the Development," Proc. Camb. Phil. Soc. vol. xiii. pt. 1 (1905), pp. 12–19. *Vide* also his observations on the subject in his other two papers in the Journ. Econ. Biol. already referred to.

"The gall growth continues its outward course until it reaches the bases of the needles, and these in their turn begin to swell up. As the growth proceeds up them the needles assume a tapering shape, very much thickened at the base and gradually diminishing in size until about halfway up, where they still remain normal. The gall is now visible to the naked eye as soon as the bud-scales are removed, being rendered evident not only on account of its swollen nature, but also by reason of its bleached appearance due to the absence of chlorophyll.

"The needles at first increase evenly in thickness on every side, but before long the swelling becomes confined on the inner (ventral) side, since this faces the main axis, which is also swelling, and the two soon meet. When this happens any further growth goes on chiefly on the dorsal side, and the leaf becomes asymmetrical in transverse section. The outer (dorsal) side of the needles soon comes in contact with the inner surface of the bud-scales, but as these are gradually unfolding all the time, they do not offer much resistance to the swelling, and the dorsal side of each gall-needle consequently becomes convex in shape.

"Owing to the erect position of the needles at this stage and their crowded spiral arrangement round the main axis, this enlargement of their bases quickly results in adjacent needles coming into contact with each other, and grooves are formed on the surface of each needle, where other needles have pressed upon it. The phyllotaxis is such that the base of any one needle must on swelling come in contact with the swollen bases of no less than four other needles, two belonging to the spiral above it, two to the spiral below.

"Each needle-base is consequently marked with four grooves. Of these, the two on the inner side are much deeper than the two on the outer side, owing to the pressure being greater in the former case, and between these grooves a slight ridge is formed which corresponds with the space between the needles of the spiral above, or below as the case may be.

"As the stem gradually elongates the needles are carried slightly apart, and the resulting space above each needle forms a chamber which is later on taken possession of by the young offspring of the *Chermes* mother. The deeply grooved inner (ventral) side of the needle forms the floor of this chamber, whilst the two needles of the spiral above each contribute a half towards the formation of the roof. It will thus be seen that each individual leaf participates in the formation of three distinct chambers, its ventral side forming the floor of the chamber above it, and the grooves on its dorsal side each forming one-half of the roofs of the two chambers below it to right and left.

"At a later stage these chambers become closed in by the development of thick tumid lips around their mouths.

"About the beginning of May the shoots begin to emerge from the bud-scales, but the galls are not at once visible, since the base of the shoot is still concealed in the persistent basal bud-scales. They soon, however, make their appearance and the galls then enter on the second stage of their existence, the history of which must be left at present as my examination is not yet completed.

"But to return to the insect. Whilst the changes described above have been proceeding in the bud, the *Chermes* larva has been steadily sucking and increasing in size. She has secreted a quantity of white wool-like wax, which, while it entirely conceals her, renders her position most conspicuous. She undergoes three ecdyses before reaching maturity, and the cast skins may be found lying beside her in the 'wool.' As soon as she reaches maturity she commences to lay eggs, and continues the process through May and on into June, until a heap of some hundreds of eggs accumulates beside her. Each egg is attached to the stem by a delicate hair-like stalk. The first eggs begin to hatch soon after the gall has emerged from the bud-scales, and the minute larvæ at once creep up the shoot and establish themselves in the gall-chambers, where they find a fleshy succulent tissue already prepared for them. They at once commence sucking and become entirely enclosed within the chambers by the development of the tumid lips previously referred to, and here they remain until the galls open.

"These, then, constitute the most important events which characterise the development of the galls during the first stage—that is, whilst still enclosed in the bud-scales.

"One very noticeable feature is the apparent absence of any effort on the part of the plant to resist the attack, for the insect appears to have everything its own way. This is, I think, chiefly due to the fact that the shoot is enclosed in the bud-scales, which exclude light and air, and thus keep the tissues of the shoot in a plastic condition. . . .

"Although my examination of the later stages is not yet complete, I have seen enough to convince me that the conditions are reversed in the next stage, and a great effort is made by the shoot to overcome the influence of the insect. And this effort is to some extent successful, in so far as the shoot is enabled to limit the insect's sphere of influence to the area over which it has already gained sway. But the effort is made too late, and always ends in the death of the galled portion of the shoot, if not of the whole shoot.

"With regard to the ultimate cause of the gall-formation, there is, I think, good reason to believe that it is due to an injection by the *Chermes* mother. It would be out of place in this paper to give the reasons for this belief in detail, but the behaviour of the chlorophyll, tannin, protoplasm, and nuclei, and the gradual radiation of the influence in every direction all seem to point to an injection as the cause. Further, if the insect be removed, say a week after it has commenced to suck, the abnormal growth is not brought to an end. The gall continues to develop, and emerges from the bud-scales just as if the insect had never been removed. The only possible explanation of this posthumous growth appears to me to be, that the poison injected during that week of the insect's life continues to act on the tissues of the plant after the death of the mother."

The pseudo-cone caused by the Himalayan insect continues to steadily increase in size throughout June and the young larvæ inside turn to a dark purplish-madder colour. They moult their skins whilst in the chambers, at least three moults taking place, and the white papery cast skins can be found in the chambers. When nearing their full growth from six to eight or at times an even greater number of larvæ occupy each chamber.

Several pseudo-cones are often to be found on the same branch (*cf.* Pl. 20. fig. 1 and Pl. 21. fig. 1), and I have at times seen young trees loaded with these galls, the latter having all the appearance of true fir-cones, the great number present adding to this deceptive appearance.

In the early days of July the young larvæ in the galls reach full growth and the galls commence to open. It has been noted that those situated on sunny slopes and on the sunny side of the tree open first.

The gall or pseudo-cone in the process of what may be termed "ripening" changes from green to orange-yellow and pale crimson; this takes place first on one side after the manner of a ripening apple and then all over, the gall often becoming bright crimson for a time, finally turning, when the insects are ready to emerge, to a dull purple, with the exception of a small patch or point in the centre of each of the diamond-shaped covers (where the upper part of the needle would come off in the European Spruce and Larch Gall), which remains bright green (Pl. 21. fig. 1).

I give the following description (with some additions and corrections) of the opening of the cone and the acquisition on emergence of their wings by the full-grown larvæ or nymphs from my paper already alluded to as published in the 'Journal of the Asiatic Society of Bengal':—

The cone does not necessarily commence opening at the top: the small chambers may open anywhere all over it. The portions more exposed to the sun and in direct contact with warm air-currents ripen first. An examination of the insects within the galls, just before the latter begin to open, will show them to be little thickish, puffy, wingless Aphids, dull purple in colour and much ridged dorsally, with greatly enlarged globose anterior coxæ (Pl. 21. fig. 2). This is the last stage of development of the insect within the gall, no functional alar appendages being present.

A section cut across the gall at this stage shows from 5 to 7 chambers of considerable size (fig. 3), each containing on the average eight purple grubs amidst a mass of fine white cottony material and cast larval skins.

In opening, the upper two edges or sides of the diamond-shaped outer covering of the chamber become detached at their points of juncture with the two lower sides of the cover of the chamber next above, thus forming a kind of lip purplish in colour, which can be forced open with a forceps. The external surfaces of the diamond-shaped coverings then contract slightly, thus causing the aperture to permanently gape, the opening becoming wider and wider as the surface dries and consequently contracts (figs. 1, 4). The slit is at first quite narrow, but as soon as it appears the insects commence to crawl out. On reaching the outside of the false cone the fat purple nymph (fig. 2) at once undergoes its last moult. In doing this, the skin splits down a median line, both dorsally and ventrally, as far as the mesothorax dorsally, and the first and second pair of coxæ ventrally; the insect then slowly crawls out, leaving the white papery cast skin, to which are attached the dark-coloured leg and antenna cases, behind it.

After this last moult it will be seen that the *Chermes* has undergone a great change.

It now appears as a small gorgeously coloured Aphid. On either side of the thorax two little bright-coloured bundles are visible, a bright Naples yellow anteriorly and vivid apple-green posteriorly (fig. 5). The whole insect, in fact, is very highly coloured and looks at this stage as if it had just been freshly painted with the very brightest tints in Nature's colour-box and then given a coating of varnish. As soon as the *Chermes* has freed itself from the last attachment of its last skin it begins to crawl actively about on the exterior surface of the gall, and the little yellow and green bundles unfold and disclose the fact that they are the rolled-up alar appendages (*cf.* fig. 5). As far as I could perceive, the insects themselves take no active part in unfolding these wings. They do not hang themselves up to get them unrolled, as is the case with Lepidoptera, but simply walk about, and under the influence of the sun and heat the wings rapidly spread out, stiffen, and become functional. I noted that in many cases, even before the insect has entirely freed itself from the last larval skin, the little bundles had so far unrolled as to be quite distinct from one another. Within half an hour from the time of leaving the cone, the wings are fully unrolled, being held at an angle on the side of, but not meeting in a roof-shaped manner over, the abdomen. These wings are pale apple-green in colour with yellow nervures except at their juncture with the thorax, where they are chrome-yellow (*vide* fig. 6).

Within one and a half hours of shedding the last skin, patches of white setæ begin to appear upon the Aphid, and the meso- and metathorax turn from orange to shining black. These hirsute white patches appear on the head, upon each division of the thorax, and two little tufts, set side by side on each segment, run medianly down the dorsal surface of the abdomen. On the prothorax these white setæ are in a transverse ridge; on the meso- and metathorax they are in two large patches as on the abdomen. The wings become a paler green or yellow, the costal and median nervures being strongly marked and orange in colour, the transverse intersecting ones being silvery (fig. 7).

The insect by now, *i. e.* within three hours of its last moult, has lost all its brilliant colouring and has become dull and inconspicuous. It only differs from the winged form to be found at this period on the needles of the Silver Fir by being colourless, but iridescent in certain lights.

A certain proportion of this winged generation, which consists of females only, from the Spruce galls fly off to the Silver Fir, where I have found them in the first half of July clinging to the new year's needles. The others remain on the needles of the Spruce They bury their proboscides in the tissue of the under side of the leaf, taking up a position parallel to the long axis of the leaf with head pointing downwards.

Summary.

We may summarise this portion of the life-history as follows:—

In the early spring the stem-mother lays a mass of eggs just beneath a bud on a branch of the Spruce in the spot where she has hibernated through the winter with her long proboscis fixed in the cambium layer of the branch. The irritation set up by the sucking of the female has already resulted in the first beginnings of a gall the swelling of which, commencing on the stem, subsequently envelops the whole of the developing spring needles of the bud. The larvæ hatching out from the eggs at the commencement of May get enclosed in this gall. The growth of the gall and the larvæ continues throughout May and June, the gall becoming mature or "ripe" and the larvæ fully grown about the first week to middle of July. The gall differs from the European one in that the whole of the needles become absorbed within it, only a minute portion of the tip protruding from the hexagonal cap or lid forming the cover to each compartment of the gall. The larvæ moult their skins several times during their growth in the chambers of the gall. In July the lower edges of the caps or lids of the galls open, the cap drying and shrinking, and the larvæ crawl out of the chambers on to the outside of the gall. Here they at once cast their skins, the little flies crawling out. At this moment the flies are highly coloured little insects, the wings being rolled up into little bundles on the thorax; these rapidly unfurl, straighten out and stiffen in the sun's rays, and become functional. Some of this winged generation, which consists of females only, remain on the Spruce and lay eggs there; the rest fly to the Silver Fir and oviposit on the needles or twigs. These eggs, or a portion of them, hatch out within a week or fortnight, and give rise to a generation of larvæ which crawl on to the branches which have developed a first thin brownish-yellow cortex and bury their very long proboscides deep down through a crevice of the bark into the cambium below. The monsoon period and possibly the autumn and winter are passed in this position. I am of opinion that it is possible that these insects form a portion of the stem-mothers or COLONICI on the Silver Fir.

III. *CHERMES HIMALAYENSIS* ON THE SILVER FIR.

Nature of Attack.

The *Chermes* feeds upon the sap of the new needles of the year, spending its life invariably on the under surface.

The second or third generations of the apterous insects descend down the needles towards their bases, causing the needles to contort and screw up, the upper portion of the shoot thus developing into a curious corkscrew, having the appearance of a large terminal "bud" within which the Aphids feed, the whole mass being very sticky from the exudations of the Aphid (*cf.* Pl. **23.** fig. 1).

Distribution.

The same as already given under the Spruce.

Description.

Young (COLONICI) *Larva.*—Madder-brown to black in colour, covered with white cottony bristles with a lateral fringe of white setæ. Proboscis very long, at least more than three times as long as insect, blackish in colour. Pl. **23.** figs. 2, 3 show these Colonici larvæ.

Stem-Mother (COLONICI).—Dead females are dark brown-madder to almost black in colour with a long blackish proboscis.

Egg-Masses.—The spring egg-masses are very similar to those of the Spruce already described, but they differ in one marked peculiarity. They are invariably covered by a white cottony filamentous substance or "wool," which entirely hides and protects them. Pl. **22.** fig. 5 shows an egg-mass with the wool drawn aside to show the eggs. This egg-mass contains the eggs of the second generation, the SEXUPARÆ and EXSULES.

Eggs.—Similar to those found upon the Spruce.

Elliptical, yellow, darkening to madder-brown, shining, having the shape of a hen's egg. Pl. **22.** figs. 3, 4, 5 show masses of these eggs, those of the second generation of the year.

Young larva (SEXUPARÆ and EXSULES).—Brown-madder in colour, with two large basal joints to the antenna, followed by another joint and a bristle. Proboscis short.

Within a few days of hatching out, the young larva commences to secrete from the dorsal area the white woolly substance which from now onwards begins to gradually clothe them.

Pl. **22.** fig. 8 shows a young newly hatched larva of the second generation from an egg laid two days before by an apterous female of the first generation of the year.

Full-grown Apterous Female (EXSULES).—Elliptical ovate or truncate ovate (figs. 2, 3), dark madder-brown in colour, convex above and flat ventrally, the dorsal segments well marked and ridged, the lateral edges flattened. Legs yellowish or madder-brown.

When full-grown the insect is usually entirely enshrouded in a thick mass of long fine filamentous wool. This wool is secreted from the segmental divisions of the thorax and body. Length about 1·25 millim. Pl. 22. fig. 2 shows a female without the "wool" covering, just before egg-laying, fig. 3 a female just commencing to develop the wool covering and to oviposit, and fig. 4 a female with the eggs almost fully if not completely laid and covered to a great extent with the wool covering (some of it in the drawing has been removed to show the eggs).

Full-grown Larva or *Nymph* (Sexuparæ).—Elongate elliptical, pointed at both ends. Shining, madder-brown, with two dull yellow swellings on either side of the thorax, which are the wings beneath the skin, and give a humped appearance to the thorax dorsally. The transverse annuli of the body are faintly visible. Body very convex dorsally, the lateral edges set with a longitudinal row of tubercles. Length about 1·45 to 1·55 millim. (Pl. 22. fig. 6.)

Winged Insect (Sexuparæ).—Umber-brown to blackish, with four transparent wings with a faint brownish tinge, the base of the main vein yellow medianly, otherwise all the veins brownish. Head umber-brown, with exserted antennæ, 4-jointed (or 5-jointed, the basal joint very short), 1 (or 2) thick, square, short, other 3 narrower than 1, elongate, swollen medianly, last shortest. Thorax black, emarginate anteriorly, with a flat elongate heart-shaped raised edge medianly, enclosing a smooth depression having this shape  on prothorax and a prominent lateral spine on side of mesothorax. Body black, rather flat, the abdominal margin of the segments prominent. Legs dull umber-brown.

No "wool" material visible on the insect when it first issues from the ruptured skin of the nymph.

Some twelve hours after leaving the skin of the nymph, short curling white cottony or "wool" filaments begin to appear:

(1) At base of head at its junction with the prothorax.
(2) Two circular patches placed transversely in the sunken depression on the prothorax.
(3) An irregular patch on the meso- and metathorax.
(4) A much larger continuous mass of wool filaments completely covering the dorsal surface of the abdomen.

Pl. 22. fig. 7 shows this fly when it has just begun to develop the woolly masses on head, thorax, and abdomen.

Life-History.

The winter is passed in the stem-mother (Colonici) stage, the insect remaining on the branches or, in the case of young trees, on the upper part of the main stem, with her long proboscis buried in the cambium layer of the tree. The insects generally occupy crevices of the bark.

The stem-mothers must awake into activity very early in the year and oviposit, for I have found the egg-masses and wool-coverings at the beginning of May at elevations as great as 9300 ft., whilst snow was still lying upon the ground.

At times these woolly egg-masses are so numerous as to clothe the bark of the stems of young trees more or less entirely from top to bottom, either encircling the stem or occupying one or two sides only. Or the eggs may have been laid on the upper portion of the stems of old trees and poles or on parts of the side branches. Tops, leading shoots, and branches covered in this manner have the appearance of being infested with the white filaments of a fungus (*cf.* Pl. 23. fig. 4).

An examination of these cottony masses with a lens early in May will show that the wool-like material merely serves as a protection to a blackish skin, the dried-up remains of the over-wintering mother. This skin partially covers the bunch of yellowish-brown glossy elliptical eggs. We have seen in the case of the Spruce that the eggs are merely partially protected by the dried female skin, no cottony material being excreted by the stem-mother (FUNDATRICES). The eggs, laid anywhere on the bark of the stem of the Silver Fir, appear to require more protection than in the case of those laid beneath the immature buds on the branches of the Spruce; and this would seem to be the reason for the development by the COLONICI mothers, and, as we shall see, by the apterous females of the spring generations, of the cottony mass to serve as a protection to the eggs.

I have found the eggs in millions upon Silver Fir trees in years of bad infestation.

In the first week of May small larvæ (*cf.* Pl. 22. fig. 8) hatch out from the eggs, and these at once crawl up on to the newly developed or developing needles of the tree, at this period just bursting through the bud-scales, where they appear as minute black specks covering the bright green tassels of needles. They insert their proboscides into the tissue of the under surface of the needle and remain fixed in this position. They are never to be found on the upper surface of the needle. These larvæ resemble exactly the young larvæ to be found at this period within the newly forming pine-apple galls or pseudo-cones of the Spruce. Within a few days, however, the young Aphids on the Silver Fir begin to secrete on the dorsal segments a white cottony material, which is extruded in bunches from certain parts of the segments and serves undoubtedly as a protection to screen the grubs from the eyes of predaceous birds and insects, &c. To the naked eye the young grubs appear at this period to be attacked or surrounded by the fine white filaments of a fungus.

Towards the end of the third week in May, after at least two moultings (I think the total number is 3) of the skin, the grubs mature, and at this period some at least lose the white cottony covering and appear as the ovate brown apterous female shown in figure 2 in Plate 22.

These are the EXSULES, or apterous insects, which remain on the Silver Fir.

These apterous females as soon as mature begin to develop cottony material, the first filaments being secreted from segmental divisions of the head and thorax. Soon after filamentous masses are extruded between the abdominal segments, and the whole insect is almost entirely covered by the woolly mass. As soon as the first cottony filaments have begun to make their appearance the apterous female commences egg-laying, the eggs being extruded from the anal end of the body (fig. 3). These eggs are lightish yellow at first, darkening to a yellow-umber or madder-brown in a few hours after being laid. About 30–40 are laid by the female, a day being spent in this operation, the female subsequently dying and her shrivelled skin remaining as a partial protection to the eggs beneath the cottony mass. Pl. 22. figs. 3 and 4 show the apterous female egg-laying and with the eggs completely laid, the figures in both instances being drawn from life under the microscope. The majority of the spring larvæ of the first generation are apterous females and lay their eggs in the third and fourth week in May.

A small proportion of the spring larvæ develop into a winged generation of individuals (*the* SEXUPARÆ ?) on the Silver Fir.

The full-grown larvæ, which will produce the winged insect, are easily recognisable on the Siver Fir needles under a lens, owing to their narrower elongate elliptical shape and to the light yellowish-brown swellings visible on either side of the thoracic region (fig. 6). The skin of this larva bursts open at the head and thoracic end and the winged insect with its wings furled in two little bundles on the thorax crawls out. The wings uncurl, soon dry and stiffen in the sun, and become functional (fig. 7).

I have not been entirely able to settle the movements of the whole of this winged portion of the spring generation of larvæ. It may be that some of them fly off to the Spruce to oviposit there, but I have not as yet been able to find any individuals of this winged generation on the Spruce.

They are to be found not unfrequently on the Silver Fir needles with their proboscides buried in the tissue of the under surface of the leaf. A proportion of them, I think, undoubtedly lay eggs on the under surface of the Silver Fir needles in a similar manner to the apterous females, and, this being so, the speculation arises as to why they should have acquired wings. It is true that the possession of alar appendages enables them to migrate from the needles upon which they were reared to others in the neighbourhood which are not occupied by numbers of egg-masses, and this may be the reason for a proportion of the young larvæ growing into a winged generation. I think, however, the most reasonable surmise is that a percentage of these migrate thus early in the year to the Spruce. If this is the case, they form the true Generation IV., the SEXUPARÆ, or the first portion of it, of the year, provided the eggs they lay upon the Spruce give rise to a sexual generation. Further observations by fellow-workers on this interesting portion of the life-history will settle this point definitely.

That a portion of the winged generation would seem to remain on the Silver Fir I have, I think, proved by the following observations:—On the 24th May I described a winged living individual under the microscope, and kept it under observation on the 25th and 26th. On the 24th the insect had merely issued from the last larval covering, acquired its functional wings, and taken up its position head downwards with its proboscis buried in the tissue of the under surface, the last larval skin being close by adhering to the needle. On the 25th the insect had darkened in colour, and had commenced to develop short cottony filaments as follows:—

(1) At base of head at its junction with the prothorax.

(2) Two circular patches placed transversely in the sunken depression on prothorax.

(3) An irregular patch on the meso- and metathorax.

(4) A much larger continuous mass of cottony filaments completely covering the dorsal surface of the abdomen.

On the 26th the cottony mass had increased and egg-laying commenced. The fly died on 27th or 28th.

This fly was drawn on the 25th May and is shown in Pl. 22. fig. 7.

We thus see that from the spring generation of larvæ two forms develop, one apterous and the other winged.

The whole of the apterous forms and a portion (or all ?) of the winged forms at once oviposit on the Silver Fir needles, laying masses of eggs which resemble the spring ones and are covered with very visible white cottony filamentous masses. Pl. 22. fig. 1 shows a portion of a Silver Fir branch exhibiting these white cottony masses on the needles, which cover either females still egg-laying or masses of eggs partially shielded by the dead skin of the female insect. This figure was painted from life, the branch having been just previously plucked from a tree.

The eggs of this second generation of the Aphid hatch out in from two to three days after being laid, and the young larvæ spread out over the under surfaces of the still young and soft light green needles, insert their proboscides into the leaf-structure, and remain feeding either in one place for the rest of their lives or more usually shift their feeding-spots later on in their development. At times the under surfaces of the needles are quite black with numbers of the dark madder-brown coloured larvæ attached to them, which appear to the naked eye as tiny black dots on the needles. If the needle is closely inspected it will be seen that it is always bent upwards a little on either side at the point at which the larva has been feeding.

Observations have shown that some of these larvæ develop into apterous females about the middle of June and lay eggs, at least a portion of which also produce another generation of the apterous females.

At the beginning of June it will be noticed that the greater proportion of the larvæ feeding on the needles of the upper or terminal portion of the new shoot have collected towards the bases of the needles and on the needle-bearing stalks, and this results in a curious malformation of the Silver Fir shoot (*cf.* Pl. 22. fig. 1). The irritation set up by the feeding larvæ causes each individual needle to cockle and twist over in a spiral direction from right to left. The needles so affected appear to lose their chlorophyll and turn a dirty yellow, either all over, or have numerous small yellow blotches amongst the green all up them. As the green needles of the whole of the upper half of the shoot of the year are affected in this manner, it results in this portion of the shoot becoming twisted up into a corkscrew mass, as shown in Plate 23. fig. 1. The tightness of the twist varies, but it is such that the needles so affected remain in this position and finally drop off. During the insects' presence the heavy exudation of sugary liquid from them covers the corkscrew mass and binds the needles yet more firmly together, giving the shoot the appearance of being terminated by a giant bud. I have noticed also that this excretion is added to by an exudation of turpentine from the Silver Fir, round nodules of resin being formed in the axils of the affected needles.

An examination of the corkscrew masses at the end of the first to the second week in

June will show numbers of the ordinary madder-brown larvæ feeding at the bases of the needles and on the stem, and also, in addition, some larger yellowish grubs which now begin to make their appearance for the first time. These yellow larvæ are usually found in the axils of the leaves, each having its proboscis firmly fixed in the tissue of the stem or base of the leaf.

We have here the distinct separation of the last generation of the insect passed during the year on the needles of the tree into two distinct forms of larvæ. The yellow larvæ give rise to a generation of winged insects which form either the latest portion of, or the true, fourth (SEXUPARÆ) generation. The larvæ remain feeding in this position until the middle to the end of the third week in June or even until the end of the month, the period apparently depending almost entirely, if not entirely, on the nature of the season experienced. If a hot dry spring followed by a late monsoon is experienced, the Aphids may be found in the corkscrew masses up to the end of June. If a wet spring is followed by an early monsoon (as in 1909), an examination of the corkscrew masses in the third week of June will show them to be dried up, open and empty.

At whatever time the yellow larvæ mature, it will be found that just before this period the insects apparently cease feeding or cease exuding sugary material. The corkscrew needles now dry and shrink apart slightly, and the small apertures so left enable the yellow larvæ, or nymphs as they now truly are, to crawl through. They creep out onto one of the lower needles or onto the stem, moult their skin, the skin splitting down anteriorly to the metathorax, and the winged insect with the small bunches of wings on the dorsal anterior surface crawls out, much in the same manner as the winged insect of the Spruce gall leaves its larval skin, and as the first generation of winged insects on the Silver Fir leave their nymph-skins.

The numerous white paper-like skins on the twigs and the untwisted needles in the neighbourhood of the large " bud " are easily visible.

The winged generation of flies resulting from these yellow nymphs act in two ways. Some remain on the Silver Fir and lay eggs covered with cottony masses on the branches and bark of the main stems of young trees and on the branches and upper part of the main stems of old trees. The remainder leave the Silver Fir and migrate to the Spruce, where I have found them fixed to the needles of the tree. Here they probably lay the eggs which give rise to the sexual generation (SEXUALES) on the Spruce. This generation I have not yet found.

The apterous females arising from the madder-brown larvæ move from the interior of the corkscrew mass down onto the untwisted needles and shoots below before egg-laying. The greater bulk of the eggs laid beneath the cottony masses are always to be found here outside and below the corkscrew mass; and there is a good reason for this, for the needles of the corkscrew, together with the portion of the shoot bearing them, as I have said, shrivel up and fall off. The other needles of the year, below those which actually formed the corkscrew, turn yellow in colour or have numerous spots and dots all up them, and in their turn wither and die, but at a later stage.

The eggs, within a week or a couple of weeks of being laid, hatch out into tiny grubs, blackish brown in colour, with a very long proboscis and the dorsal surface covered with white cottony bristles, the lateral edges being set with a fringe of white setæ, giving the insects the appearance of an *Icerya* scale insect in miniature (Pl. 23. figs. 2, 3).

These little grubs proceed down to the parts of the shoot or branches covered with the first light thin brownish-yellow cortex, insert their proboscides down through a crevice into the cambium layer and remain feeding there. Pl. 23. fig. 2 shows these small larvæ feeding on the cortex, and fig. 3 two more highly magnified. The larvæ pass through the monsoon rains and, I think, the autumn and succeeding winter here, and form a portion of the Colonici, or apterous females, which lay the eggs of the first spring generation of the year. The other or true portion of the Colonici on the Silver Fir migrate from the Spruce about the middle to third week in July. It is a point which will require very considerable investigation and close experiments to decide whether any of the apterous females (the true Exsules) which leave the Silver Fir corkscrew "bud" and lay eggs below give rise in the following year to winged insects, or Sexuparæ.

We have now to turn to the winged insect which emerges from the Spruce pine-apple gall, or pseudo-cone, and flies to the Silver Fir. This period of emergence is about the middle of July, and a large proportion of the flies from the Spruce galls would seem to migrate to the Silver Fir, for I have found them plentifully on the under side of the needles.

On reaching the Silver Fir the fly selects a needle below the corkscrew "bud" and comes to rest on the under side in a position usually pointing up and down or parallel to the long axis of the needle, the head pointing either upwards or downwards, most usually the latter.

The fly then commences to oviposit, laying from 60 to 80 or possibly as many as 100 eggs. The number is far greater than that of the eggs laid by the apterous female on the Silver Fir.

The eggs are egg-shaped, dark madder or umber-brown in colour, and are deposited in a heap like a squashed bunch of grapes, except that the mass is more spread out at the base. The eggs when first laid are flesh-pink in colour, soon darkening.

The abdomen of the fly shrivels up after egg-laying and the upper wings remain entirely covering the egg-mass, the insect dying *in situ* and remaining fixed to the needle on taking up her position there.

Before egg-laying the fly develops on her head and thorax a white woolly material, which projects in front of the head and down the sides a little way in a manner similar to that already described for the Silver Fir fly.

When the fly gets blown or knocked off the needle, which, owing to her fragility, must soon happen, the cotton remains as a covering and protection to the eggs.

These eggs would appear to hatch out within a few days after being deposited, and the young grubs crawl down onto the shoots or branches from the needles and feed in the manner already described, their long proboscides being buried in the cambium down through an interstice of the bark (Pl. 23. figs. 2, 3).

The life-history of the insect on the Silver Fir would therefore appear to have been worked out with some completeness, were it not for the fact that during an autumn tour in the Himalaya, made between the end of September and the middle of November 1906, I discovered dead winged individuals of this insect in some numbers on the under surface of the Silver Fir needles towards the end of September and beginning of October. Now these flies could not have occupied this position throughout the heavy monsoon rains in July and August without getting washed off. A simple explanation for this may be that they come from Spruce galls which had not opened before the monsoon broke and which had only matured at this period.

Failing such an explanation, it would appear possible that a generation of the apterous females (EXSULES) may lay eggs towards the beginning of September and that the winged flies had arisen from a portion of these eggs. I could find no eggs upon the trees.

Summary.

We may summarise this portion of the life-history as follows:—

In the early spring egg-masses covered with a woolly material are found on the bark of the main stem and branches of saplings and on the branches of older trees. As the young needles of the Silver Fir unfold from the buds these eggs hatch out and minute grubs crawl up onto the young tender spring needles, insert their proboscides into the tissue of the under surface of the leaf and feed there. In about three weeks, after several (probably usually three) moults, the larger portion of these larvæ mature as apterous female insects, develop the white cottony material, and commence egg-laying. A portion of the spring eggs, however, produce larvæ which, when full-grown, are easily distinguishable from the apterous female larvæ. These larvæ or nymphs, which are to be found much more rarely upon the trees, shed the last larval skin (this being the fourth moult) and a winged insect emerges. These winged insects appear to mostly lay eggs on the Silver Fir needles. It is possible, however, that a certain proportion migrate to the Spruce.

From this first generation of eggs laid about the third week in May new minute larvæ emerge in from 2–3 days and spread out over the Silver Fir needles now grown to some length. They may be often seen thickly studding the needles as minute black specks, looking rather like a fungus attack on the needles.

From these larvæ a second generation of apterous females may be developed in favourable dry hot years. Usually, however, it will be observed that when the young larvæ are about a week old they collect down towards the bases of the needles and feeding here set up an irritation which results in an exudation of turpentine, and also causes the uppermost new needles of the year to curl up in a corkscrew manner, the sticky excretions binding them together into a large twisted "bud." Within the corkscrew "bud" larvæ of two kinds will be found, the normal madder-brown coloured ones and others with a yellowish tinge. The former develop into the apterous females and lay eggs either on the needles below the corkscrew mass or on the stem below it.

The yellowish larvæ leave the corkscrew mass on becoming full-grown, the needles by this time having dried and shrunk apart to some extent, thus permitting the exit of the larvæ. These larvæ or nymphs shed their last skin and emerge as winged insects.

A portion of these winged individuals remain on the Silver Fir, develop a cottony material, and oviposit on the needles or stem of the tree, the egg-masses being covered by the cottony substance. The remainder of the winged generation migrate to the Spruce and are to be found on the needles of that tree. These probably give rise to a sexual generation (SEXUALES) upon this tree.

Thus by the end of June we have on the Silver Fir egg-masses covered by a cottony material laid on the needles or on the bark of the stems of saplings and branches of older trees. The position is therefore much as it was at the end of April.

These eggs hatch out within a week or so, giving rise to tiny blackish-brown insects covered with white cottony bristles and edged with a fringe of white setæ, which crawl onto the stems covered with a first young cortex and bury their long proboscides through crevices into the cambium layer below (Pl. 23. figs. 2, 3). These larvæ are a portion of the COLONICI and remain here through the rains and through the ensuing autumn and winter, eventually laying the eggs of the spring generation.

It would appear possible, however, that some of the Exsules may mature and lay eggs in the early autumn towards the close of the monsoon about the beginning of September, since I have found dead winged flies very commonly with their proboscides fixed on the under side of the needles of Silver Fir at the end of September and beginning of October. These flies could not be those which issue from the pseudo-cones on the Spruce in the middle of July and migrate to the Silver Fir, for such minute fragile things could never pass two months in such an exposed situation as the under surface of a Silver Fir needle during the monsoon season without being blown or washed off.

I can only at present account for the presence of these winged individuals on the Silver Fir at this period by the above supposition, unless the winged insects come from some belated Spruce galls which did not open before the monsoon broke over the hills.

IV. TABLE SUMMARISING THE LIFE HISTORY ON THE SPRUCE AND SILVER FIR.

In the first section of this paper I have given the table from Burdon's paper showing the development of the various generations of the European insect on the Spruce and Larch in the two-year rotation.

Under the individual trees I have given a summary of the generations of the insect passed through on each.

The following (p. 120) is a rough attempt to construct a table for the generations of the Himalayan Insect similar to the one drawn up for the European species on the Spruce and Larch.

	Primary Host: *Picea Morinda* (Spruce).	Intermediate Host: *Abies Webbiana* (Silver Fir).
1st year.	I. Fundatrices. { Hibernate. Cause galls destroying the whole shoot. Wingless. All ♀. II. Alatæ .... { Larvæ inhabit galls. Adults all winged. All ♀. Non-Migrantes. Migrantes.	
2nd year.	I. Fundatrices (as before). V. Sexuales? { Wingless. Cause no gall. ♂ & ♀. V. Sexuales? { Wingless. Cause no gall. ♂ & ♀. II. Alatæ (as before). Non-Migrantes. Migrantes.	III. Colonici. { Hibernate. Cause no gall. Wingless. All ♀. Larvæ live on the needles and cause no gall. IV. Sexuparæ. Adults winged. — Exsules. Adults wingless. Larvæ live on needles at first, subsequently moving down onto upper part of shoot and bases of needles, the latter corkscrewing up tightly, the shoot having the appearance of ending in a large terminal "bud." IV. Sexuparæ. Adults winged. — Exsules. Adults wingless.
	I. Fundatrices. I. Fundatrices.	Colonici? These hibernating larvæ, which are to be found numerously upon the trees during the monsoon months, consist of the Exsules and Migrantes, and form the Colonici generation of the spring on the Silver Fir.

V. Damage committed in the Forest by *Chermes himalayensis*.

The *Chermes* when abundant undoubtedly greatly interfere with and retard the growth of young trees of both Spruce and Silver Fir.

In the case of the Spruce it is a common sight in the Western Himalaya to see young trees loaded with galls, as many as 80 per cent. of the branches bearing at times several pseudo-cones apiece upon them.

The Spruce only produces a few buds in the axils of the leaves, the majority of the axils being without them. All these buds develop in the spring, no reserve stock being available to replace casualties. Thus when a young tree is severely attacked practically the whole of the growth of the year is lost. When this attack is repeated year after year the tree becomes thin and straggly in growth, bears numerous unsightly dry black dead galls upon its branches, has a scraggy appearance, and gradually becomes moribund and dies.

Fig. 1.

Development during the years 1902 to 1904 of a healthy Spruce shoot (*Picea excelsa*, Link), which was laid down in 1901 and bore five buds.

Fig. 2.

Development during the same period of a Spruce shoot with five buds, which was taken from the same tree as fig. 1, but was attacked by *Chermes* in the first two years.

Mr. Burdon in his paper already quoted described an experiment carried out by himself to ascertain the damage done by *Chermes* on the Spruce. He proved that a shoot starting with a crop of five buds galled by the *Chermes* lost the majority in three years. On this he wrote:—

"It has been stated that the damage done by *Chermes* on the Spruce is not of a serious nature, but I think the above facts are sufficient to show that the injury is by no means to be lightly regarded, and any one who compares healthy trees with those which have been galled year after year will at once realize how extensive and far-reaching is the injury caused by *Chermes*."

An illustration such as the above detailed one carried out by Mr. Burdon will appeal most forcibly to the forester, for he can appreciate at a glance the tremendous damage being done to his young growth if much of this sort of thing is taking place amongst it.

I have little doubt that were experiments of this nature carried on over a period of years in, for instance, a Spruce area in Jaunsar, where the *Chermes* is abundant, results of a similar nature to those arrived at by Mr. Burdon at Cambridge would be recorded from the Himalaya. And the damage done by our Himalayan insect is much more severe, since every infested bud, *i. e.* shoot, means the total disappearance of that shoot.

On the Silver Fir, again, the growth of young trees is seriously impeded owing to the peculiar method of feeding of the later generations, or second generation, of the Colonici (the Exsules and Sexuparæ). This results, as we have seen, in a contortion and dwarfing of the upper parts of the new shoots attacked by the insect, the needles on the upper half twisting round one another tightly to form a loose kind of gall-like structure, the needles of which subsequently wither, dry, and open to allow of the exit of the insects. This upper part with its portion of the stem turns yellow and drops of.

An experiment of a similar nature to Mr. Burdon's with the Spruce would be of high interest to ascertain the damage done to young trees by this curling up of the ends of the new growth of the year.

This is not the only damage done to the new year's shoot, as many of the lower needles of the year are attacked by *Chermes* grubs either before they have moved into the corkscrew or by those which remain outside. Each one of these at the point where it pierces the tissue of the leaf and feeds causes the chlorophyll to be destroyed, and the needle becomes bent at the point, the upper portion often drying up and dropping.

I have seen (it is a common sight in parts of the hills) young trees with 90 per cent. of the new shoots corkscrewed up in the above-mentioned manner, whilst the branches below and the main stem showed numerous patches of the cottony egg-masses. The eggs in these cottony masses we have seen hatch out into the young grubs shown in Pl. 23. figs. 2, 3, and these would appear to pass the rest of the year and the winter sucking the sap from the young cortex-covered branches through their long proboscides. I have found these larvæ in thousands upon the branches of young trees in late July, and the drain they must exert upon the young trees cannot but be otherwise than most prejudicial to their growth.

Of course the habit of growth of the Spruce and Silver Fir in mixture in the Himalaya facilitates the increase and distribution of the pest. The insect is certainly responsible to a far greater degree than we foresters in India have realized for the poor state of the young growth of Spruce and Silver Fir in many parts of the Western Himalaya.

In young badly-infested plantations it might be serviceable to snip off the galls from the Spruce *before* the flies issue, since in the case of the Indian insect the whole of the shoot is usually affected in their formation, and thus there is no chance of any further growth being obtained from it.

My acknowledgments are due to my friend Mr. E. R. Burdon for his courteous permission to reproduce the two text-figures on page 121.

EXPLANATION OF THE PLATES.

Plate 20.

Fig. 1. Spruce branches showing three young pink and yellow coloured galls containing larvæ of *Chermes himalayensis.* The dark-coloured gall with the gaping chambers on its surface is a previous year's gall.

2. Section across a partially grown gall on the Spruce, plucked from the tree on May 30th.
3. Young larva taken on May 30th from a chamber in the gall portrayed in fig. 2 (× 15).
4. Larva about three-fourths grown. The first commencement or bulging of the wing-protuberances is seen on either side of the thorax (× 15).

Plate 21.

Fig. 1. Mature galls of *Chermes himalayensis* on Spruce branches. The gall-chambers are just opening to allow of the emergence of the fully grown larvæ. July 15th, 1909.

2. Full-grown larva on emergence from the Spruce gall. The wing-protuberances are seen on the lateral edges of the body (× 15).
3. Section across a mature gall showing the partitions and larvæ in them (× about 3).
4. Portion of a gall showing the chambers opened by the shrinkage in drying and consequent gaping of the lids. The green tips of the needles which project from the centre of the lid are well seen. (× about 2.)
5. Winged insect (Alatæ) shortly after emergence from the last larval skin, showing the still unrolled brightly coloured wings.
6. Winged insect (Alatæ) with wings fully unrolled and functional, from half an hour to an hour after emergence of larva from gall.
7. Winged insect (Alatæ) fully developed, about three hours after emergence of larva from gall. The cottony material has commenced to develop on the head, thorax, and abdomen of the fly.

Plate 22.

Fig. 1. Young spring shoot of the Silver Fir, showing on the needles dead and living apterous females with egg-masses covered over by the white cottony material. May 24th.

2. Full-grown apterous female on a Silver Fir needle just before the development of the cottony material which precedes egg-laying. May 24th.
3. Full-grown apterous female from the spring eggs commencing to secrete the cottony material and to lay the first eggs. May 25th.
4. Full-grown apterous female towards the end of the egg-laying period. May 26th.
5. Egg-mass with cottony material removed to show method of deposition of eggs on the needle. May 26th.
6. Full-grown larva of the winged female from the spring eggs just before moulting its last larval skin. May 24th.
7. Winged female from the spring eggs showing the cottony masses beginning to appear on head, thorax, and abdomen. May 25th.
8. Young, newly hatched larva, from apterous female of the first generation of the year.

N.B.—All the above figures were drawn from living insects *in situ* on Silver Fir needles at Kalatope, Chamba, N.W. Himalaya, by M. E. Stebbing, mostly enlarged.

Plate 23.

Fig. 1. Branch of Silver Fir showing the peculiar corkscrew masses into which the upper portions of the new shoots of the year are twisted by *Chermes himalayensis*. June 24th, 1909.

2. Young grubs on the cortex of young branches of Silver Fir, hatched from the eggs laid by the corkscrew generation of apterous females. July 18th.

3. The same, more highly magnified, showing the enormously long proboscides inserted through a crevice into the cambium layer.

4. Portion of the bark of the main stem of a Silver Fir sapling, showing the cottony egg-masses adhering to the bark as seen in the early spring before the hatching out of the first larvæ of the year.

Trans. Linn. Soc., Ser. 2. Zool. Vol. XI. Pl. 20.

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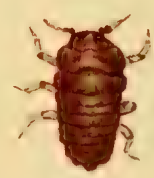

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M. E. Stebbing, pinx.

CHERMES HIMALAYENSIS ON PICEA MORINDA.

Swan Eng. Co., Chromo.

TRANS. LINN. SOC., SER. 2. ZOOL. VOL. XI. PL 21.

M. E. Stebbing, pinx.

CHERMES HIMALAYENSIS ON PICEA MORINDA.

Swan Eng. Co., Chromo.

TRANS. LINN. SOC., SER. 2. ZOOL. VOL. XI. PL. 22.

M. E. Stebbing. pinx.

CHERMES HIMALAYENSIS ON ABIES WEBBIANA.

Swan Eng. Co., Chromo

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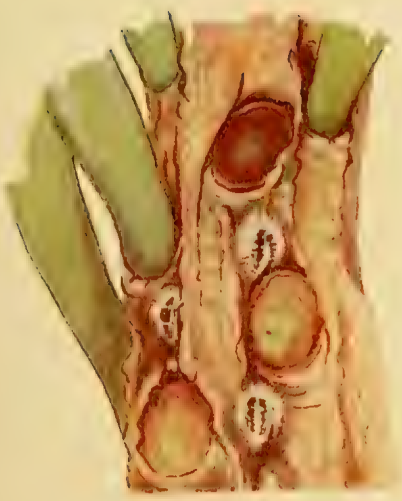

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M. E. Stebbing, pinx.

CHERMES HIMALAYENSIS ON ABIES WEBBIANA.

Swan Eng. Co., Chromo

VII. *Some Points in the Anatomy of the Larva of* Tipula maxima. *A Contribution to our Knowledge of the Respiration and Circulation in Insects. By* JAMES MEIKLE BROWN, *B.Sc., F.L.S.*

(Plates 24–27.)

Read 5th May, 1910.

THE respiration of Insects has always presented features of difficulty. In land forms, with spiracles arranged in series along the sides of the body, a closing apparatus is present which seems to aid in forcing the renewed air into the minute tubules of the tracheal system. The air is probably renewed largely by diffusion. In many aquatic forms, however, there are no open spiracles, but tracheal gills occur, through the walls of which air must diffuse into the ramifying air-tubes contained within the gills. An intermediate type is met with in the so-called "metapneustic" forms, where the air-tubes are open at the posterior end only through one pair of spiracles. One must suppose that greater difficulty will be experienced in these types in renewing the air contained in the smaller branches, and some additional structures might be supposed to be necessary. Further, no closing apparatus (valves) seems to occur within these spiracles, and no regular contractions ("breathing movements") of the body can be distinguished.

It was to study a form of this kind that the examination of the larva of *Tipula* was taken up, in the hope that it might throw some light on the question.

Further, in three such larvæ as those of *T. oleracea*, *T. maxima*, and *T. eluta* we have a progressive series, for the first is terrestrial, the last aquatic, and the second amphibious, and it was hoped that some progressive modification from land to water mode of life might be discovered. This has proved to be the case to some degree.

The most detailed study was made with the larva of *T. maxima*. Specimens of different age were kept alive and observed. Some were traced through their transformations. The structures were worked out, partly by dissections and partly by serial sections. Material was fixed in different ways, but picro-corrosive, and a mixture of picric acid, corrosive sublimate, acetic acid, formol, and alcohol, used hot, gave the best results. Various stains, including iron-hæmatoxylin, Delafield's hæmatoxylin, hæmalum, orange G, fuchsin, and eosin, were tried. Living specimens were injected with carmine to determine, if possible, the function of the pericardial cells.

My best thanks are due to Prof. Denny, M.Sc., for advice throughout the work, and to Mr. T. J. Evans, B.A., for suggestions and help in staining and preparing sections.

The Larva of *Tipula maxima*. (Pl. 24. fig. 1.)

This larva, a form of "leather-jacket," is found beneath stones, either close to or in the bed of streams, at almost all seasons of the year. It is a vegetable feeder, consuming leaves and roots of grass, and also apparently swallowing quantities of soil. It is a sluggish creature, burrowing in the damp earth, and its burrows can be followed for some distance. It pupates about June, in the earth, and emerges during July or August.

The larva, when full-grown, is about $1\frac{1}{2}$ inches in length. It presents the following external features:—

1. The strong chitinous *capsule* ("head") bears the jaws and serves to support the jaw-muscles, but does not contain the "brain."

2. The *trunk* is composed of 11 segments, more or less similar to each other, with the exception of the posterior one. The head-capsule is completely retractile within the first segment. The segments increase in size towards the middle of the body, where they become indistinctly ringed externally into two; but this division does not correspond to internal segmentation, except that the alary muscles of the "diaphragm" are attached to the body-wall at the extremities and also at the middle points of the segments (Pl. 27. fig. 19). The hindmost segment is different from the others, and, besides bearing the anus ventrally, appears to be modified in relation to respiration. No indications of limbs occur on any of the segments.

The *hindmost segment* (Pl. 24. figs. 2, 3, 4, & 5) is obliquely truncated behind. This truncated region, which is surrounded by three pairs of flattened triangular processes, bearing along their margins a fringe of strong hairs (*m.f.*), includes the two spiracles (*sp.*), which appear as dark, broadly-oval spots, lying within a somewhat saucer-shaped depression. By the folding inwards of the processes or lobes the spiracles can be completely enclosed within a cavity, the stiff fringe serving to contain an air-bubble at the same time. This generally occurs when the larva withdraws itself beneath the water. Each of the dorsal lobes bears in addition to the marginal fringe a specially long sensory hair (*s.h.*) at its apex, and three others ($s.h._1$) symmetrically arranged, but of different character from the first one. The structure of the spiracles is described below.

The ventral surface of this segment (Pl. 24. fig. 3) carries the anus (*a.*) in the midst of a raised and somewhat swollen area. This raised area serves also to give origin to four pairs of hollow, unjointed, palp-like processes (Pl. 24. figs. 2, 3, & 4, *b.g.*). Two pairs, one anterior to, and the other lateral to the anus, are long, tube-like structures tapering towards their extremities, freely movable and specially extended when the larva is below water. Two much smaller pairs—in fact, mere pointed outgrowths—occur in positions shown in the figures. From their structure and relations these seem to serve as "blood-gills." They contain each a branch of the tracheal system, and a strong flow of blood is maintained through them. They are not present in the common leather-jacket (*T. oleracea*), which lives in fields, while in the larva of *T. eluta* they are still more prominent, the larva being more completely aquatic.

Respiration.

The respiratory system consists essentially of a pair of large longitudinal tracheal trunks lying dorsal to the pericardial diaphragm (Pl. 27. fig. 19, *tr.l.*), and traversing the body from the posterior segment to about the middle of the first body-segment, where they end blindly in connection with the body-wall, at positions where the respiratory trumpets of the pupa will open. From these longitudinal trunks, branches arise segmentally to supply the body-wall and viscera (see Pl. 27. fig. 19).

The lateral trunks communicate with the exterior through the pair of spiracles on the hind face of the posterior segment.

The *spiracles* themselves are of complicated structure (see Pls. 24 & 25. figs. 4, 6, 7, 8, & 9). Externally they appear as broadly oval dark spots showing in surface view two distinct regions:—

1. A *central area* consisting of an imperforate disc of chitin occupying about one half of the total diameter (*sp.d.*).

2. A *surrounding margin* (*sp.m.*) formed of numerous rods of chitin radiating from the central disc to the circumference of the spiracle, and lying side by side so closely as to leave but very narrow slits between them. These slits appear further to be crossed by numerous transverse connections, giving the whole a lattice-like appearance. Air enters between the radial bars. Seen in sections this marginal lattice-work is formed of three sets of parts:—

1. Passing in a radial direction from the margin of the spiracle to the central disc, but at a lower level than the outer surface (and hence not seen at all in surface view), is a series of hollow chitinous *radial bars* (*r.b.l.*), irregularly oval in section, some bifurcating towards the centre, while others are joined with their neighbours by connecting branches.

2. Arising from these are the series of Y-shaped upstanding *chitinous pillars* (*Y.*), each of the radial bars bearing a complete series.

3. Supported by the upper ends of contiguous Y-pillars is a second series of *radial bars* (*r.b.u.*), slightly flat-topped but wedge-shaped below. These being supported by branches of neighbouring Y-pillars will necessarily alternate with the lower radial bars. Further, these are the bars seen in surface view, the transverse connections being the Y-pillars seen from above.

To complete the structure the Y-pillars are connected together by very numerous and excessively fine chitinous threads (*f.h.*), which branch and intercommunicate, the whole forming a close network.

This spiracle cover appears quite incapable of closing, and the arrangement seems to be a complicated form of filtering apparatus, probably also preventing the entrance of water to the spiracles when submerged.

The spiracles open, not directly into the longitudinal tracheal tubes, but into two "*stigmatic chambers*," which, in turn, lead into the tracheal tubes (Pl. 24. fig. 6, *st.ch.*).

The "stigmatic chambers" are tubular or cylindrical pits, almost circular in transverse section, but expanded ventrally immediately within the spiracle.

In the walls of the pits the following layers can be distinguished (Pl. 25. fig. 10):—

1. The *hypodermis*, consisting of regular block-shaped cells with large nuclei (*hyp.*).

2. The *laminated cuticle* (*cut.*), moderately thick, having the same characters as the external cuticle of the body-wall. From this cuticle there arise large numbers of chitinous *hair-like outgrowths* (*ch.*), projecting into the stigmatic chamber and forming a very dense lining to it. Each hair gives rise to side branches which unite with those of neighbouring hairs, in much the same way as was noticed in the hairs of the Y-pieces of the spiracle cover. This lining covers the whole internal surface of the chamber, except where the bunches of tracheæ arise, and seems to take the place of the tænidia common to tracheæ. [In one of my series of sections these same hair-like outgrowths occurred in a branch tracheal tube in the mid-region of the body, in place of the usual spiral thread.]

At frequent intervals along the length of the stigmatic chambers bunches of clear-walled tubes, without "spiral thread," and enclosed in a nucleated sheath, take origin (Pls. 24 & 25. figs. 6 & 10, *tr.bd.*). These bundles radiate on all sides from the chamber, passing outwards and somewhat forwards, divide into smaller and smaller bundles by the separation of groups of tubes. A short distance from the stigmatic cavity the nucleated sheath ceases, after which large nuclei occur at rather rare intervals amongst the tubes, and most frequently at points where the groups of tubes separate from the main bundle (Pl. 25. figs. 10 & 12). Nearing the body-wall of the posterior segment the groups become separated entirely into individual tubes (without sheath), which in their turn branch until, becoming excessively fine threads, they become attached to the inner surface of the body-wall, where they form an apparently web-like covering. Entangled amongst these fine tubules, corpuscles of the body-cavity fluid ("blood") occur in large numbers (Pl. 25. figs. 13 & 14, *corp.*).

The whole of this region appears to be an exceedingly complex respiratory structure. The blood on its way to the dorsal vessel in this region, which it enters through a posterior orifice—through which the strongest inflow seems to occur,—must necessarily circulate amongst these fine air-tubes, and probably here occurs some of the gaseous exchange.

The two stigmatic chambers are connected together by a loop tracheal tube with tænidia, which branches from the inner side of each pit about halfway forward, and curving ventralwards, meets its fellow in the middle line. From this loop-tube two branches arise, pass ventralwards and forwards to supply the hindmost pair of blood-gills. The anterior and smaller pairs of blood-gills receive their tracheal supply from a ventral branch arising at the anterior end of each stigmatic pit. Hence the whole tracheal supply to this respiratory region arises either directly or indirectly from the stigmatic chambers, where one may suppose the air to be most completely renewed.

The *ventral processes or "blood-gills"* (Pls. 24 & 26. figs. 2, 3, 4, & 18) are hollow tube-like outgrowths of the body-wall. They are divided longitudinally into two channels by a fine membrane-like partition supported by the large air-tube which traverses the structure. The blood flowing backwards along the ventral sinus of the body, circulates through these gills, flowing outwards along one channel and returning along the other, whence it passes dorsalwards to enter the dorsal vessel through its posterior opening. The flow through these gills can be distinctly observed in the young larva, when it is seen to be intermittent, following the pulsation of the dorsal vessel.

Blood-gills are also described by Fr. Müller as occurring in larvæ of Trichoptera as eversible finger-like tubules, into which the blood flows. They do not generally possess a tracheal network, but occasionally very fine tracheal branches enter. Pictet describes them in pupæ of Caddis-flies, and Schiödte in the larva of *Pelobius*. They are present in *Chironomus* and some other larvæ.

Blood-gills differ from tracheal gills found in many aquatic insect-larvæ in the character of the tracheal supply and in the presence of large blood-sinuses. In the case of tracheal gills probably the exchange occurs directly by diffusion from the water to the tracheæ, while in the case of blood-gills the blood itself plays an important part. G. Gilson, in describing the rectal blood-gills of Odonata (Journ. Linn. Soc., Zool. xxv. 1896, pp. 413–418), shows that, besides the blood-supply, these receive also a tracheal supply of peculiar character, and suggests that the fresh supply of oxygen is absorbed from the water through the medium of the protoplasm of the hypodermis of the gill *in* which the tracheæ lie and passed directly to these tracheæ, while the carbonic acid is brought to the gill through the medium of the blood-flow and directly diffused to the outer medium without any intermediate passage through the air-tubes.

In the larva under consideration, the structure of the parts involved also points to the conclusion that both the blood and the tracheal system play important parts in the exchange of gases, and could Gilson's suggestion be proved to be correct, it would throw a flood of light on this difficult question.

The *triangular processes* (Pl. 24. figs. 4 & 5) which enclose the area around the spiracles bear along their free margins rows of stiff flattened hairs, those nearest the apex being larger. When the processes are drawn together, an air-bubble is enclosed and held by the bristle-like arrangement. The closing, however, does not invariably occur when the animal is submerged. The fenestrated arrangement of the covers of the spiracles will prevent the entrance of water into the air-tubes, while the blood-gills probably serve for respiration when the animal is submerged. At the apex of each dorsal process, and within the fringe, a specially long sensory hair takes its origin (Pl. 24. fig. 5, *s.h.*). It is articulated to its base of origin, so that its direction can be varied. Their exact function was not decided. They appear to be sensitive to touch, but on stimulating them the flaps were not invariably retracted. Perhaps they may serve to indicate the necessity for folding the processes on submergence.

Three other *sensory hairs* of different form also occur—one median, between the above-mentioned one and the fringe, and two lateral ones, all within the area of the fringe. They are somewhat shorter than the fringing-hairs and arise from a knob-like articulation (Pl. 24. fig. 5 *a*).

The arrangement of the chief dorsal branches of the tracheal system is shown in Pl. 27. fig. 19.

Reviewing the system in the larva of T. maxima, we notice:—

1. An extensive system of fine air-tubes taking origin from the stigmatic chambers and radiating to the body-wall. Amongst these tubules the blood circulates. It may be suggested that this is an adaptation for bringing the blood into relation with the air near to the spiracles themselves.

2. The presence of blood-gills for respiration when submerged.

In the terrestrial form T. oleracea.—(1) The spiracle structure and disposition of air-tubes agree with the above, the stigmatic chambers being, however, shorter. The same necessity for the arrangement exists here as in the above.

(2) Blood-gills are not developed.

In an undetermined aquatic form, which, however, appears like T. eluta (see Pl. 26. figs. 21 & 22).—1. A pair of spiracles occur on the posterior face of the hind segment, as in *T. maxima*. They also open into a stigmatic chamber leading into the longitudinal air-tubes. There is, however, a difference in construction. The cover of the spiracle consists of a solid conical plug of chitin which fits into the spiracle and projects downwards into the chamber like a stopper, but leaves a comparatively narrow border on all sides. This is supported from the rim of the spiracle by a single narrow circlet of chitinous props, consisting of very short radial bars separated from each other by narrow slits (like the outer radial bars in *T. maxima*). These are supported directly by upright pillars without the intervention of Y-pieces (Pl. 26. fig. 22). Thus we have a very narrow border to the spiracle, through which air can enter. Further, the filtering-hairs, arising from the chitinous lining to the chamber, traverse the distance between the wall and stopper and *unite* the one with the other. Side branch threads occur forming an efficient filter which would prevent the entrance of water. (A very similar structure is described in the larva of *Dicranota bimaculata* by Miall.) *No* bunches of air-tubes pass from this chamber to the body-wall. This part of the system appears therefore simplified. 2. The ventral blood-gills are, however, much more strongly developed, and, as the creature is usually submerged, will play a more important part in respiration.

Circulation.

The *dorsal vessel*, or "heart" (Pl. 27. fig. 19, *h.*), occupies the usual position in the mid-dorsal line of the body. The chambered portion extends from the 4th segment to the 11th (hindmost), and includes eight chambers. Anteriorly it is continued as a narrow uniform tube ("aorta") as far as the cerebral ganglia. The dorsal vessel lies immediately upon, and is organically connected with, the muscular pericardial diaphragm. In certain parts the wall of the heart and the diaphragm cannot be distinguished from each other. The heart is further supported by branches of the tracheal system. The diaphragm (Pl. 27. fig. 19, *d.*) extends from the posterior segment as far forwards as the middle of the fourth. It is supported from the body-wall by the alary muscles, which are attached not only at the junctions between segments but also at the middle of each segment. In the posterior segment the diaphragm turns ventralwards, and serves to cut off the posterior region as a special sinus.

Wall of "heart" (see Pl. 26. figs. 20 *a* & 20 *b*).—Sections of the dorsal vessel show the following layers:—

1. A middle layer of circular striated muscle (*a*). This appears to form a continuous layer throughout the contractile region, though it is generally described as interrupted at intervals.

2. An elastic fibrous layer (*b*) on the outer and inner sides of the muscle-layer. Very large spindle-shaped nuclei (*n.*) occur at intervals in these layers.

3. The surface ("cuticle") of these last layers (*c*) appears to be distinctly differentiated from the inner portions, taking stains more deeply. Owing to contraction of the dorsal vessel these outer layers generally appear raised into irregular ridges. On the outside of the heart, and running in a longitudinal direction, a number of deeply staining fibrils (*f.*) occur. These are branches of the tracheal system, but it is difficult to determine whether they possess any lumen or not; they certainly *appear* to be solid. In transverse sections these longitudinal tracheal threads appear to be supported at the summits of outstanding projections of the outer ("cuticle") layer, giving the appearance of short pegs capped by a slight enlargement and deeply stained. Upon these the pericardial cells (*p.c.*) generally rest, so that they appear to be supported by short props outstanding from the wall of the heart.

Kowalewsky describes the pericardial cells as being attached to the heart by short *muscular* props. They do not, however, appear in this case to be muscular.

The surface view of the wall of the heart shows fine cross-striations running obliquely round the vessel. Two series of striations cross in opposite directions. These striations are not continuous throughout the length of the vessel, but occur interrupted at regular intervals. This, perhaps, has some meaning with reference to the observation made above that the muscle-layer is generally described as interrupted at regular intervals.

The large binucleated pericardial cells (mentioned above, but described in detail below) are irregularly arranged as a loose tissue on the outer surface of the heart, while a few occur also on the inner side (Pl. 26. fig. 20 *b*, *p.c.'*). They generally appear to be more or less in longitudinal rows, and bound together partly by the tracheal threads.

Valves.

1. The *intersegmental* (*interventricular*) *valves* (Pl. 26. fig. 15, *v.i.*) occur as paired lateral thickenings of the inner fibrous layer of the heart, and project inwards and slightly forwards, and are of such size that during the contraction of the vessel they meet in the mid line. In structure each appears to be of fibrous substance—an enlargement of the inner fibrous intima—with a pair of large nuclei at its base, and numerous nucleated cells (which have the appearance of pericardial cells) embedded in or arranged on the surface.

There seem to be no muscles in connection with these valves, and from observation of living animals they appear to work automatically, being forced slightly backwards, and hence closing, during the contraction of the segment immediately in front.

2. The *ostial valves* (Pl. 26. figs. 15, *v.o.*, & 16) occur immediately posterior to the

above. They appear as pocket- or pouch-like expansions of the wall of the heart, a median almost vertical slit (*o.*) occurring in the centre of the pouch. During pulsations these pockets are alternately turned inwards (*i. e.* projecting into the lumen of the heart) when the valves are open, and outwards when the valves close. At the free edges of the slit the outer (cuticle) layer is thickened, but otherwise they possess no special structure. The margins of the pouches are, however, supported by strands from the diaphragm. No special opening or closing muscles could be detected, and their action also appears to be automatic, depending on the movements of the heart-wall and on the external and internal blood-pressure.

The *pericardial diaphragm* is in structure much like the wall of the heart.

It consists of a base of striated muscle in the form of fan-shaped bands, converging to the point of attachment to the lateral body-wall (alary muscles). In the middle line they spread out and serve as supports to the heart, with which they are in places in connection. They further give support to the transparent fibrous membrane, which is overlaid by the loose tissue formed by the "*pericardial cells.*" These are of peculiar form. Their shape is variable, but generally irregular, with outstretching processes by which one cell becomes associated with its neighbours. Many of these processes become long and thread-like. Fine branches of the tracheal system occur amongst the cells in large numbers. Each cell has generally two large and prominent nuclei. Often the cells present the appearance of vacuolization.

The pericardial cells occur (1) on the surfaces of the diaphragm, (2) on the surfaces of the heart.

The *function of the pericardial cells,* which differ in structure absolutely from the fat-body, seems to be, largely at least, excretory.

Animals injected with carmine powder, and left for a period and then fixed, showed the pericardial cells laden with fine granules of carmine. This was seen both in the pericardial cells on the wall of the heart, and in those on the pericardium itself. The presence of numerous tracheal branches also suggests an excretory function *.

The posterior end of heart.—In most insects the dorsal vessel ends blindly, but in this case it is not so. In the hindmost body-segment the heart becomes deeper from the dorsal to the ventral side, and so forms a much enlarged posterior chamber. The hind face of this opens backwards by means of a vertical slit, the edges of the slit folding inwards and acting as a valve. During pulsation an exceptionally strong flow of fluid enters through this opening and plays an important part in "sucking" the blood through the posterior respiratory region of the body.

Pulsations of the Heart.

During pulsation a gradual wave of contraction passes along the dorsal vessel from behind forwards.

* Kowalewsky states that the carmine is absorbed by the leucocytes and passed on by these to the pericardial cells after solution, the pericardial cells themselves being unable to ingest. My preparations did not, however, show the leucocytes containing carmine, but the pericardial cells were everywhere crowded with minute particles, as were the cells of the Malpighian tubes.

Taking any one point of the heart, the pulsation may be said to include four phases:—

(*a*) The *resting position*, during which the heart is expanded to its normal diameter and the blood is streaming rapidly forward. As the pressure from behind increases, or perhaps as the resistance in front increases, the second phase is reached.

(*b*) A *slight expansion* occurs, due to the stretching of the elastic walls by the rapid increase in internal pressure. This is followed at once by

(*c*) A forceful and *sudden contraction*, which drives the contained blood forward, a back flow being prevented by the closing of the intersegmental valves. After a slight pause,

(*d*) finally a recovery *by expansion* to the original position of rest, in which phase (*i. e.* rest) the heart remains for a period equal to about half the total period.

Movements of Ostial Valves.

During the pulsation of the vessel the ostial valves pass through a regular succession of movements.

(*a*) During the resting phase (*a*, above) the valves are open, *i. e.* the pouch is bulged inwards, and blood is entering in a steady stream and joins the forward flow in the heart. They remain in this position until the heart expands (*b*, above), when they suddenly bulge outwards and close. This movement does not appear to be due to muscular movement of the valve, but to be the result of the increase in internal pressure.

During contraction (*c*, above) they are closed, and the blood is flowing forward through the intersegmental valve to the chamber in front.

The moment the heart relaxes and begins to expand (*d*, above) the relief of pressure within causes the ostial pouch once more to suddenly invert, and the valve opens and blood enters and joins the forward flow.

Blood returns posteriorly along the ventral sinus and also along each side of the heart in the pericardial sinus, some entering the heart at the ostia. No signs of any special flow into the pericardial sinus through the diaphragm could be detected.

In the posterior segment of the body the periodic rush and stoppage of the blood is well seen. The movement here appears largely due to the suction exerted by the expansion of the posterior chamber of the heart and the opening of the posterior ostium.

The blood-flow throughout the body is intermittent, and synchronous with the pulsations of the dorsal vessel.

On the average, a pulsation occupies 2·5 seconds, or at the rate of about 24 per minute, the resting phase occupying about half the whole period.

During the pulsations of the heart no regular and corresponding elevation and depression of the diaphragm could be observed, and, at any rate in this larva, I am inclined to believe that its chief function is that of support, and that it plays no part, or very little, in the directive action on the blood-flow.

The blood consists of a colourless fluid containing numerous large corpuscles (Pl. 25. fig. 17), generally somewhat spherical or ovoid, but sometimes more spindle-shaped, and containing a large nucleus. Occasionally they are binucleate, this probably, however, being seen in those in process of division.

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EXPLANATION OF PLATES 24–27.

Contractions used :—

a. Anus.
b.g. Blood-gills.
ch. Chitinous hairs lining the stigmatic chambers.
ch.p. Chitinous plug.
cut. Cuticle.
corp. Blood-corpuscles.
f.h. Filtering-hairs.
hyp. Hypodermis.
m. Muscles.
m.f. Marginal fringe of hairs.
n. Nucleus.
œs. Œsophagus.
o. Ostium of heart.
p. Pericardial diaphragm.
p.c. Pericardial cells.
r.b.l. Lower radial bars.
r.b.u. Upper radial bars.
s.d. Salivary duct.
sp. Spiracle.
sp.d. Central disc of spiracle cover.
sp.m. Marginal border of the same.
st.ch. Stigmatic chamber.
sh. Sheath of tracheal bundle.
s.h. & $s.h._1$. Sensory hairs.
tr. Tracheal tubes.
tr.t. Tracheal tubules.
tr.l. Longitudinal tracheal trunk.
tr.bd. Bundle of tracheal tubules.
v.o. Ostial valve.
v.i. Interventricular valve.
Y. Y-piece.

Note.—Figs. 1–20 refer to *T. maxima.*
Figs. 21 & 22 refer to an undetermined aquatic species, which is very like *T. eluta.*

Fig. 1. Larva of *T. maxima,* from a preserved specimen.
2, 3, & 4. Posterior end of the same, in side view, ventral view, and posterior view respectively.
5 & 5 *a.* Dorsal triangular lobe, with marginal fringe and sensory hairs.
6. Longitudinal vertical section through a spiracle. (Slightly diagrammatic.)
7. Radial section across the spiracle cover.
8. Tangential section across the same.
9. Diagram showing the arrangement of the parts forming the spiracle cover.
10. Portion of a transverse section across the stigmatic chamber.
11. Some of the chitinous hairs more highly magnified.
12. Transverse sections across a bundle of air-tubules. *a,* near the origin ; *b,* more distal.

Fig. 13. Portion of section across the posterior region of the body, showing the tracheal tubules radiating from the bundles and becoming attached to the body-wall.

14. Portion of the above, more highly magnified.

15. Portion of a horizontal longitudinal section of the heart.

16. Portion of the above at the ostium, more highly magnified.

17. Blood-cells.

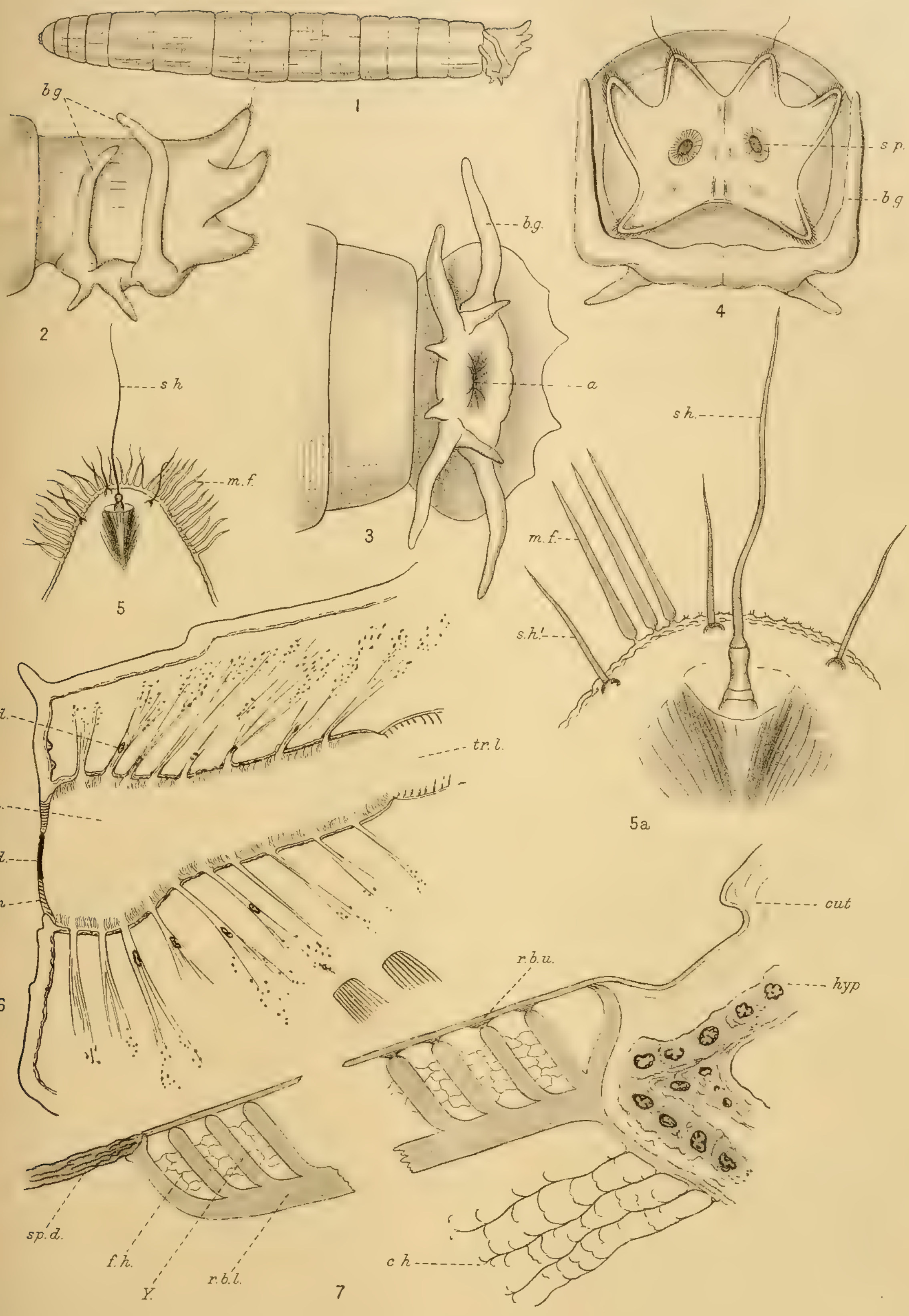
18. Transverse sections across the blood-gills.

19. Dissection of a larva from the dorsal side, showing the distribution of the dorsal tracheal tubes.

20. Sections across the wall of the heart.

21. Median radial section across the spiracle of the aquatic type.

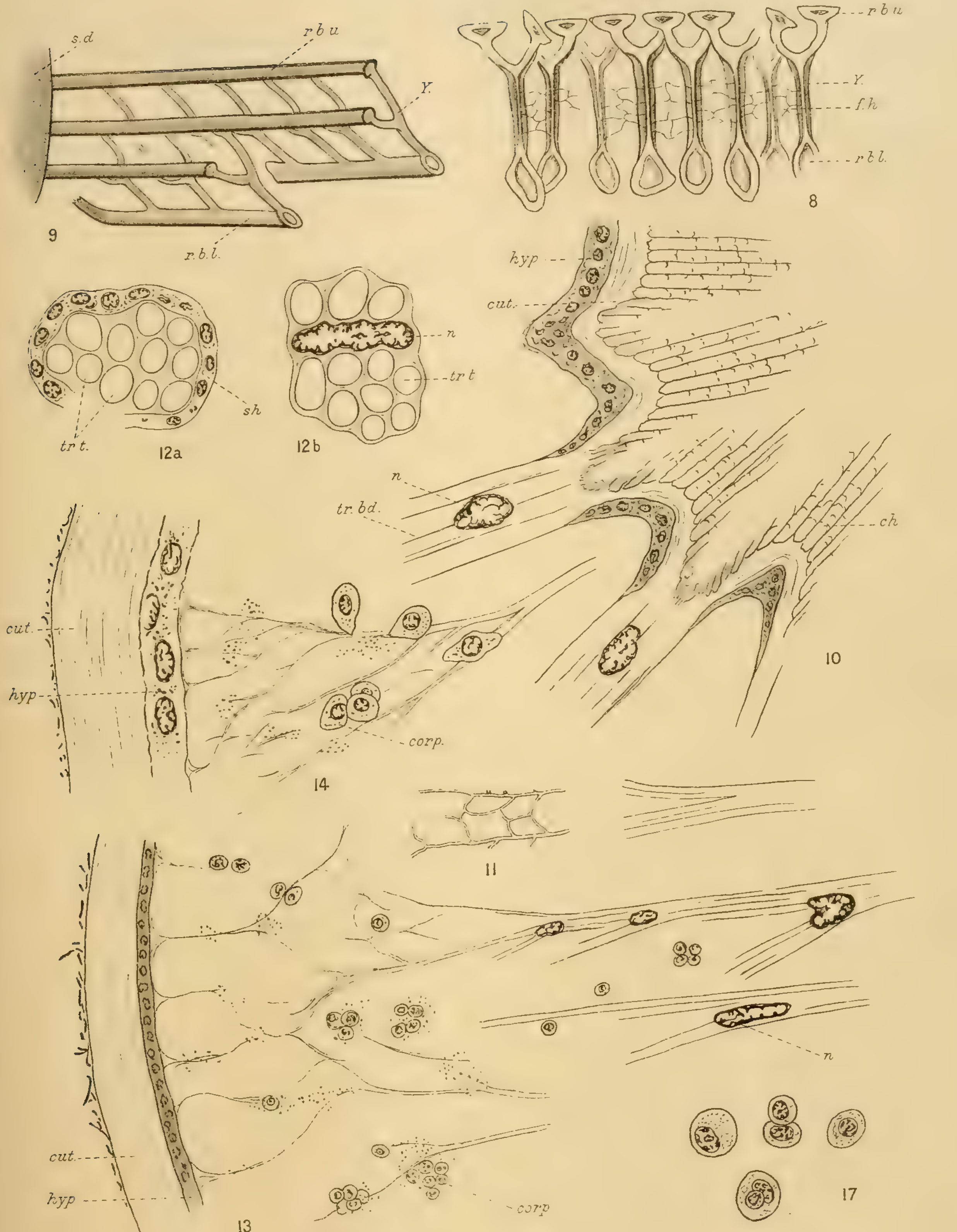
22. Tangential section across the marginal region of the same.



J.M. Brown del.

West, Newman lith.

TIPULA MAXIMA.



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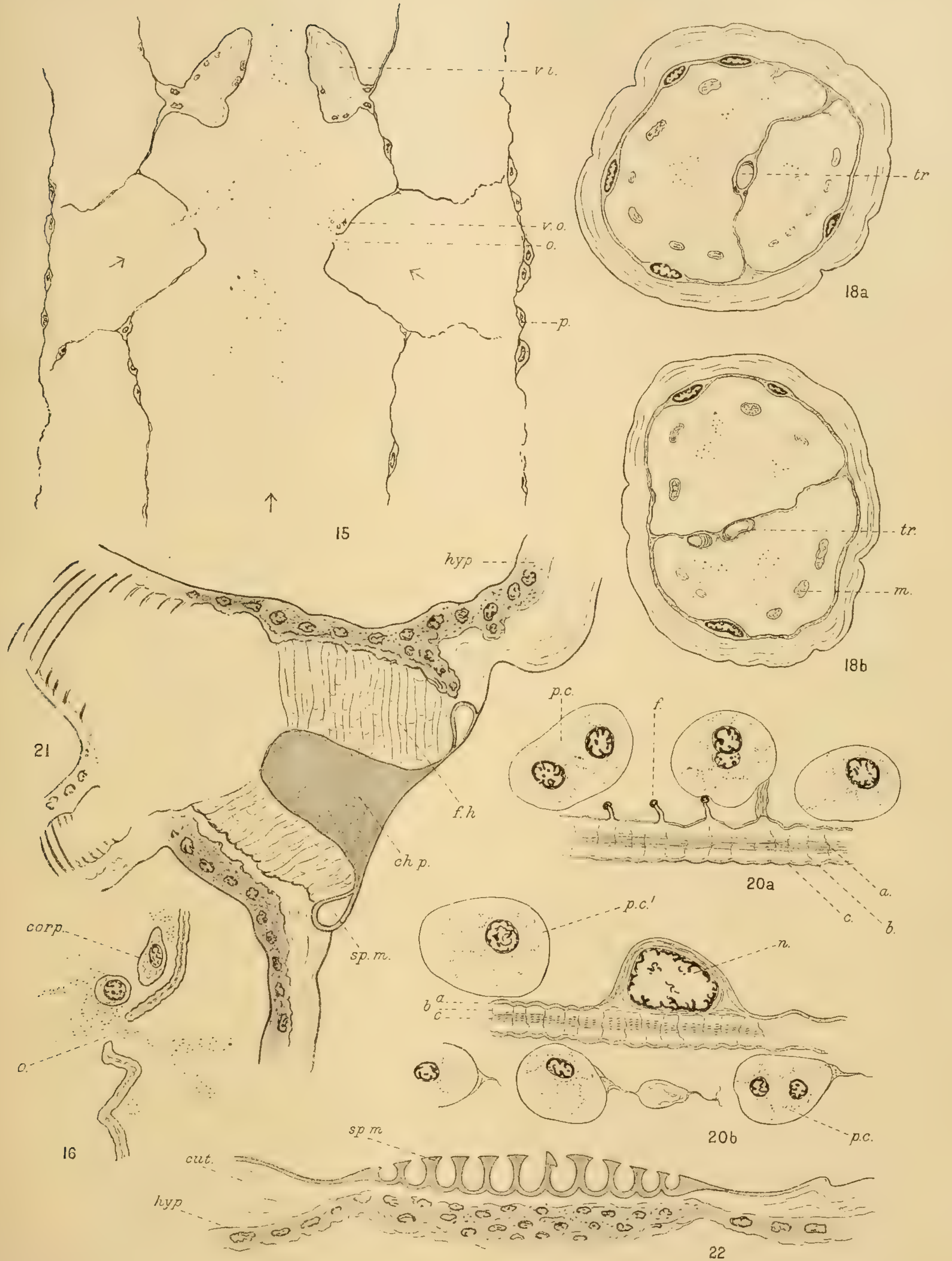

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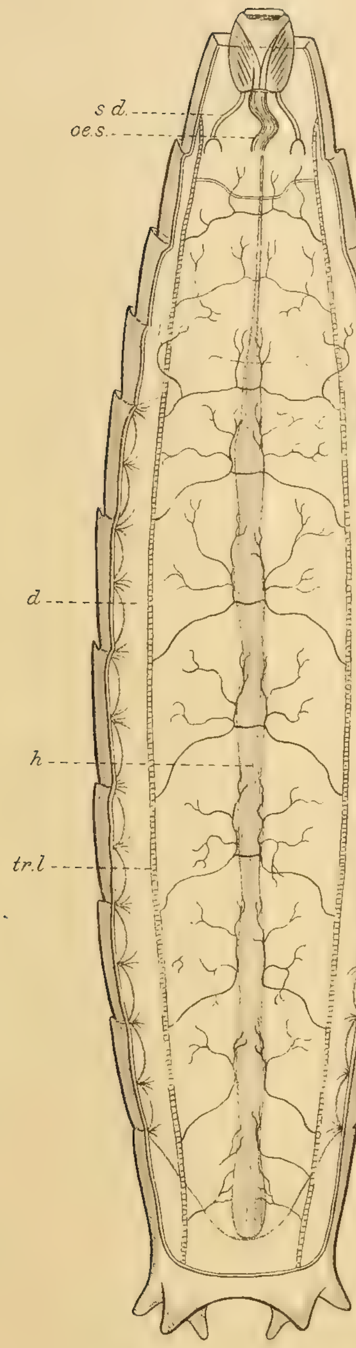

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TIPULA MAXIMA.

VIII. *Three Species of Harpactid Copepoda.*

By Canon A. M. Norman, *M.A., D.C.L., LL.D., F.R.S., F.L.S.*

(Plates 28–30.)

Read 16th February, 1911.

THE following three species of Crustacea were found in 1888, in the Firth of Clyde, when I was with Sir John Murray in his yacht. The *Laophonte* was dredged in Lamlash Bay. *Ancorabolus* and *Arthropsyllus* were found under somewhat peculiar circumstances. It was blowing hard, and we ran for shelter under the north-east corner of the island of Little Cumbrae. The dredge was let down in about 20 fathoms, and came up full of broken and decaying seaweed, among which nothing could be seen. However, I worked a portion through sieves, but there was scarcely any product. Nevertheless, among the very few things were found the two species just mentioned and *Campylaspis costata*, G. O. Sars—all three additions to the British fauna.

The *Ancorabolus* surpasses all known Crustacea in its wonderful ornamental sculpture, with the exception of *Pontostratiotes abyssicola*, G. S. Brady, procured by the 'Challenger' Expedition at the great depth of 2200 fathoms in lat. 37° 29′ S., long. 27° 31′ W. When *Ancorabolus* was found it was almost smothered by fragments of filamentous algæ which clung to it.

The drawings here published were kindly made for me by Mr. Andrew Scott in 1890, but the pressure of various work has compelled me to defer publication.

Genus Laophonte, Philippi.

Laophonte bulbifera, sp. n. (Pl. 28. figs. 1–7.)

Animal with head rather broad, thence tapering gradually backwards to the caudal rami. Head as broad as long; rostrum well produced, obtuse, terminating in two minute cilia. 2nd and 3rd segments of urosome produced outwards and backwards, terminating in a minute spine. Whole animal densely pubescent.

Caudal rami remarkable on account of their bulbous form; they are as broad as long and scarcely equal in length to the preceding segment. Principal seta long, equal to the whole length of the animal; exterior to this is a second long seta, which, together with four small setæ, terminate the ramus.

Anterior antennæ 6-jointed and slender for the genus; their basal joint short, with two small projections on the outer margin; 2nd joint twice as long; 3rd rather shorter than the 2nd; 4th and 5th very short, last joint equal to the two preceding.

Posterior antennæ unusually slender for the genus; outer ramus well developed and slender; inner ramus slender, terminating in four setæ.

2nd maxillipeds with the hand narrow elongated ovate; claw long and very slender.

1st feet having the 2nd basal joint narrow and fully twice as long as broad. Inner ramus is slender throughout, 1st articulation has both margins setose; outer ramus is 2-jointed, the 1st with a single seta on the outer margin and the 2nd with five.

4th feet having inner ramus less than half the outer, scarcely exceeding the 1st joint of the outer in length; its 1st joint has one interior seta and the 2nd carries five setæ.

5th feet having an inner expansion of the 1st joint bearing two setæ, and nearer the attachment another seta. The outer lobe of the basal joint bears the usual seta. The 2nd joint is remarkable, as compared with other species of the genus, for its great length, being six times as long as broad, and is furnished with two setæ at its outer base, three setæ towards the termination, and terminates in a simple seta.

Size ·8 mm.

The specimen here described was dredged in Lamlash Bay, in the Firth of Clyde, in July 1885.

The species is characterized, first, by its 6-jointed antennæ; second, by the outer branch of the 1st feet consisting of only two joints; third, by the peculiar form of the bulbous caudal rami; fourth, by the structure of the 5th feet. This peculiar 5th foot finds its counterpart in *Laophonte elongata*, Boeck, and *Laophonte typhlops*, G. O. Sars.

Family Ancorabolidæ, G. O. Sars.

"Body slender, tapering behind, with no sharply marked boundary between the anterior and posterior divisions. All the segments very sharply defined and, excepting the last 2 or 3, produced to peculiar horn-like projections, either dorsal or lateral, or both dorsal and lateral; cephalic segment somewhat flattened in front, with the antero-lateral corners generally produced; rostral projection of varying shape in the different genera, in some cases wanting. Genital segment imperfectly subdivided in female. Caudal rami long and slender, with one of the apical setæ much elongated. Eye wholly absent. Anterior antennæ with the number of joints much reduced, terminal part (in female) uniarticulate. Posterior antennæ without any trace of an outer ramus. Oral parts poorly developed, but, on the whole, of normal structure. Natatory legs slender and projecting more or less laterally, 2nd basal joint obliquely produced; 1st pair generally differing in structure from the others, but never prehensile. Last pair of legs with the distal joint long and slender, proximal joint generally produced outside to a long narrow process tipped with a slender bristle. A single ovisac present in the female."

The above is Sars's description of the family which he has created. In it he has placed four genera, each of a single species. Of these I was previously acquainted with two—*Ancorabolus* and *Arthropsyllus*. It is this latter genus which in my description of *Ancorabolus* I mentioned as "a second species" of the same genus taken at the same time as *Ancorabolus mirabilis*.

The most remarkable character appears to consist in the form of the feet, which have the second basal joint produced outwards to a considerable extent, so that the attachments of the two branches are a considerable distance apart, and the inner branch is much smaller than the outer. In this respect the family approaches *Laophontodes*, save that the 1st pair of that genus resembles that of *Laophonte*. Moreover, the form of the 1st and 2nd antennæ and of the 5th feet, as well as the transformed branch of the 3rd feet of the male, shows strong resemblances. As Sars remarks, the structure of the 1st feet more nearly resembles that of the genus *Cletodes*, which undoubtedly shows other alliances.

Genus Ancorabolus, Norman.

"Body armed with numerous horn-like, partly branched processes curving backwards, and forming several rows, dorsal, subdorsal, and lateral. Rostral projection well defined, narrow linear. Anterior antennæ in female composed of only 3 joints, in male 5-articulate and distinctly hinged. Posterior antennæ with the distal joint very slender, linear. Mandibular palp small, uniarticulate. Posterior maxillipeds very slender. 1st pair of legs differing conspicuously in structure from the succeeding ones; both rami biarticulate, the inner one being the longer. Inner ramus of the three succeeding pairs much smaller than the outer, but distinctly biarticulate. 1st joint very short, 2nd narrow linear; outer ramus slender, 3-articulate. Inner ramus of 2nd pairs of legs in male slightly transformed. Last pair of legs with a well-defined setiferous expansion inside the proximal joint, wanting, however, in male."

Such are the characters which Sars assigns to the genus as restricted. That author has changed my spelling of *Ancorabolus* to *Anchorabolus*. Why? The generic name is derived from ἄγκυρα and βάλλω (an anchor-caster) and the Latin form is *Ancora* (more rarely *Anchora*).

Ancorabolus mirabilis, Norman. (Pl. 29. figs. 1–9.)

1903. *Ancorabolus mirabilis,* Norman, "Notes on the Nat. Hist. of East Finmark," Ann. & Mag. Nat. Hist. ser. 7, vol. xi. p. 2.

1909. *Anchorabolus mirabilis,* G. O. Sars, Crustacea of Norway, vol. v. Copepoda, Harpacticoida, p. 312, pl. 211.

Rostrum well developed, horizontally directed, cleft at the extremity, bearing one or two pairs of setæ on the sides, situated on little protuberances. Cephalon and four following segments ornamented with a wonderful series of simple furcate, and three-branched large horn-like processes, which are arranged as follows:—The cephalon bears two pairs of backward-directed horn-like processes on the back: the anterior pair are simple, the posterior trifid. The margin of the cephalon bears, first, a simple lancet-shaped spine followed by a larger trifid process, followed by a bifid, and posterior to this a trifid process. These are all of large size. The following four segments have a pair of simple dorsal processes, beneath which are subdorsal processes, which on the three earlier segments are bifid, but on the last of larger size and simple. On the lateral margin are very large falcate processes, curving backwards. The three earlier segments of the urosome are furnished with subdorsal simple and lateral processes. These lateral processes gradually increase in size backwards from the head to the 3rd segment of the urosome, where they are subequal in length to the breadth of the body. All the processes described have the outer margin ciliated. Last segment of urosome is rather more than half the length of the preceding. The caudal rami are very long and slender, equal in length to two and a half preceding segments, bearing on the middle of the outer margin a spinule, and at the extremity four minute spines, and centrally a very long spine, so that the whole length of the ramus is as long as the whole of the rest of the body.

The 1st antennæ are 3-jointed and slender. The 1st joint has at the extremity of the lower margin a small denticulation, and in some specimens there is also a small curved process near the commencement on the outer side of the 2nd joint. *The posterior antennæ* are 2-jointed, devoid of a secondary branch, slender, and 2nd joint longer than the 1st. *Hinder maxillipeds* very slender and long, nearly parallel-sided; nail very long and slender. *The legs* are all remarkable from the 2nd basal joint being produced outwards to a considerable extent, so that the attachment of the inner branch is far removed from that of the outer. *1st pair* has the inner branch twice the length of the outer; its basal joint is without setæ, 2nd joint terminates in three setæ. The outer branch has the 1st joint rather more than half the length of the 2nd, and bears one seta on the outer margin; the 2nd joint has two setæ on the outer side and three terminal. In the *2nd, 3rd,* and *4th pairs* the inner ramus is very much shorter than the outer and terminates in two or three setæ. Its 1st joint is not more than one-third or one-fourth the length of the 2nd. *The 5th pair* has the outer limb very long and linear, more than six times as long as broad, and carries two setæ on the outer margin, one on the inner and two terminal. The simple seta of the exterior margin of the basal joint is of great size. The inner lobe of the basal joint is long and slender, about equal to half of the outer joint; it is furnished with two setæ on the inner margin and two apical.

Length of female ·8 mm.

The male I have not seen. Sars describes it as "smaller than female, and with the anterior antennæ distinctly hinged, 5-articulate, 3rd joint slightly dilated, last joint claw-like. Inner ramus of 2nd pair of legs armed at the tip with a somewhat flexuous claw-like spine in addition to the setæ. Last pair of legs much smaller than in female, one of the setæ wanting on the outer side of distal joint, proximal joint without any expansion inside."

This species was first dredged by me in the Firth of Clyde, in 1888, among a mass of decaying weeds on the east side of Little Cumbrae. In 1890 I again met with it in the Varanger Fiord in East Finmark, and Sars has met with it in several places on the Norwegian coast.

Genus Arthropsyllus, G. O. Sars.

Body flanked each side with a series of acutely produced lappets arising from the lateral parts of all segments except the last two. Cephalic segment with a broadly triangular rostral projection, antero-lateral corners rounded off. Antennules in female 3-jointed, those of male strongly hinged. Antennæ somewhat robust. Legs with

2nd basal joint less produced outwards than in *Ancorabolus*. 1st pair with both rami 2-jointed and subequal in size. Inner ramus of three following pairs well developed, 2-jointed, shorter than the outer. Last pair of legs very similar in character to those of *Ancorabolus*. 2nd pair of legs in male armed at the tip of the inner branch with a curved spine of considerable size.

ARTHROPSYLLUS SERRATUS, G. O. Sars, var. SPINIFERA, Norman. (Pl. 30. figs. 1–14.)

1909. *Arthropsyllus serratus*, G. O. Sars, Crustacea of Norway, vol. v. Copepoda, Harpacticoida, p. 318, pl. 214.

Body depressed; head broadest, thence gradually tapering backwards; segments well marked. Cephalon broad, about as broad as long; rostrum widely rounded and slightly prominent; lateral margins of cephalon slightly notched behind the rostrum, followed by three lateral lobes, of which the middle one is the shortest and the posterior armed with a spine. Segments of the body and first three of the urosome armed with large, falcate, sharply-pointed lateral processes. The body-segments and two earlier segments of the urosome furnished posteriorly with four small spines. The 3rd segment of the urosome bears only two such spines. The last two segments of the urosome subequal, the terminal being rather shorter. Caudal rami subequal in length to three segments of the urosome, bearing two spines on the outer margin, three small terminal, and the long final seta which, together with the rami, equals the length of the entire animal except the head.

Anterior antennæ 3-jointed, moderately stout and long; joints nearly equal, bearing numerous spines.

Posterior antennæ consisting of two equal joints and entirely devoid of a secondary branch; the 1st joint with two setæ on the outer margin, the 2nd with two spines on the inner margin, and terminating with five setæ.

Posterior maxillipeds with the hand elongately ovate, terminal claw unusually long and slender.

1st feet with two branches subequal in length and 2-jointed; inner ramus terminating in two long setæ, outer with one seta on the 1st joint, two on the 2nd, and three at the extremity. *Succeeding feet* with the outer ramus 3-jointed, and the inner is much shorter than the outer, 2-jointed, the 1st joint very short. The setose armature is nearly similar to that of the 1st pair, except that the 2nd joint of the exterior branch carries a long seta on its inner face.

The 5th feet have the outer branch long and narrow, five or six times as long as broad, with two setæ on the outer margin and three terminal, of which the central is much the longest. The basal joint has the interior produced lobe with four setæ, and is about half the length of the terminal joint.

Length ·7 mm.

Male with antennules very stout, 6- or 7-jointed; 3rd joint greatly swollen, terminal strong, nail-like.

2nd foot with the inner branch bearing a strong, curved spine-process and two long setæ.

5th feet of nearly the same structure as those of the female, but very much shorter.

This species was dredged, in company with *Ancorabolus mirabilis*, on the east side of Little Cumbrae, in the Firth of Clyde, in 1888. Sars has found it in the outer part of the Trondhjem Fiord and other places in Norway, and records a specimen taken by Mr. Nordgaard at Repvaag in East Finmark.

In my description of *Ancorabolus* I referred to this form as a second species of that genus. I feel considerable difficulty with respect to the description I have given. In its structural details it seems to agree closely with Sars's species, but in the drawing which I publish it will be seen that the segments are armed with spines. These are not noted by Sars. The drawing was made for me by Mr. A. Scott in 1890, who is extremely accurate. In my specimens now mounted I am unable to see, in consequence of the opacity of the animal, the spines referred to. I thought it was better, therefore, to give it a varietal name, which can hereafter be used as specific if the form should prove to be distinct from that described by Sars.

EXPLANATION OF THE PLATES.

Plate 28.

Fig. 1.	*Laophonte*	*bulbifera,*	sp. n.	
2.	„	„	„	Antennule.
3.	„	„	„	Antenna.
4.	„	„	„	2nd maxilliped.
5.	„	„	„	1st foot.
6.	„	„	„	4th foot.
7.	„	„	„	5th foot.

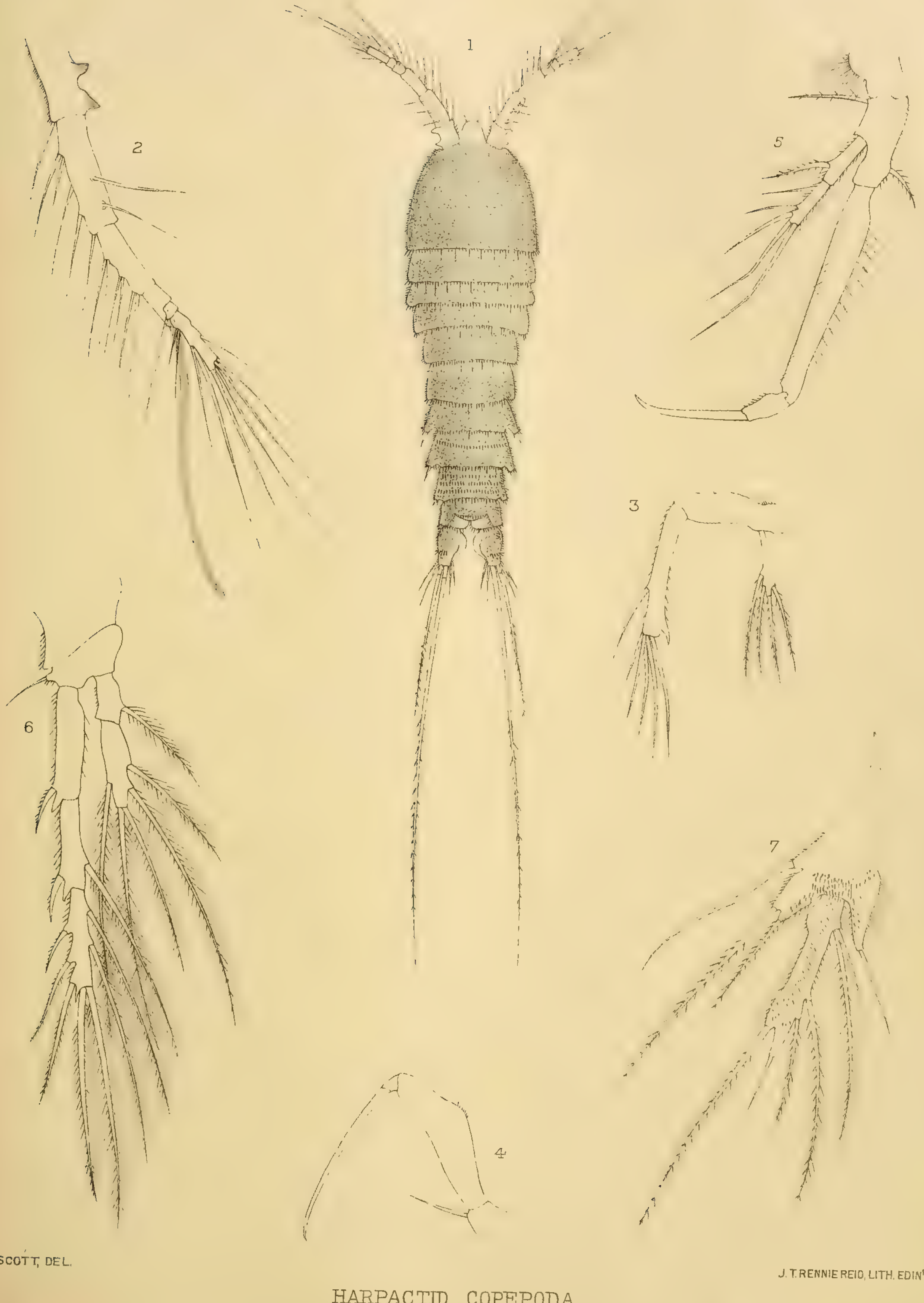
Plate 29.

Fig. 1.	*Ancorabolus*	*mirabilis,*	Norman.	
2.	„	„	„	Antennule.
3.	„	„	„	Rostrum and base of antennule of a variety.
4.	„	„	„	Antenna.
5.	„	„	„	2nd maxilliped.
6.	„	„	„	1st foot.
7.	„	„	„	2nd foot.
8.	„	„	„	3rd foot.
9.	„	„	„	Last foot.

Plate 30.

Fig. 1. *Arthropsyllus serratus*, G. O. Sars, var. *spinifera*, Norman.

2.	,,	,,	,,	,,	Antennule (female).
3.	,,	,,	,,	,,	Antennule (male).
4.	,,	,,	,,	,,	Antenna.
5.	,,	,,	,,	,,	Mandible.
6.	,,	,,	,,	,,	Maxilla.
7.	,,	,,	,,	,,	1st maxilliped.
8.	,,	,,	,,	,,	2nd maxilliped.
9.	,,	,,	,,	,,	1st foot.
10.	,,	,,	,,	,,	2nd foot.
11.	,,	,,	,,	,,	3rd foot (female).
12.	,,	,,	,,	,,	3rd foot (male).
13.	,,	,	,,	,,	5th foot (female).
14.	,,	,,	,,	,,	5th foot (male).



A. SCOTT, DEL.

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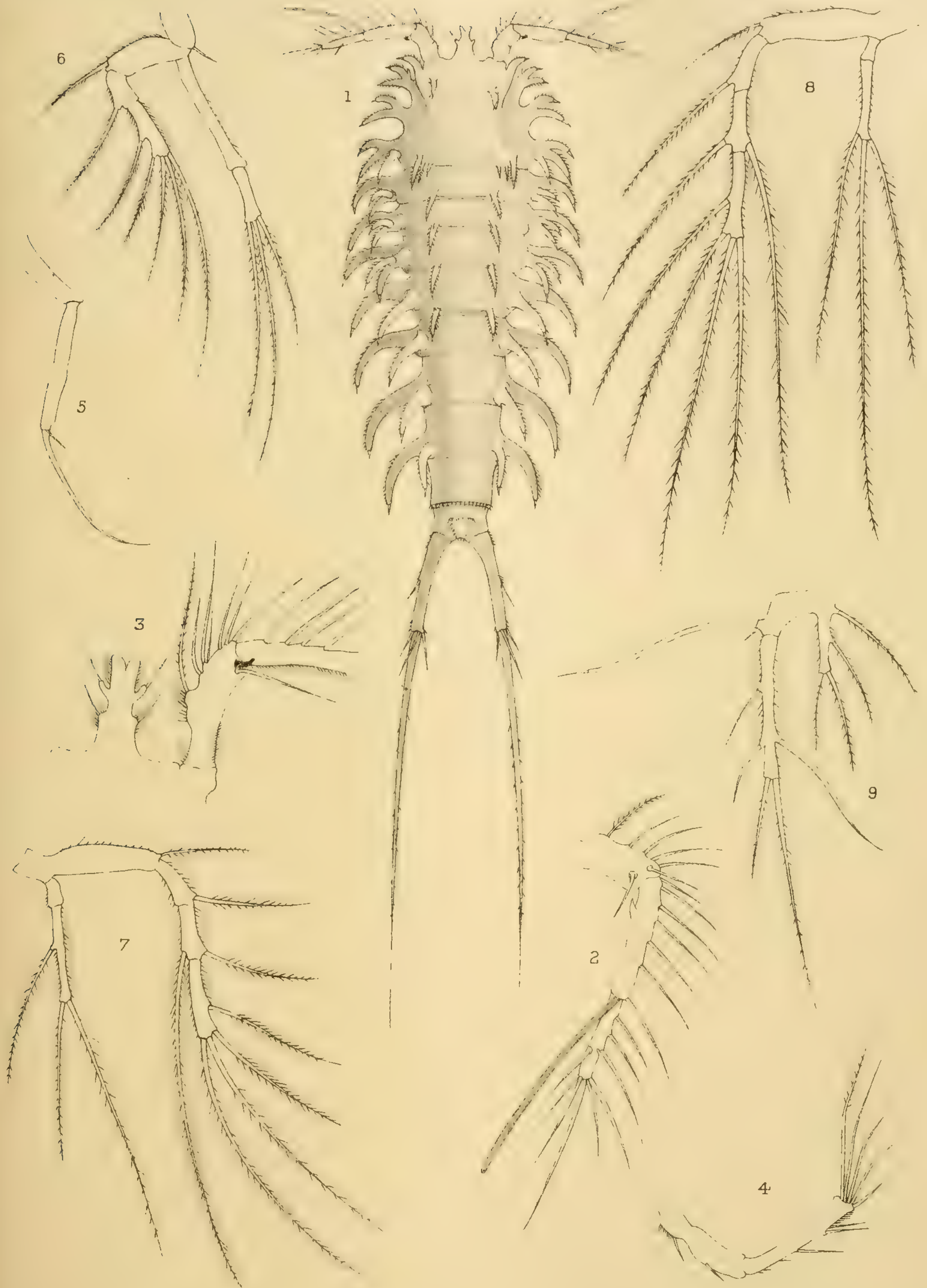
HARPACTID COPEPODA.



A. SCOTT, DEL.

J. T. RENNIE REID, LITH. EDIN^R.

HARPACTID COPEPODA.

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J. T. RENNIE REID, LITH EDIN^R

HARPACTID COPEPODA.

IX. *Dermaptera (Earwigs) preserved in Amber, from Prussia.*

By Malcolm Burr, *M.A., D.Sc., F.L.S., F.Z.S., F.E.S.*

(Plate 31.)

Read 2nd March, 1911.

Through the kindness of the late Dr. Klebs, of Königsberg, who possessed the finest collection in existence of insects in amber, I have had the privilege of examining the earwigs that have been thus preserved. The Director of the Berlin Natural History Museum has also very kindly communicated to me the species in his charge for purposes of comparison and examination.

A good number are immature, having the essential characters feebly developed, but there are mature males of four distinct and well-defined species. These are, on the whole, exceedingly well preserved, but it is very irritating when the important features are obscured by the opaque white material and waviness noted by Mr. Shelford in his paper on the cockroaches in amber (J. Linn. Soc., Zool. xxx. p. 336, 1910).

In all these four species the tarsi have the second segment more or less dilated, and therefore they must be referred to the family Forficulidæ in the strict sense. But some of them have distinct keels along the shoulder of the elytra, a feature which in this family is confined to certain genera of the Ancistrogastrinæ and Opisthocosmiinæ, with which these fossil species have no near relation. In other respects, as the cylindrical branches of the forceps, some of these specimens differ from the typical genus *Forficula*, although one at least cannot be generically separated from *Forficula auricularia*, L.

Properly speaking, therefore, a new genus should be erected for the others, as they fall into no genus at present existing; but I hesitate to base new genera upon such relatively meagre material, and prefer to range them all in *Forficula*, using that name in the comprehensive old-fashioned sense.

When this particular family has been once more revised and reduced to a better system, it may be possible to range these fossil species in genera that may be required for existing forms.

The first feature that strikes the observer of these specimens is their up-to-date appearance. There is nothing archaic or old-fashioned about them, and although I am unable to find in them close relationship with any known forms, there is nothing to suggest that these very creatures may not yet be discovered.

Forficula præcursor, for instance, is very much like some known Oriental and Ethiopian species, while the forceps and pygidium of *F. klebsi* closely resemble those of *Nala figinii*, Burr, from Eritrea. The coloration, so far as can be detected, the general appearance, and especially the keels of the elytra of *F. baltica* and *F. pristina* are very suggestive of the genus *Nala*, but the lobed second tarsal segment at once excludes them from the family Labiduridæ: in *F. baltica* the dilation is very feeble, as may be seen from the figure, but it is enough to forbid the inclusion of the species in the Labiduridæ.

The specimens are all in Baltic amber, which is commonly attributed to the Lower Oligocene age.

FORFICULA BALTICA, sp. n. (Pl. 31. figs. 1–1 *b*.)

Statura mediocri; colore fusco; antennæ 12-segmentatæ, segmento 4 quam 3 dimidio breviori; pronotum quam caput æque latum, subquadratum; elytra et alæ perfecte explicatæ, elytris carinatis; pedes graciles; tarsi pulvillo nullo, segmento 2 cylindrico, primo et tertio æque longis; abdomen cylindricum; segmentum penultimum ventrale ♂ amplum, rotundato-quadratum; pygidium ♂ breve, transversum, media spinula armatum; forcipis bracchia ♂ basi remota, sat valida, cylindrica, sensim arcuata, margine interno medio dente acuti armato; ♀ simplicia, recta.

	♂.	♀.
Long. corporis	7·5 mm.	12 mm. (?)
„ forcipis	1 „	2 „

Size medium, general colour brownish black, very dark.

Antennæ with 12 segments, black; the first rather long and thick; second minute; third long and cylindrical; fourth half as long as third and a little thicker, somewhat thicker at the apex than at the base; fifth about as long as third, cylindrical; sixth and the rest as long as third or a little longer, almost cylindrical.

Head smooth, black.

Pronotum as broad as the head and as long as broad; anterior margin convex. The sides and posterior margin straight, with the angles rounded and covered with short sharp bristles.

Traces of a minute scutellum apparently discernible in one specimen.

Elytra well developed, black, covered with short sharp bristles, well rounded at the shoulders, truncate posteriorly. A sharp keel seems to run from the shoulder to the apex.

Wings well developed, of the same structure and colour as the elytra.

Legs black; femora rather thick, especially the anterior pair.

Tibiæ slender; tarsi slender, first and third segments equally long; second cylindrical, feebly dilated, short, but still longer than broad; ungues typical; no pulvillus discernible.

Abdomen parallel, black, no pliciform tubercles discernible, sparsely covered with dark tubercles and thickly pubescent except on the pale and smooth posterior borders to the segments.

Last dorsal segment (♂) transverse, rectangular, not tubercular.

Pygidium (♂) short and very transverse, with a short point in the middle.

Forceps remote at base, cylindrical, rather strong, rapidly tapering, regularly arcuate, with a sharp tooth near the middle on the inner margin.

Of this species there is a single male in the Simon Collection of the Berlin Museum. It is very well preserved, as may be seen from the figure, and the texture and pubescence may be easily distinguished. The colour is very dark, only relieved by the smooth transverse bands along the posterior margins of the abdominal segments, which are much paler.

The second tarsal segment is but feebly dilated, but possibly the lobe is produced beneath the third sufficiently to warrant its inclusion in the Chelisochinæ, a position which would be justified by its general appearance, which, like the size and type of forceps, recalls that of *Proreus melanocephalus*, Dohrn, an Oriental species with which it might well claim relationship.

It is not possible to be certain as to the existence of the keel of the elytra, but there seems to be one: this feature is rare in the Chelisochinæ and does not occur in *Proreus*.

Forficula klebsi, sp. n. (Pl. 31. figs. 2–6 *b*.)

Statura minore; forcipis bracchia ♂ sat valida, haud dilatata, medio dente acuto armata; pygidium ♂ productum, depressum, apice acuminatum.

	♂.
Long. corporis	8–11 mm.
„ forcipis	3–4 „

Antennæ with 16 segments; the basal one not very thick; second minute; third about as long as the first, cylindrical; fourth about half as long as third, subclavate, the rest gradually lengthening, all subclavate.

Head broad, black; eyes prominent.

Pronotum transverse, a little broader than the head, all margins straight, and angles rounded; very dark brown or black, the sides reddish brown.

Elytra black or deep brown, lighter near the shoulders; costal keel apparent, posterior margin gently sinuate.

Wings prominent, smooth, orange-yellow.

Legs yellowish or blackish; first tarsal segment slender, as long as second and third united; second small, dilated; third short and rather broad.

Abdomen very dark brown or black, slightly broader about the middle than at the apex.

Last dorsal segment simple, transverse, posterior margin truncate.

Pygidium long and rather broad, parallel-sided in basal half, apical half strongly narrowed and acute.

Forceps remote at base, rather stout, apparently rounded, slightly depressed and dilated along the inner margin in the basal half, elongate, feebly curved and gradually attenuate, with a sharp tooth about the middle directly apically, which terminates the very narrow dilated portion.

This species is represented by a pair in the Simon Collection (Berlin Museum) and two males in the Klebs Collection (Nos. 2729 and 4181: the former is the type).

The tarsi are visible in No. 4181, as may be seen in the figure; they are typically forficuline.

In No. 2729 there are a pair of firm globular bodies situated so symmetrically on the second and third abdominal segments that they look like organs, but in No. 4181, which has a similar pair, it is evident that they are not similarly disposed, and in the Simon specimen there are none: I think they are probably Acari preserved in the amber.

The female which I attribute to this species is in a bad state of preservation; but it is interesting to note that it holds a small insect, apparently Dipterous, in its forceps: the dorsal surface is entirely obscured by the cloud of the opaque white substance, and only a profile view is possible; the inside of the creature has been eaten away, leaving the empty shell.

The Simon Collection contains a larva which may be referable here: the second tarsal segment is narrow, but, when seen from the side, lobed, which is suggestive of Chelisochine relationship; the forceps show no trace of segmentation; the antennæ are thick, with seven segments discernible.

Forficula ? pristina, sp. n. (Pl. 31. fig. 7.)

♂. Pygidium foliatum; forcipis bracchia basi remota, haud dilatata, simplicia, arcuata.

	♂.
Long. corporis	10·5 mm.
„ forcipis	2 „

Antennæ apparently as in preceding species.

Head and pronotum —— ?

Elytra very deep greenish black, smooth, apically truncate.

Wings prominent, deep brown.

Legs black, tarsi —— ?

Abdomen parallel-sided.

Pygidium prominent, depressed and broad, dilated, posterior margin gently sinuate.

Forceps with the branches remote at the base, rather stout, rounded, simple, unarmed, gently arcuate.

No. 4171. Type (coll. Klebs).

The tarsi of this unique specimen are unfortunately hidden, but in general appearance and structure it appears related to *F. klebsi* and *F. præcursor*. Strictly speaking, dilated forceps are characteristic of the genus *Forficula*, but I cannot prevail upon myself to erect a new genus for this species, in spite of a strong resemblance to the small species of *Nala*, such as *N. lividipes*. Both the other species above referred to have the same general resemblance, but the strongly dilated second tarsal segment proves them to belong to the true Forficulidæ and not to the Labiduridæ.

Forficula præcursor, sp. n. (Pl. 31. figs. 8, 9.)

Statura mediocri; pygidium breve, apice rotundatum; forcipis bracchia ♂ per tertiam partem basalem intus dilatata ac deplanta, hac parte intus denticulata, dente nullo terminata.

		♂.
Long. corporis	. . . .	8·5–10 mm.
„ forcipis	. . . .	3 „

Antennæ as in *F. klebsi.*

Head broad, the eyes big.

Pronotum about as broad as the head; the anterior margin gently convex in the middle; sides gently, posterior margin strongly, rounded.

Elytra and wings ample, long, parallel, smooth, the former truncate apically; the elytra are black, with a slightly oblique rather broad brown discoidal band; the wings brown, with a black band near the suture.

Legs black; second tarsal segment strongly lobed.

Abdomen slate-coloured, almost parallel-sided; last dorsal segment simple, transverse, truncate.

Pygidium short and rounded.

Forceps with the branches dilated and depressed, the depressed part with inner margin denticulate: the dilated part dies out a little beyond the first third of the total length of the forceps, ending in an obtuse angle, with no tooth; beyond this point, the branches are slenderer and nearly straight, very gently curved at the apex.

Nos. 4182 (type) and 4175, both ♂ ♂.

This species differs from the last in the narrowed pronotum, which is rounded posteriorly, in the rounded pygidium and dilated forceps. The latter are of the typical *Forficula* form, and recall those of the Indian *F. beelzebub*, Burr, and the African *F. senegalensis*, Serv.

Forficula sp. (Pl. 31. fig. 10.)

This specimen is so badly preserved that it is useless to describe it; it has some resemblance to *F. baltica*, but the texture is not discernible.

Forficula sp. (Pl. 31. fig. 11.)

A mutilated female, of which only the ventral view is offered: the tarsi are Forficuline: it may well be a female of *F. klebsi.*

? Labidura sp. (Pl. 31. fig. 12.)

No. 4176.

A small larva, 3·5 mm. long, with simple second tarsal segment; this may be due to immaturity, in which case the specimen may be a larva of one of the species of *Forficula* described. I can detect no trace of segmentation in the forceps, which are perfectly straight.

? PYGIDICRANA sp. (Pl. 31. fig. 13.)

No. 4184.

Another young larva. The body is 3 mm. long and the forceps also 3 mm. long; these are quite straight and hairy, with no visible trace of segmentation: the femora are unusually broad, and the tarsi short and slender, though I think I can detect a slight dilation on one of the second segments. But the whole appearance of the creature is that of a larva of a *Pygidicrana*: the broad femora, especially, are suggestive of the latter, a group which is now confined to the tropics. The four or five antennal segments are, however, long and slender, and not quite short as in that group.

EXPLANATION OF PLATE 31.

Fig. 1. *Forficula baltica*, Burr. ♂. ×6. Type.
1 *a*. ,, ,, Tarsus, magnified.
1 *b*. ,, ,, Tarsus, from beneath, magnified.
2. *Forficula klebsi*, Burr. ♂. ×6. Type. (No. K. 2729.)
3. ,, ,, ,, ♂. ×4. (No. K. 4181.)
4. ,, ,, ,, ♂. ×6.
5. ,, ,, ,, ♀. ×5. Holding a fly between the forceps.
6. ,, ,, ,, (?). Immature. ×16.
6 *a* & *b*. ,, ,, ,, Tarsi.
7. *Forficula ? pristina*, Burr. ♂. ×4. Type. (No. 4171.)
8. *Forficula præcursor*, Burr. ♂. ×4. (No. 4175.)
9. ,, ,, ♂. ×6. Type. (No. 4182.)
10. *Forficula* sp. ♂. ×8.
11. *Forficula* sp. ♂. ×12.
12. ? *Labidura* sp. Immature. ×10. (No. K. 4176.)
13. ? *Pygidicrana* sp. Immature. ×12. (No. K. 4184.)

A. SCOTT, DEL. (WESTWOOD BEQUEST.)

J T RENNIE REID, LITH EDIN^{R}

DERMAPTERA IN AMBER.

X. *Contributions to a Knowledge of the Structure and Biology of some Indian Insects.—* I. *On the Life-history of* Croce filipennis, *Westw.* (*Order* Neuroptera, *Fam.* Hemerobiidæ). *By* A. D. Imms, *B.A., D.Sc., Professor of Biology, Muir College, and Fellow of the University, Allahabad.* (*Communicated by the* Rev. Canon W. W. Fowler, *M.A., D.Sc., F.L.S.*)

(Plate 32.)

Read 15th June, 1911.

Contents.

1. Introductory Remarks.

The Nemopteridæ form a small specialised group of insects usually classified as a subfamily of the Neuropterous family Hemerobiidæ. Only a small number of species have been described up to the present, and their most striking characteristic is seen in the enormously elongated and filiform hind wings, which project for a long distance beyond the apex of the abdomen. Scarcely anything has been recorded concerning either the habits or life-histories of these remarkable insects, and the present paper is offered as a small contribution towards a knowledge of the bionomics of the common Indian species *Croce filipennis*, Westw.

Many years ago Roux * figured a remarkable larva with an immensely long and attenuated neck, and a rounded head bearing a pair of large prominent mandibles. It occurred among accumulated sand in the tombs and pyramids of Egypt, and he regarded it as a fully matured insect, and described it as such under the name of *Necrophilus arenarius*. Westwood †, in 1840, pointed out that it appeared in reality to be the larva of a Neuropterous insect, and suggested that it might possibly belong to the Nemopteridæ. According to Longinos Navas ‡, in his recent monograph of the Nemopteridæ, Schaum §

* Ann. Sci. Nat. t. xxviii. (1833) pl. 7. fig. 3.

† 'Introduction to the Modern Classification of Insects,' vol. ii. p. 55.

‡ Mem. Real Acad. Cien. y Artes de Barcelona, vol. viii. Núm. 18, 1910, p. 344, fig. 2ª.

§ Berliner entomol. Zeitsch. Bd. i. (1857) pp. 1–9, t. 1. figs. 1–1 *d*.

also believed that *Necrophilus arenarius* was a larval form belonging to this subfamily. Sharp * also holds a similar view as regards its affinities. Last year Lefroy † obtained some eggs from a captive female of *Croce filipennis*, which hatched out into small white larvæ, of the same form as that represented in Roux's figure, except without the greatly elongated neck. I am not aware that anything further has been contributed towards a knowledge of the life-history of the Nemopteridæ.

Croce filipennis was originally described by Westwood ‡ under the title of *Nematoptera filipennis* as follows :—

"Nem. luteo-fusca; alis anticis albo-hyalinis; stigmate fusco; posticis longissimis, basi nigricantibus latioribus; apice albo filiformi. Long. corp. lin. $3\frac{1}{2}$. Expans. alar. antic. lin. $11\frac{1}{2}$. Long. alar. postic. 1 unc. 3 lin. Habitat in India orientali. In Mus. D. W. W. Saunders, F.L.S., &c."

In 1847 Westwood § refers to it as *Nemoptera filipennis* and describes it as follows :—

"Nemoptera subfulva antennis fuscis, alis anticis hyalinis stigmate fusco, alis posticis longissimis filiformibus dimidio basali fusco apice albo.

"Nemoptera dull fulvous coloured, antennæ brown, fore wings hyaline iridescent, with a pale brown stigma, hind wings very long, thread-like, the basal half brown, the extremity white.—Expansion of the fore wings nearly 1 inch. Length of the hind wings $1\frac{1}{4}$ inch.

"Inhabits Central India. In the collections of Col. Hearsey and Mr. Hope."

In 1885 M'Lachlan ‖ proposed the new generic name *Croce* for a group of the Nemopteridæ comprising species usually of small size. They are characterised by the front being very strongly produced into a slender beak, by short antennæ (which are usually somewhat thickened towards the apex), by transparent anterior wings with very open neuration and usually with a strongly defined pterostigmatic mark, and especially by long setaceous posterior wings, strongly ciliated, in which even the rudiments of neuration are scarcely to be traced. *Croce filipennis* is taken as the type of the genus.

2. The Distribution and Habits of the Imago.

Croce filipennis appears to be the commonest and most widely distributed species of the Nemopteridæ found in India. Through the courtesy of Dr. N. Annandale I have been able to examine the specimens in the collection of the Indian Museum, Calcutta. It contains three species of the subfamily, and these have been recently reported on by Needham ¶ :—

1. *Croce filipennis* occurs around Calcutta (*N. Annandale*); Katihar in the Purneah District (*C. A. Paiva*); Surat and Igatpuri, Bombay (*Lefroy Collection*); and Allahabad (*A. D. Imms*).

* Cambridge Natural History, vol. v. p. 462.

† 'Indian Insect Life,' Calcutta, 1909, p. 160.

‡ "A Monograph of the Genus *Nematoptera*," Proc. Zool. Soc. Lond. 1841, pp. 9–14.

§ 'Cabinet of Oriental Entomology,' p. 70, pl. 34. fig. 6.

‖ "On the Discovery of a Species of the Neuropterous Family Nemopteridæ, with general considerations regarding the Family," Trans. Ent. Soc. Lond. 1885, pp. 375–379.

¶ Records Ind. Mus. vol. iii. 1909, p. 196.

2. *Nina* (*Croce*) *capillaris*, Klug, is represented in the collection by one specimen from Bushire, Persian Gulf (*W. D. Cumming*) *.

3. *Halter halterata*, Forsk., is represented by a series of specimens from North Baluchistan (*Dr. Maynard*).

In the neighbourhood of Allahabad I have observed *Croce filipennis* during the last three years. It is on the wing from the end of March to the end of April. The earliest date I have observed it was March 28th, and the latest April 24th. From about April 3rd to April 16th it attains its greatest abundance. I have seldom noticed it out of doors; the most usual situation for finding it is in the rooms of bungalows, outhouses, &c., where the larval life is spent. It avoids the sun when flying and is principally crepuscular in habits. It commences to fly about half an hour to one hour before sunset, though in dull corners where there is very little light I have seen it flying at all times of the day, and at night it is sometimes attracted to a light. It is a feeble flier and examples can be caught with ease. They have a habit of three or four individuals flying closely together in a group, occasionally for half an hour or more at a time. They soar up and down after the manner of the Ephemeridæ, and keep to a narrow confined area often for some considerable time. Most likely the habit is concerned with courtship though, in spite of frequent observation, I have not observed the sexes couple. During flight the thread-like hind wings stream behind the body and are kept outstretched so as to make an angle of about 60° with one another. When resting the insect reposes on dark woodwork and other suitable objects, its fore wings are closed over the back after the manner of those of a butterfly, and the hind wings are extended backwards, but at a more acute angle with one another than when flying.

3. The Eggs.

The eggs are oval in shape (Pl. 32. fig. 3) with a smooth and glistening surface. There is a slight variation in the size among different eggs, the length varying from ·50–·55 mm., and the width from ·30–·35 mm. Their colour varies from greyish green to a blue-green, and they are laid singly in nooks and crannies among dust and sand on the floors of neglected rooms and buildings. The particles of sand adhere to the surface of the eggs, and the latter become so efficiently concealed by this means that it is almost impossible to detect them unless the females are confined in a small vessel during oviposition. Captive females laid eggs freely when placed in glass beakers; they were deposited apparently at random on the sides and bottom of the vessel.

The table on p. 154 shows the number of eggs laid by captive females, and the time taken to hatch when kept in a relatively cool room.

The time taken for the larvæ to hatch out thus varies between 10 and 12 days. The young larva escapes from the egg by the separation of an irregular lid-like cap at one end, which remains attached by a portion of the shell.

* Navas has recently described a new species of this genus, *N. meade-waldoi*, from Murree in the Himalayas. *Vide* Zeits. für wissens. Insecktenbiol. Bd. vii. Heft 1, Jan. 1911.

Female.	Number of eggs deposited.	When laid.	When hatched.
A.	38	April 10th	April 21st
B.	25	„ 10th	„ 21st
C.	40	„ 10th	„ 22nd
D.	29	„ 12th	„ 23rd
E.	13	„ 13th	„ 24th
F.	18	„ 15th	„ 26th
Three females.	40–50 between them.	„ 6th	„ 15th

4. The Larva.

A. *The young Larva.*—The young larva when first hatched is white, with brownish mandibles, and the eyes appear as a purplish-black spot on either side of the head (Pl. 32. fig. 2). In thirteen examples the length varied from 1·40–1·77 mm., the average length being 1·5 mm. The breadth across the widest part of the body varied from ·35–·42 mm. For the purposes of description, it will be convenient to divide the larva into three regions, viz.: the head, the neck and the trunk. The *head* is very slightly broader than long, the widest part being the region between the eyes; posteriorly it narrows very considerably. The antero-lateral angles are rounded, and the anterior border of the head is excavated into a moderately deep sinus; the posterior border is curved to form a relatively shallow sinus. The eyes are situated on a rounded protuberance bulging out on each side of the head, and placed just external to the point of insertion of the antenna of its side. They consist of a group of six or seven pigmented ocelli on each side. The antennæ are somewhat longer than the head, measuring ·40–·42 mm. long. They are ten-jointed; the basal joint is shallow and annular, and the second joint stout and wide, the two joints together forming a scape. The flagellum, or remainder of the antenna, consists of elongate basal and terminal joints, both subequal in length, and measuring ·11–·13 mm. long. Between these two joints is an intervening region composed of six small joints of about equal size. The apical joint of the antenna is terminated by setæ possibly of a sensory nature. The mandibles are rather longer than the head; they are curved and acuminate, and each is provided with a row of four teeth along the inside margin of its proximal half. The first tooth is very small (in some specimens it is wanting altogether), the second large, and the two distal teeth are largest of all. The maxillæ (Pl. 32. fig. 4) are highly modified and closely resemble the mandibles in form. In length they equal the mandibles, but they are narrower and are not provided with teeth. They lie immediately ventral to the mandibles and are closely applied to a groove on the under surface of the latter. They are not visible from above, except through the partial transparency of the mandibles. There are no maxillary palpi. The labium is fused up with the ventral region of the head; a pair of prominent labial palpi are present (*l.p.* in fig. 4). The palpi are three-jointed, the terminal joint being the longest. The joints are related to one another in length as 5 : 3 : 11.

The *neck* consists of two segments, and is a little longer, though much narrower, than the head. The first segment carries no appendages, but the second segment bears the first pair of legs, and is consequently to be regarded as the prothorax. The first division of the neck is the shorter and narrower of the two and its diameter lessens posteriorly. The second division of the neck broadens posteriorly and, in addition to its shape and slightly larger size, it differs from the first segment in its antero-lateral angles being more prominently rounded.

The *trunk* is a region of composite nature. It carries the second and third pairs of legs, and consists of the meso- and metathorax imperfectly demarcated from the abdomen. The indications of segmentation are a little indistinct, but the abdomen appears to be composed of ten segments. The legs are long and slender, subequal in length. The coxa and trochanter are short; the femur, tibia, and tarsus are related respectively to one another in length as 10 : 11 : 6. The tarsus is terminated by a pair of slender curved claws.

Over the dorsal surface of the body of the larva are distributed curious cuticular structures, each borne on a small chitinous tubercle with which it is articulated. There are two types of these structures, one of which is small and lanceolate with entire margins, and the other larger and dentate. I propose to distinguish them as the lanceolate and dentate spines (Pl. 32. fig. 5). The lanceolate spines are the less common type of the two, and are found on the outer border of the mandibles and on the legs. Those on the tarsi and the apices of the tibiæ are slightly longer than the spines that occur higher up. The two distal teeth of the mandibles each carry laterally a lanceolate spine, and the two proximal teeth each bear a dentate spine. A number of dentate spines are scattered over the dorsal surface of the head, and a row of five specially prominent spines occurs around the base of each mandible. The first segment of the neck carries a double longitudinal row of dentate spines on each side—a dorsal row of three (or four) spines and a dorso-lateral row of three. The second neck-segment bears a pair of dentate spines on its anterior margin—an antero-lateral pair, and a longitudinal dorsal row of six spines on either side of the middle line. In the trunk-region the dentate spines are principally arranged in transverse rows and are most numerous posteriorly.

B. *The half-grown Larva.*—The half-grown larva differs from the newly hatched larva, not only in its much greater size, but also in the body being much flatter and less convex, in the greater chitinization of the cuticle, in being pigmented, and in the relatively larger size of the trunk-region.

The head is similar in shape to that of the newly hatched larva, but the mandibles differ in having usually nine tooth-like projections along their inner edges instead of four. They are not to be regarded functionally as teeth, for they carry articulated spines, and, moreover, the manner in which the larva seizes its prey by the tips of its jaws, and the fact that it feeds on the juices of its prey by means of suction, precludes the idea of their being regarded as teeth in the ordinary acceptance of the term. It is difficult to conceive what purpose, if any, they may fulfil. They are perhaps to be regarded as enlarged and slightly modified papillæ of the same type as those found on other parts of the body. The dentate spines are larger and much more numerous than in the young larva. In coloration it is similar to that of the full-grown larva to be described below.

C. *The full-grown Larva.*—Examples of the full-grown larva varied in length from 6·8–7·2 mm., with a width of 3·5 mm. across the widest part of the body. The *head* and jaws are yellow-brown, the latter being a little darker at their extremities. The dorsal surface of the head has a granulated appearance produced by the numerous dentate spines scattered over it (Pl. 32. fig. 3). Between the eyes there is a pair of darker brown patches, and on them open a pair of chitinous tunnels which are directed into the head. Each eye-group is placed on a rounded tubercle on either side of the head. The first segment of the *neck* is buff-coloured, the second segment is darker and inclining to brownish towards the base. The *trunk*-region is light brown, darkening towards the mid-dorsal line. The brown coloration is disposed in a series of transverse segmental bands, whose width narrows towards the outer margins of each segment. A median longitudinal streak of buff-colour runs down the whole length of the trunk-region, except in the third segment, where it is crossed by the transverse brown band of that segment. The outer margins of each segment are suffused with buff-colour, and the buff-coloured longitudinal streak is bisected by a narrow brown line extending from the fourth to the seventh segment. The terminal papilla-like apical segment of the body is buff-coloured, and the legs are pale brownish. Ventrally, the head and jaws are of the same colour as exhibited on the dorsal aspect; the first segment of the neck and a large portion of the second segment are buff-coloured, while the rest of the body and legs are light brown.

The table of measurements on p. 157 shows the relative growth of the different regions of the body during three periods in the life-history of the larva,

The Habits of the Larva.—A number of larvæ in all stages of development were reared in captivity, and they fed upon Psocids and very young larvæ of a species of *Dermestes*; they are exclusively carnivorous. The process of feeding was observed under a Zeiss binocular microscope in the case of a larva confined within a small glass vessel for the purpose. The prey is seized by the tips of the mandibles and held there until its juices are completely sucked out by the pumping-action of the pharynx. The maxillæ (Pl. 32. fig. 4) resemble the mandibles very closely in shape and size, and fit into the underside of the latter, which is grooved to receive them. An imperfect channel is thus formed by the mandibles and maxillæ on either side, and the juices of the prey were easily observed to pass down it to the head, and afterwards down the œsophagus in the neck. The neck is very flexible, and consequently the head has considerable latitude in its movements. On one occasion I noticed a Psocid crawl on to the back of a *Croce* larva, and the latter bent its head and neck completely over its back with great ease and seized it. The adaptation of the mandibles and maxillæ to form an imperfect suctorial tube has been previously observed among other subfamilies of the Hemerobiidæ, notably by

	Newly hatched larva.	Half-grown larva.	Full-grown larva.
Length of head including mandibles ..	·52– ·65 mm.	1·07 mm.	1·8 mm.
Length of head without mandibles	·27– ·30 ,,	·50 ,,	·85 ,,
Maximum breadth of head	·30– ·35 ,,	·55 ,,	·95 ,,
Length of first division of neck	·17– ·18 ,,	·37 ,,	·75 ,,
Maximum breadth of do.	·10– ·14 ,,	·17 ,,	·35 ,,
Length of second division of neck	·20– ·22 ,,	·37 ,,	·75 ,,
Maximum breadth of do.	·15– ·20 ,,	·35 ,,	·50 ,,
Length of trunk-region..............	·52– ·77 ,,	1·80 ,,	3·5 ,,
Maximum breadth of do.	·35– ·42 ,,	1·15 ,,	2·5 ,,
Total length of larva................	1·40–1·77 ,,	3·61 ,,	6·8 ,,

Meinert * in the larvæ of *Myrmeleon* and *Hemerobius*. Completely suctorial mandibles have been described by Schiödte † in the larva of the European Coleopterous insect *Gyrinus marinus*, and they have been long known in the larva of *Dytiscus marginalis* from the early observations of Swammerdam ‡ and later by De Geer, and more recently by Miall and by Burgess. *Gyrinus* and *Dytiscus* differ from the larvæ of the Hemerobiidæ in that the maxillæ are not specially modified, nor do they aid in performing any suctorial function ; but the mandibles are perforated by a minute pore close to their apices, and this leads into a channel passing through the centre of each mandible to the mouth.

The larvæ frequent disused or neglected rooms and outhouses, living on the floor among accumulated sand and dust. In such situations Psocids are extremely plentiful, and I believe that they form their principal prey. In their habitat the larvæ are well concealed by a covering of particles of sand and dust. They cover themselves by pushing the posterior end of the abdomen into the latter, and bury themselves until only the head remains visible. They afterwards emerge with a coating of such particles, which are to a large extent kept in position by the numerous dentate spines covering the body. Thus concealed, the larva remains motionless for long periods, until it may dart forward to seize some prey that may wander in its vicinity. It was a matter of great difficulty to discover the larvæ when the habitat was only suspected and not definitely known. The first larvæ were met with in July 1907, and the most advantageous way of detecting them was to examine a quantity of sweepings from the floor of a neglected room

* "Om Mundens Bygning hos Larverne af Myrmeleontiderne, Hemerobierne, og Dytiscerne," Vidensk. Medd. Nat. Foren. 1879, p. 69.

† "De metamorphosi Eleutheratorum, Bidrag til Insekternes Udviklings-historie," Kröyer, Naturh. Tikskr. 1862.

‡ 'Biblia Naturæ,' vol. i. p. 325.

spread over a flat open vessel. If tobacco smoke be puffed over the sweepings, any larvæ present may sooner or later be detected moving about.

The most active period of larval life is during the hot weather and subsequent "rains." At the end of the latter the greater part of growth has taken place. During the Indian cold-weather season they are much less active, seldom move unless disturbed, and only occasionally feed on the Psocids when presented before them. Nearly full-grown larvæ were met with as early as July 25th, eight months further having to elapse before they pupated. On the other hand, a larva measuring only 3·6 mm. long was found as late as March 6th—less than a fortnight before they usually commence spinning the occoon. Possibly in some instances the life-history may occupy a second year. Owing to my absence from Allahabad this larva died and I was unable to determine the accuracy of this suggestion.

5. The Pupa.

Towards the middle of March the larvæ become full-fed and commence to form their cocoons. The latter are nearly spherical in form, and are composed of fine particles of dust or sand loosely bound together by means of silk (Pl. 32. fig. 6). The cocoon resembles its surroundings very closely, and even when found in captivity in vessels containing only a small quantity of sand and dust it is not easy to discover. On opening a cocoon its interior is seen to be white and smooth, being lined with silken threads closely woven together. The average size of the cocoons taken from several specimens is 5 mm. long and 3 mm. across.

The larva after spinning up remains in a resting condition for about fourteen days. It is curved upon itself with the head bent towards the ventral side of the body, becomes whitish in colour, and unless disturbed betrays no signs of movement. By about the tenth day after spinning the cocoon, the trunk-region of the larva became darker in colour and much swollen, the head and neck appeared as dead and empty husks, and, moreover, the animal exhibited no movement. By the thirteenth day the larval cuticle ruptured and the pupal appendages appeared externally.

The pupa measures 3 mm. in length, 1·8 mm. wide across the head, and 2·25 mm. in maximum width. It is markedly flexed towards its ventral surface, and all the imaginal appendages are clearly visible and enclosed in sheaths that are external in position (fig. 7). The sheaths of the fore wings extend backwards to about two-thirds the length of the abdomen. The extremely elongated hind wings are enclosed in sheaths that are coiled on themselves after the manner of a watch-spring (figs. 7 & 8). They cross one another towards their bases, close to the hinder extremity of the abdomen, so that the right wing-case crosses the left one and comes to lie on the left side, while the left wing-case passes over to the right side (fig. 8). By this means they are conveniently stored away in a compact manner so as to occupy a very small space. The head is separated from the thorax by a narrow flexible neck derived from the first segment of the neck in the larva. The labrum and frontal region of the head are but little produced in the pupa, and totally different from the elongate shape they assume in the perfect insect. The maxillæ and their palpi project freely forwards for a long distance in front of the labrum. A pair of pupal or provisional mandibles is present, and when the imago is about to emerge the pupa cuts a small roundish hole in the cocoon by means of these jaws. When the imago emerges it leaves the pupal envelope still partly within the cocoon. One imago was observed soon after it had emerged—the fore wings are fully expanded before the hind wings. The latter at that stage were still partly coiled upon themselves, and only gradually became straightened out. The larvæ were reared in a darkened and fairly cool room, and it was found that the time the insect spends within the cocoon varies from 18 to 22 days. A larva that formed its cocoon on March 15th emerged as a perfect insect on April 6th. Another that spun up on March 20th emerged on April 7th.

Assuming that the imago is on the wing for 10 days before depositing her eggs, the total life-history of the species from the egg to the winged state thus occupies a period of eleven and a half months or a little more.

6. Summary.

Croce filipennis is recorded in India from Bengal, Central India, and the United Provinces. The imago is on the wing for about 14 days during the month of April. It is principally crepuscular in habit, and frequents bungalows and other buildings. Its complete life-history occupies a period of about $11\frac{1}{2}$ months.

The eggs are oval and greenish in colour and measure $\cdot5 \times \cdot3$ mm.; they are laid singly and are concealed with a coating of particles of sand and dust. Six captured females laid from 13–40 eggs apiece, and a period of 10–12 days elapsed before they hatched.

The young larva measures 1·5 mm. long, and is of the same general type common among the Hemerobiidæ and closely resembles that of the Ascelaphidæ. The body is divisible into a head, a "neck"-region of two segments, and a trunk-region of apparently ten segments. The second segment of the "neck" is the prothorax, and the first two segments of the trunk-region represent the meso- and metathorax respectively.

During larval life it is exclusively carnivorous, and was reared upon Psocids and young larvæ of *Dermestes*. It feeds by means of suction, the maxillæ fitting into a groove beneath the mandibles, the two parts together forming a pair of imperfect suctorial tubes. The larva lives among accumulated dust and sand on the floors of buildings. The full-grown larva averages 7 mm. in length, and differs from the young larva in being pigmented, flatter in form, and in the proportionately larger size of the trunk-region.

The pupa is enclosed in a nearly spherical cocoon composed of particles of sand and dust woven together by threads of silk. The insect spends about three weeks within the cocoon, and the pupa is provided with a pair of provisional mandibles for cutting through its wall to allow of the emergence of the perfect insect.

Allahabad, July 1910.

Addendum.—Since these observations were concluded a note has appeared in the Journal Bombay Nat. Hist. Soc. xx. 1910, p. 530, by C. C. Ghosh, on *Croce filipennis*.

The author was able to observe the actual formation of the cocoon, and states that the larva exudes the silk from the hinder extremity of the body. A retractile straight needle-like process is thrown out and taken in alternately, which applies the silk to the particles of sand. A brief description and figures of the larva are given, but no account of the pupa. I am indebted to Mr. T. Bainbrigge Fletcher, of the Agricultural Research Institute, Pusa, for bringing this note to my knowledge.

7. EXPLANATION OF PLATE 32

Fig. 1. The newly-hatched larva of *Croce filipennis* (much enlarged).

Fig. 2. The full-grown larva (much enlarged).

Fig. 3. Outline figure of the egg, with a millimetre on the same scale of magnification.

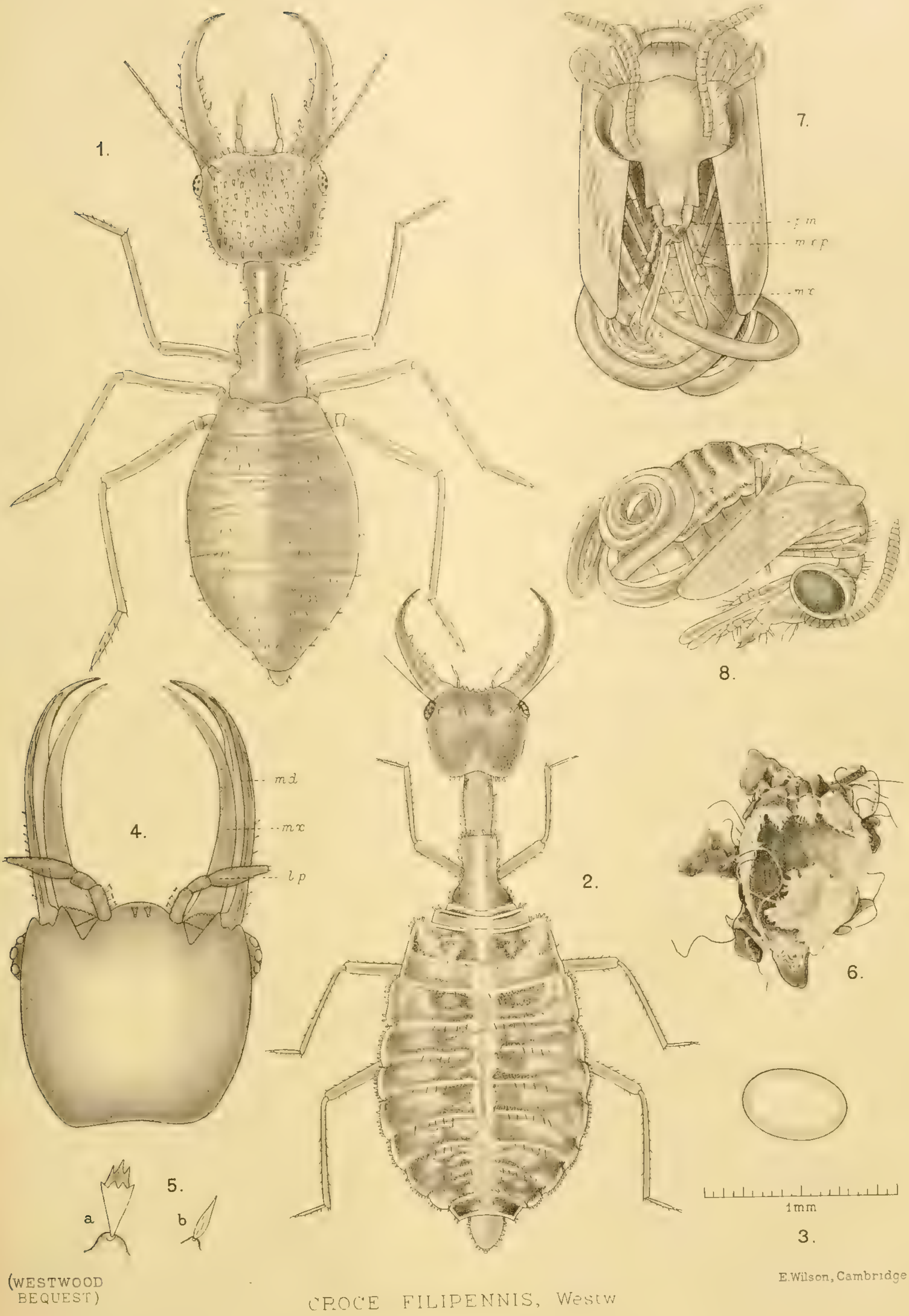
Fig. 4. Figure of the ventral aspect of the head of the newly hatched larva, showing the mouth-parts. The maxillæ have been partially separated from the groove they occupy beneath the mandibles. *md.*, mandible; *mx.*, maxilla; *l.p.*, labial palp. Camera lucida drawing, Leitz obj. 3, oc. 4— × 105. [The antennæ have been omitted from the figure.]

Fig. 5. Cuticular spines from a young larva. *a*, dentate spine; *b*, lanceolate spine. Leitz obj. 6, oc. 4— × 460.

Fig. 6. A cocoon opened to show the internal lining of silk. The cocoon is constructed of waste particles and sweepings from the floor of an empty room. (Enlarged.)

Fig. 7. The pupa viewed from the ventral aspect. *p.m.*, provisional mandibles; *mx.*, maxilla; *mx.p.*, maxillary palp. (Enlarged.)

Fig. 8. The pupa viewed from the right side (enlarged).



(WESTWOOD BEQUEST)

CROCE FILIPENNIS, Westw.

E. Wilson, Cambridge

XI. Synagoga mira, *a Crustacean of the Order Ascothoracica.*

By Canon A. M. Norman, *M.A., D.C.L., LL.D., F.R.S., F.L.S.*

(Plates 33–35.)

Read 20th June, 1912.

Prof. de Lacaze-Duthiers published in 1882 a monograph of a small and remarkable Crustacean which he found off the Algerian coast, parasitic upon a new Antipatharian which he named *Gerardia*. This parasite he called *Laura gerardiæ* *.

This Crustacean was covered by the polypes of *Gerardiæ*, except a very small opening on the dorsal margin. It was contained in a *Cypris*-like sheath formed by two very large valves, which were five or six times the length of the body itself. Lacaze-Duthiers bred the young and assigned the species to the Cirripedia, establishing for it a new group which he styled "*Ascothoracidæ* ou *Rhizothoracidæ*," the former of which names has since been generally adopted.

Since the publication of Lacaze-Duthiers' admirable and exhaustive monograph five more species of the group have been discovered:—

1. I briefly noticed a species, which is the subject of the present paper, in the Report of the British Association 1887 (1888), p. 86.
2. Dr. G. H. Herbert Fowler † described a curious Crustacean parasite which he found in a specimen of the coral *Bathyactis symmetrica* which had been dredged by the 'Challenger' in the Pacific Ocean in lat. 35° 41′ N., long. 157° 42′ E., in the great depth of 2300 fathoms.
3. Mr. N. Knipowitsch ‡ found a species in the White Sea inhabiting the two Echinodermata *Echinaster sarsii* and *Solaster papposus*; this species he named *Dendrogaster astericola*.
4. M. Otto le Roi § has described two additional species of *Dendrogaster*—the one *D. arborescens* from *Dipsacaster sladeni*, Alcock, the Cape; and *D. ludvigi* from *Echinaster fallax*, Müll. & Trosch., the Philippines.

Monsieur A. Gruvel, in his 'Monograph des Cirrhipèdes ou Thécostraces,' 1905, instituted a distinct order *Ascothoracica* to receive these forms and has made each of them a type of a new family—*Synagogidæ*, *Lauridæ*, *Petrarcidæ*, *Dendrogasteridæ*.

* "Histoire de la *Laura gerardiæ*. Type nouveau de Crustacé Parasite, 1882." (Extract of vol. xlii. Mémoires de l'Acad. des Sci.)—Archives Zoologie Expérimentale et Générale, ser. 3, vol. i. Notes et Revue, p. xix.—A. Gruvel, Monog. des Cirrhipèdes ou Thécostraces, 1905, p. 338.

† G. Herbert Fowler, "A remarkable Crustacean Parasite, and its Bearing on the Phylogeny of the Entomostraca," Quart. Journ. Micr. Sci., July 1889.—A. Gruvel, Monog. des Cirrhipèdes ou Thécostraces, 1905, p. 342.

‡ Knipowitsch, N., Biolog. Centralblatt, vol. x., 1890–1891, p. 707; Arch. de Zool. Expérimentale et Générale, ser. 3, vol. i. 1893, Notes et Revue, p. xvii.—A. Gruvel, Monog. des Cirrhipèdes ou Thécostraces, 1905, p. 345.

§ Otto le Roi, "Zwei neue parasitische Cirripedien aus der Gruppe der Ascothoracida," Zoologischen Anzeiger, Bd. xxix. Nr. 12, Sept. 19, 1905.

CIRRIPEDIA.

Order ASCOTHORACICA.

Family SYNAGOGIDÆ, Gruvel.

SYNAGOGA MIRA, Norman.

In 1887, when working at Naples, Signor Lo Bianco brought me some parasites in spirits which he had found on the Actinozoan *Antipathes larix*, Esper. The parasites were external and had all been removed from the host to which they had been attached. These most interesting parasites I briefly described in the British Association Report for 1887 (1888), p. 86, under the name *Synagoja mira.* I purposed to write a full account of this species shortly afterwards, but I delayed doing this in the hope of being able to procure the earlier stages of development, which I had requested Signor Lo Bianco to kindly look out for me; these, however, he was unable to procure. About two years ago, finding that my material was not sufficient to clear up certain points connected with the sexual characters, I wrote to Dr. Giesbrecht to ask him if he could procure for me some further, and fresh, specimens of the species. He has now written me to say that, although he has examined such specimens of *Antipathes* and *Isis* as had come into the Station, he has not been able to meet with *Synagoga.* He tells me that the two genera just mentioned are much scarcer in the Bay than they used to be; he adds that "*Synagoga* has not been found in the Bay of Naples since the time that you described it." It would seem, therefore, that the species must be extremely rare. As long ago as 1890 I had a series of illustrative drawings made for me by Mr. A. Scott; a few additional drawings have been made by Mr. E. Popple.

The *Synagoga* is enclosed in a mantle or sheath in form as the bivalve of *Cypris* or *Estheria.* This enclosing sheath is nearly ovate (Pl. 33. fig. 1), somewhat narrower in front, where it is slightly emarginate above; its measurements when full-grown are 4 mm. in length and 3 mm. in breadth; the external surface is covered with minute triangular spinules which are somewhat larger towards the margins; the eggs are contained in ovaries within the sheath. The animal itself is attached by two very strong bundles of muscles to the upper portion of the sheath, and with this exception enjoys perfect freedom of motion; it is rarely withdrawn wholly within the sheath.

The body consists of a cephalon, furnished with very large and strongly developed antennules (Pl. 33. fig. 2), very prominent buccal mass, and the peculiar organ hereafter to be described. The mesosome or body is composed of six segments bearing six pairs of legs. The metasome or tail is five-jointed, of which the first is the genital segment; this is followed by three segments without appendages, and the fifth which carries distally a pair of serrated spines and two large unjointed rami, which remind one of the same organs in *Nebalia bipes.*

The antennules (Pl. 33. figs. 2 & 3) take the form of grasping-organs of remarkable size and strength, strong muscles also uniting the several joints. The first joint is about equal to the second, or rather longer, and smooth; the second joint is bent at an angle with the first, and has at the base behind a bunch of small cilia, the front is smooth. The third joint is triangular, wider in front than behind, with a bunch of delicate cilia on the proximal half of the front margin. The fourth joint is narrowly triangular, the greatest width is behind; in front it is projected into a small lobe which is furnished with two strong produced spines, the front margins of which are serrated; beyond these large spines are two or three small denticulate processes: this peculiar formation of the fourth joint seems to suit it for uniting with the terminal claw to form a strong grasping-organ. The fifth joint is longer than the combined length of the front margins of the two preceding joints; it tapers gently from the base to the extremity and is fringed throughout the front margin with very large and finely plumose setæ. The sixth joint is subequal in length to the preceding: from near the base of the hind margin there is projected a lobe which is more than equal in length to the breadth of the joint; at its base this lobe gives out a little process which carries a long and peculiar seta and terminates in three long setæ. Moreover, near the distal extremity of the same margin of the joint another articulated lobe is seen, which terminates in three setæ. Beyond this on the side of the joint spring three small setæ. The limb ends in a strongly curved claw denticulated on its inner edge and furnished with a small seta on its side.

The mouth-organs are enclosed in a very large pear-shaped sheath much constricted at the base (Pl. 33. fig. 2 and Pl. 34. figs. 1 & 2), and thence swelling out and then narrowing to the extremity; this sheath bears a bundle of down-like cilia at half its length, and the extremity is drawn out to a spine-like point bordered with a few minute cilia (Pl. 34. fig. 2). Within this sheath are a remarkable series of organs, the structure and arrangement of which will be better understood from study of the illustrations given than from any verbal description; one of the outer pair of mouth-organs is represented in fig. 3. The next pair are shorter and may be seen in fig. 4. The beautiful and complicated structure of the third pair is seen in fig. 5, while the split teeth of its margin are shown in the more enlarged drawing fig. 6. The central organ with its powerful and acute termination and saw-like edge behind is represented in fig. 7. It would appear that there is only one of this central organ, while the other organs are in pairs.

The six pairs of feet are all composed of a two-jointed peduncle and two branches. The outer branch in all cases is composed of two joints; the inner branch of the first and of the sixth pairs is two-jointed, while that branch in the second, third, fourth, and fifth pairs is three-jointed. The first pair (Pl. 35. fig. 1) has the basal joint of the peduncle without setæ, the second joint carries three setæ on the distal portion of the inner face. The inner branch consists of two joints of subequal length, of which the first carries about five setæ on the inner side and the second joint has three terminal setæ; the outer branch has the first joint as long as the whole of the inner branch and is devoid of setæ, the second joint is equal in length to two-thirds of the first and terminates in a dense bunch of setæ. The second feet (Pl. 35. fig. 2) have the peduncle of very much stouter proportions than those of the first feet; the first joint carries one distal external seta and the inner margins of both joints are densely setose, the inner branch has three joints nearly subequal to each other in length and are densely setose on the inner margins and the apex, the outer two-jointed branch has the first joint equal in length to the first two joints of the inner branch; the second joint is fully twice as long as the terminal joint of the inner and is setose both on the inner and outer margins; the third, fourth, and fifth feet are of very similar structure to the second just described. The sixth pair (Pl. 35. fig. 3) has the first joint of the peduncle long and comparatively narrow; there are no conspicuous setæ either on that or the following joint. Both rami are two-jointed and furnished with long setæ, especially on their inner margins.

The last joint of the metasome (Pl. 35. fig. 7) carries two spines, which are considerably longer than the breadth of the segment from which they spring; these spines have the margins serrated. Besides these spines the body terminates in two one-jointed uropods (Pl. 33. fig. 6); these uropods are more than twice as long as the preceding segment, on the outer margins they carry two plumose setæ and two terminal, while their inner margins are densely clothed with similar setæ; the outer margins of these rami are dentate from the base to the origin of the first external seta. With respect to the organs of generation, I am not able to describe them satisfactorily, and it was chiefly with a view of examining them more fully that I desired to procure fresh specimens of *Synagoga*. Posteriorly to the sixth pair of feet on the first segment of the metasome a peculiar organ is found which appears to be that of the male. At half its distance from the base a portion bends downwards and terminates in a conical point which appears to be the penis; beyond this point the limb arches and is gradually attenuated. Pl. 35. fig. 4 represents this appendage as seen from side. Fig. 5 (which is, however, partly diagrammatic) gives the appearance as seen from below. We find other specimens in which the first segment of the metasome is more produced downwards than the last segment of the mesosome (Pl. 35. fig. 6), and this produced segment is crenulated at the extremity and on the front margin; this would appear to represent the vulva of the female, and thus it would seem that the two sexes are separate.

Behind the antennæ there is an organ which occupies the place of what Lacaze-Duthiers calls in *Laura* the first feet: the organ here can scarcely be regarded as a foot, inasmuch as behind it we have six pairs of distinct feet, nor does it present the appearance of a foot; nevertheless it would seem to discharge part of the functions of the first foot in *Laura*, inasmuch as I take the papilla to be the orifice of the oviduct which brings the ova from the ovary, situated beneath the mantle. Of this organ there are given three illustrations (Pl. 34. figs. 8, 9, 10), but for the differences between them I am unable to account.

Pl. 33. fig. 5 represents a tubule containing ova from beneath the mantle. Fig. 4 represents a portion of the margin of the mantle and shows the more fully developed ova within.

The several genera of the order Ascothoracica differ in development of the various organs, and these changes have, doubtless, been brought about by the more or less distinctly parasitic mode of life of each species. The *Petrarca bathyactidis* of Fowler inhabits the Actinozoan *Bathyactis symmetrica*, and lives in the mesenterial chambers of its host. Active powers of locomotion would be useless, and the limbs and tail are merely represented by lobes of the body. The antennæ are an exception, ending in two nails and a spine. Yet we find strong resemblances in the enclosing mantle, form of the buccal cone, and general structure to the other genera.

In the *Dendrogaster astericola* of Knipowitsch we again have an internal parasite within the body of the Echinoderms *Echinaster sarsii* and *Solaster papposus*. What the author draws as figure of the "*Larve au stade* Cypris" so closely accords in general structure with *Laura* and *Synagoga* that it seems impossible to regard it as an immature form.

Laura gerardiæ of Lacaze-Duthiers, the most fully described species, has its body covered over by the *Gerardia*, so that it is protected in a great measure from outside interference, and it is contained in such a gigantic test that were it free it seems impossible that it could lift so large a mass; moreover, its limbs are free from swimming-setæ.

Synagoga mira is less protected than the preceding genera; it lives externally upon the *Antipathes*, and instead of being covered by the host it simply clings to it by its massive antennæ and would seem to have the power of relaxing its hold and swimming off to attach itself to another part of the host. Its bifid feet are largely furnished with setæ, which would enable it to swim easily.

As compared with *Laura*, *Synagoga* shows the following points of difference:—In *Laura* the mantle which enwraps the body is of a prodigious size, in *Synagoga* it is only large enough just to cover the body. In *Laura* the antennæ are small and insignificant; in *Synagoga* they are very large and strong, and the mouth-organs are much more highly and elaborately developed. In *Laura* Duthiers finds a very small organ which he styles "antennules ou tubercules sous-céphaliques"; of these I have not been able to find any trace in *Synagoga*. *Laura* has only six pairs of unbranched feet, of which the first pair contains the female organ in its upper portion and also discharges the matured ova; the four following feet have at their bases the organs of the male, and thus the animal is an hermaphrodite. The feet, being without setose adornment, are unfitted for swimming. *Synagoga* bears the peculiar organ (Pl. 34. figs. 8–10) which would seem to discharge at least some of the functions of the first feet of *Laura*; behind this are six pairs of bifid feet, which are densely setose, and behind these there are appendages of the first segment of the metasome, which, differing in character in different specimens, are regarded as the distinctive organs of two separate sexes. Lastly, *Synagoga* has the terminal rami much more fully developed, and, moreover, carries two large spines on the last segment of the metasome above the well-developed rami.

EXPLANATION OF THE PLATES.

Plate 33.

Fig. 1. Entire animal of *Synagoga mira* with its shell, female.

2. „ „ „ „ with shell removed, showing the bases of the large muscles which attach the animal to the shell.
3. The antennule.
4. Portion of margin of shell showing structure and ova within.
5. Portion of ovaries in tubule removed from the shell.
6. Uropods from below showing telsonic spines at the base, but their upper portion and attachment hidden by the uropods.

Plate 34.

Fig. 1. Mouth-organs in the form of a cone as seen naturally in the enclosing sheath.

2. The same under pressure to exhibit the various portions of the mouth-organs.
3. The uppermost pair of these organs.
4. Second pair.
5. The third pair.
6. Portion of the teeth of the third pair to show they are divided.
7. The central organ. Whereas the other members of the mouth are in pairs, there is only one central organ.

8, 9, 10. Three different illustrations of the peculiar organ situated behind the antennæ, showing the papilla which is supposed to represent the orifice of the oviduct.

Plate 35.

Fig. 1. Foot of first pair

2. Foot of second pair.
3. Foot of sixth pair.
4. Penis seen from the side as attached to a first segment of the metasome.
5. The same as seen from below, partly diagrammatic.
6. The last segment of the mesosome and the first of the metasome; this last supposed to represent the generative segment of the female.
7. Spines attached to telson.

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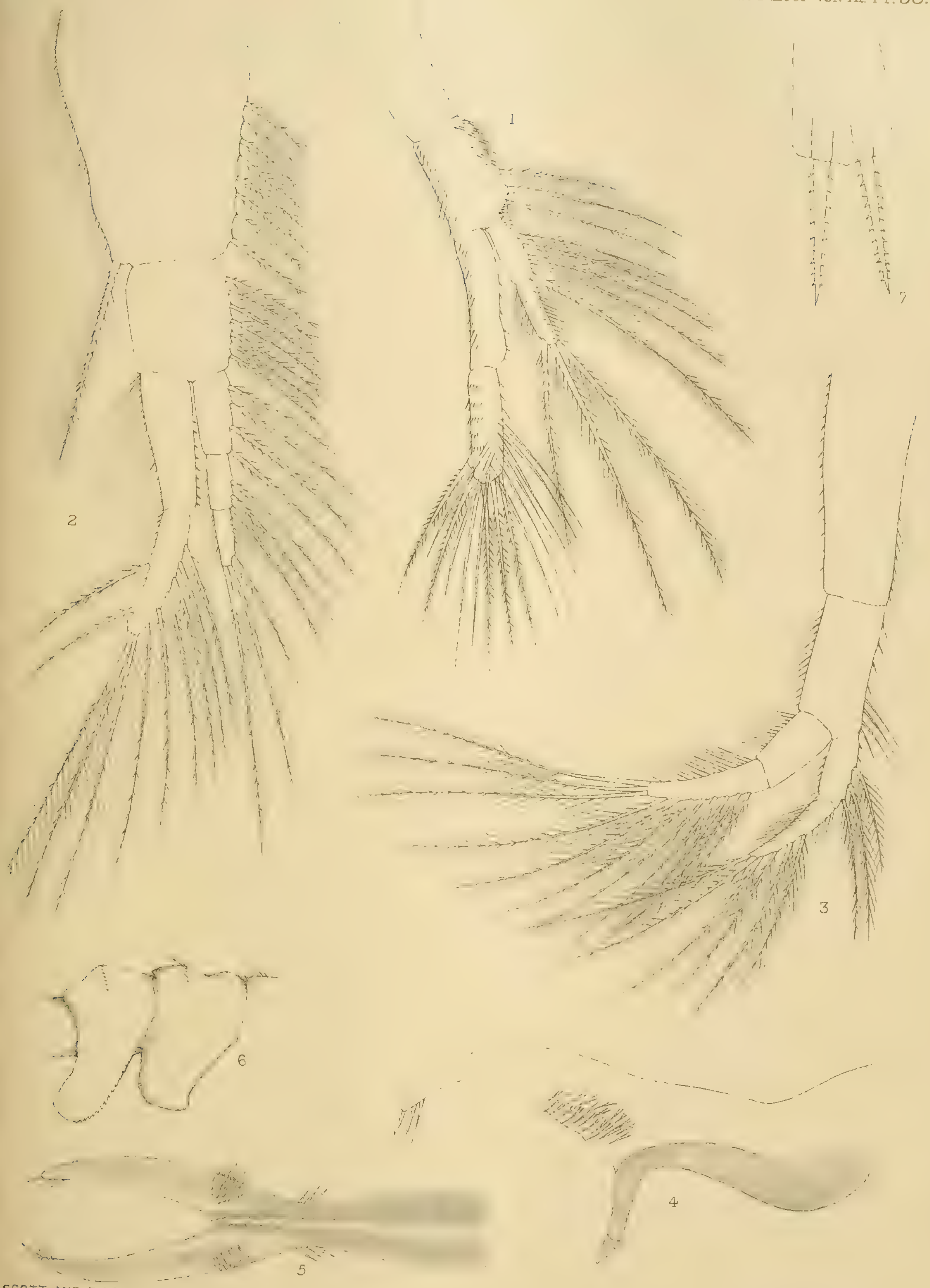

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SYNAGOGA MIRA.

XII. *Contributions to a Knowledge of the Structure and Biology of some Indian Insects.*—II. *On* Embia major, *sp. nov., from the Himalayas. By* A. D. Imms, *B.A., D.Sc., F.L.S., Forest Zoologist to the Government of India and Fellow of the University of Allahabad.*

(Plates 36–38 and 6 Text-figures.)

Read 3rd April, 1913.

Contents.

1. Introductory Remarks.

The Embiidæ form a small and well-defined group of Insects of very wide distribution. In their range they are almost cosmopolitan, being absent only from the polar and cooler temperate regions of the earth. They exhibit a remarkable simplicity and uniformity of structure which are partly due to primitive features in their organization, and to the fact that certain other characters have been probably secondarily acquired through degeneration. They further exhibit in almost all of the species very marked sexual dimorphism. It has long been known that the individuals of both sexes have the faculty of secreting silk, with which they manufacture the tunnels constituting their nests. That the Embiidæ are an ancient group, and now long past the zenith of their prime is probable. In this respect they are worthy of comparison with *Peripatus* and *Anaspides* among other Arthropods.

The described species of Embiidæ are about sixty in number, the exact figure depending upon the validity of certain specific names. So far as I have been able to ascertain, forty-two of these species have been based upon an acquaintance with one sex only, thirty-nine being founded on male examples and three on female. From this it is evident that in only 18 species, or 30 per cent. of the total number of known species, have both sexes been described. Among the Embiidæ in particular, unless both sexes happen to be taken in association with one another, it becomes a matter of great difficulty afterwards to correlate a particular male with any particular female. Owing to this cause, and also to the fact that both immature and mature winged examples are frequently taken, a good deal of uncertainty exists at present with regard to several species. The unsuspected discovery that, in at least four species, the males are dimorphic, further complicates matters. As additional species become known, these difficulties are liable to result in the synonymy of the Embiidæ becoming complexly involved. It is therefore imperative, in my opinion, that entomologists should refrain as far as possible from describing new species of Embiidæ based upon one sex only.

In the case of the males, the best and most constant characters are those afforded by the structure of the two terminal segments of the abdomen. The gratitude of all students of the Embiidæ is due to Enderlein, who is the first investigator to attempt systematically to study this region of the body. His recent monograph (1912) for this reason makes a most important advance in our knowledge of the group.

Hitherto only four species of Embiidæ have been recorded from India, and all pertaining to the genus *Oligotoma*, Westw., viz.:—

O. latreillii, Rambur, Hist. Nat. Neurop. 1842, p. 312. Bombay.
O. michaeli, MacLachlan, Journ. Linn. Soc. Lond., Zool. vol. xiii. (1877) p. 383, pl. 21. figs. 1–3. Umballa and Calcutta.
O. bramina, Saussure, Mitt. Schweiz. Ent. Ges. ix. (1896) p. 352. Bombay.
O. saundersi, Westwood, Trans. Linn. Soc. Lond. vol. xvii. (1837) p. 373, pl. 2. figs. 2, 2 *a–f*. Jubbulpore, Calcutta, and Pusa.

Whether these four names represent four separate and distinct species is extremely doubtful. Enderlein (1912) regards *O. bramina* as being a synonym of *O. michaeli*, while Krauss (1911) in his "Monographie der Embien" considers them to be two species. On the other hand, Krauss regards *O. latreillii* as being a synonym of *O. saundersi*.

Embia major is remarkable in being by far the largest species of Embiidæ yet discovered.

The genus *Embia*, Latr., furthermore, has not previously been known to occur in any part of the Oriental zoo-geographical region. In the bordering countries of the Palæarctic region three species of the genus, however, are known to occur, viz.:—

E. persica, MacLachlan, Journ. Linn. Soc. Lond., Zool. vol. xiii. (1877) p. 382. North Persia.
E. mauritanica, Lucas, Explor. Sci. Algérie, vol. iii. Neur., 1849, pp. 111–114, figs. 2 *a*–2 *n*. Syria. (Also recorded from Algeria, the Canary Isles, and British East Africa.)
E. tartara, Saussure, Mitt. Schweiz. Ent. Ges. ix. (1896) p. 352. Turkestan.

In July 1909 I had the good fortune to meet with two large male Embiids belonging to the species herein described for the first time. They occurred among herbage growing along the sides of a rivulet, at an altitude of 4600 feet, in the Naini Tal district, in the Himalayan foot-hills of Kumaon. Since that time, I have visited various parts of the same district at different times of the year, and have been successful in also procuring the female, the eggs, and the silken nests of the insect in comparative abundance. I was thus enabled to make a more extended series of observations on the habits and post-embryonic development of a single species of Embiidæ, than has fallen to the fortune of previous students of the group.

2. Description of the Male.

Deep brown-black, clothed with dark brown or almost black hairs. The antennæ 20–29-jointed, a little shorter than the combined length of the head and thorax. The head, thorax, and abdomen mutually related in length in the proportion of 3 : 5 : 8. The first joint of the hind tarsi with two arolia. The 10th tergum completely divided into a pair of plates, the right being considerably larger than the left. The left plate produced into a stout curved process; the process of the right plate only represented by a minute papilla. The process of the 9th sternum large, curved at the apex only. Basal joint of the left cercus much enlarged, conical; its proximal surface armed with numerous minute scattered denticles. Distal joint of both cerci similar to one another. Upper wing 8·5–11·25 mm. long, 2·75–3·5 mm. broad; lower wing 8–10·5 mm. long, 2·5–3·5 mm. broad.

Length 12·75–18 mm.

The Head.—The head is longer than broad with the posterior margin rounded; it attains its greatest diameter between the eyes. It is uniformly clothed with longish, almost black hairs. The *eyes* are only partially visible from above, reniform in shape, and have their concave side closely embracing the basal joint of the antenna.

The *labrum* is much broader than long, with its anterior angles prominently rounded (Pl. 38. fig. 8). It presents no special features. The *epipharynx* is represented by a longitudinal row of setæ on either side of the pharyngeal surface of the labrum. These setæ are most probably sensory in function. The *clypeus* is larger than the labrum and is divided into a membranous *ante-clypeus* (*a.cl.* in fig. 8), and a wider and fully chitinised *post-clypeus* (*p.cl.*), which articulates with the epicranium just in front of the bases of the antennæ.

The *antennæ* vary in length from 6–7·5 mm. and are larger than the thorax, but a little shorter than the combined length of the head and thorax. The number of joints varies between 20 and 29, the most usual number being from 23–27. More than half the individuals examined had one or both of their antennæ imperfect. The basal joint (Pl. 38. fig. 2) is the widest, and the third joint the largest; the succeeding joints differ very little individually among themselves. The combined length of the 4th, 5th, and 6th joints exceeds that of the first two joints.

The *mandibles* (Pl. 38. fig. 5) are slender, considerably longer than broad, and much less massive than those of the female. They are armed with two very small apical teeth placed side by side, and there are no other definite teeth. Below the apex of each mandible the inner margin is produced for less than half its length into a sharp cutting-edge. The inner angle of each mandible is somewhat produced, and to it is attached the tendon of the *adductor muscle* (*add.*).

The *ginglymus* (*ging.*) is directed obliquely outwards and lies above and partly behind the *condyle* (*cond.*). To the outer angle of each mandible is attached the tendon of the *abductor muscle* (*abd.*), but there is no special process developed.

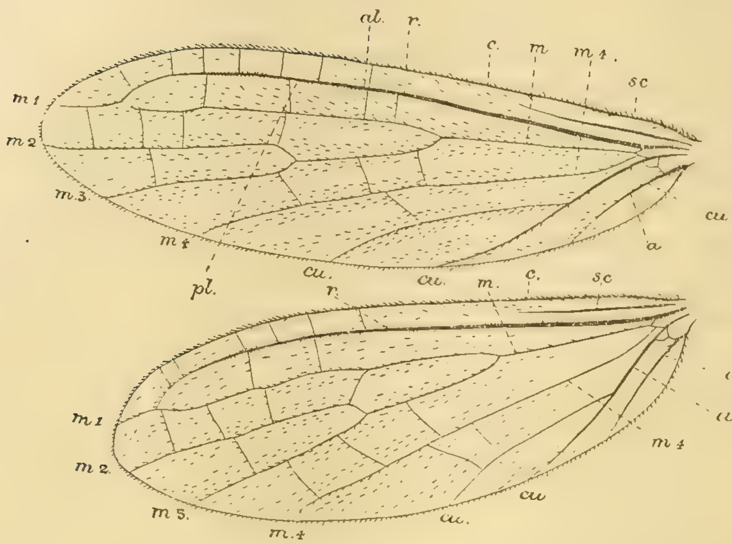
The *first maxillæ* each consist of a five-jointed palp, a membranous galea, and a stout lacinia, carried by the cardo and stipes (Pl. 38. fig. 11). The joints of the *palpi* are related to one another in length in the proportion of 17 : 9 : 15 : 18 : 22,—the second joint being much the shortest and the apical joint the longest. The *galea* (*gal.*) is membranous and unarmed. The *lacinia* (*lac.*) is strongly chitinised and armed with a pair of small apical teeth situated side by side; along the inner margin of the lacinia is a row of stiff elongate setæ. The *cardo* (*car.*) and *stipes* (*st.*) present no special features; the former is the larger of the two joints.

The *second maxillæ* (*labium*) consist of a quadrangular *submentum* (m_2 in Pl. 38. fig. 9), a well-developed *mentum* (m_1). They differ considerably in form from those figured by Grassi and Sandias (1897, pl. 19. fig. 7) for *Haploembia solieri* (Rambur).

Arising from near the base of the submentum are the *labial palpi* (*l.p.*), which are three-jointed. The joints are related to one another in length in the proportion of approximately 12 : 14 : 17. In some specimens, however, the two basal joints are practically equal in size. A vestigeal *palpiger* is present, and its limits are indicated by an indistinct suture (*pgr.*). Distally, the mentum carries a pair of large external lobes or *paraglossæ* (*g.*), which are the counter-parts of the galeæ of the 1st maxillæ. Situated on either side of the median line, and between the paraglossæ, are a pair of small pointed lobes representing a divided ligula (*l.*) and corresponding to the *laciniæ* of the 1st maxillæ. The *mentum* exhibits indications of a paired formation being divided into halves by an indistinct median line which is much less chitinised than the rest of the sclerite. The *hypopharynx* appears as a median projection from the floor of the mouth. Viewed from above it appears quadrangular in form, and longer than broad. Its dorsal surface is invested with a covering of extremely minute scales, which are pectinate along the distal margin. In many instances the middle tooth of each scale is prolonged into a slender spine. On the ventral surface of the hypopharynx the scales become less numerous and disappear. Such scales have also been noted and figured by Enderlein (1909, p. 168, fig. 3) in *Oligotoma saundersi*, Westw., who regards them as taste-scales.

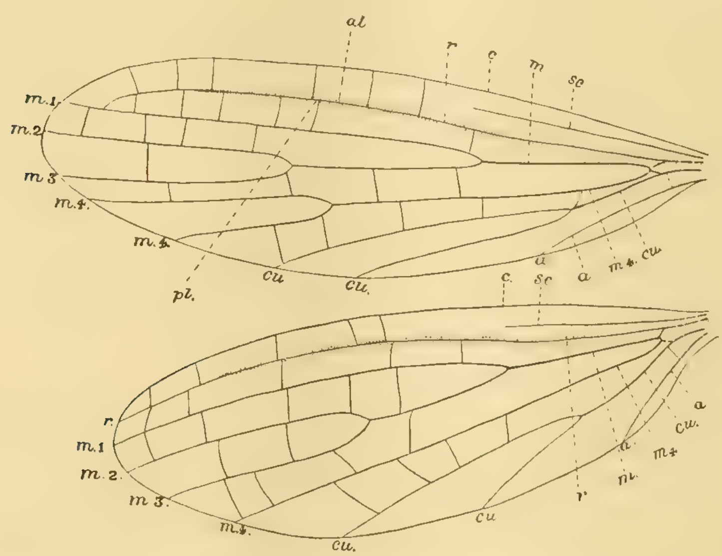
The Thorax.—The *prothorax* is narrower than the head, sub-quadrate, but slightly broader than long. Its anterior margin is straight and the sides slightly diverge posteriorly. The hind margin is produced into a median convexity (Pl. 37. fig. 1). The anterior fourth of the tergum is definitely constricted off from the rest by means of a deep transverse sulcus. At right angles to the latter and terminating in it anteriorly, is a shallow median longitudinal groove. Both the anterior margin and the sides are clothed with stiff black hairs. The *mesothorax* is the largest division of the three, subquadrate in shape, slightly broader than long, and wider than the prothorax. Its anterior margin is clothed with pilose hairs. The *metathorax* is entirely glabrous and a little shorter than the mesothorax. The *fore-wings* vary in length from 8·5–11·25 mm., and their breadth varies from 2·75–3·5 mm. The *hind-wings* vary from 8–10·5 mm. in length and 2·5–3·5 mm. in breadth. The length of the wings compared with that of the abdomen exhibits a certain amount of variation in different individuals. In some examples the apices of the closed wings extend a little beyond the tips of the cerci, while in other specimens they only reach far enough posteriorly to cover a portion of the basal joint alone of each cercus. The *neuration* exhibits a very wide range of individual variation, especially as regards the transverse veins, and, furthermore, the veins of the right and left wings frequently differ from one another. If examined immediately after the last ecdysis, the wings are seen to be hyaline and the veins are more clearly exhibited. When the full darkening of the chitin is attained the veins are reduced to the condition of being merely darker lines of thickened cuticle following the original neuration. A comparison of the wings in the hyaline and fully developed conditions, shows that the neuration undergoes practically no reduction or modification during the period taken by the wing-membranes to harden and mature. In some specimens, however, certain of the longitudinal veins exhibit a tendency to dwindle away at their apices, before quite reaching the margin of the wing. In this respect *Embia major* is an example of the first step in the reduction of the wing neuration, which attains its maximum in the genus *Oligotoma*. The surface of the wings is clothed with minute pilose hairs together with longitudinal rows of longer hairs. These latter are disposed along the courses of the veins and in the areas between the veins (text-fig. 1), but are entirely wanting from the hyaline longitudinal areas of the wing-membrane. The margins of the wings are fringed with regularly arranged longish setæ. In the text-figure the neuration of an average specimen is represented. The terminology followed is that advocated by Comstock and Needham (1898, p. 423), which is based on a study of the phylogenetic development of the wing-veins of Insects. The *costal vein* (*c.*) is confluent with the anterior margin in both pairs of wings. The *subcostal vein* (*sc.*) is short, being less than one-third of the length of the wing; it tapers to a point and dwindles away altogether. This vein is thickly chitinised, and just visible to the unaided eye. The *radial vein* (*r.*) is the most conspicuous vein of all, being very strongly chitinised and much thickened in calibre. Running parallel to, and almost in contact with the anterior and posterior margins of the radial vein, are a pair of very fine dull red lines (*al.* and *pl.* in text-fig. 1). These two lines terminate a short distance before reaching the junction of the radial and median veins. They are termed by Enderlein (1912, p. 10) the "*Radiussaumlinien*" (*Radiolimbolarien*), and by Krauss (1911, p. 7) the "*Radius-Nebenlinien*." They possess a certain amount of value as a specific character, and may be conveniently referred to as the *anterior* and *posterior radial lines*. A short distance before reaching the apex of the wing the radial vein joins the median. A variable series of 4–7 transverse veins, situated in the distal half of each wing, unite the costal with the radial vein. The *median vein* and its branches are distributed over about one-half the total area of each wing

Text-fig. 1.



Neuration of the upper and lower wings of a typical specimen of *Embia major* (slightly diagrammatic).—*c.*, costal vein; *sc.*, subcostal vein; *r.*, radial vein; *al.*, anterior radial line; *pl.*, posterior radial line; *m.*, upper stem of radial vein; $m._1$, $m._2$, $m._3$, branches of the upper stem of the radial vein; $m._4$, lower stem of radial vein; *cu.*, cubital vein and its branches; *a.*, anal vein. The courses of the *anterior* and *posterior radial lines* in both wings are represented by the dotted lines. × 9. (Westwood Bequest.)

Text-fig. 2.



The probable neuration of the ancestral type from which *Embia major* has originated. This conclusion is arrived at by combining in one figure the variations exhibited in different individuals, and also the condition of the neuration seen immediately after the last ecdysis. (Reference lettering as in text-fig. 1.) × 9. (Westwood Bequest.)

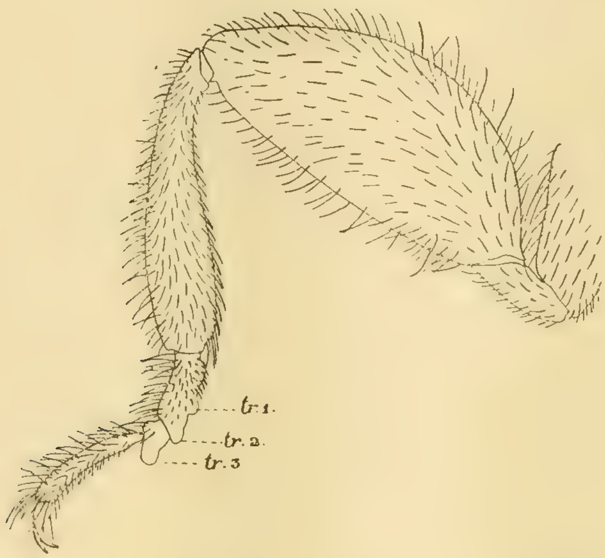
(m, m_1–m_4 in text-figs. 1 and 2). It consists of two main stems (m and m_4) arising close together at the base of the wing. The upper stem bifurcates into two branches before reaching the middle of the wing. The upper branch (m_1) remains undivided and receives the apex of the radial vein. It is, furthermore, united to that vein by a series of 4–6 cross-veins. The lower branch divides into two veins (m_2 and m_3): the upper vein m_2 is connected with m_1 by a variable series of cross-veins; the lower vein m_3 is united to m_2 by one or two cross-veins. The lower stem of the radial vein (m_4), as a rule, remains undivided; in the left upper wing of one specimen, however, it was found to be bifurcated (*vide* text-fig. 2). It is joined to the veins in front by 3 or 4 transverse veins, and to the cubital vein behind by 1–4 similar veins. The *cubital vein* (*cu.*) bifurcates at a distance from its origin equal to about one-third of its length. The upper branch is joined to the median vein by the cross-veins just referred to; the lower branch does not receive any cross-veins, but is greatly thickened and chitinised like the radius, and clearly visible to the unaided eye. The *anal vein* (*a.*) is the smallest vein of all and is unbranched; it is connected with the basal stem of the cubital vein by a single transverse vein. Enderlein, however, remarks:—" Die Analis is die zarte und hyaline Clavusnaht, die Axillaris läuft in der Mitte des Clavus kräftig und endet ohne Nodulus-bildung vom Ende des Clavus in den Hinterrand" (1912, p. 10). This interpretation I believe to be incorrect, for " Nähte " occur between other veins also, and can be seen in the newly formed wing immediately after the last ecdysis, before full chitinisation has taken place. The vein which appears to me to represent the true anal vein is the one he terms the axillary. In text-fig. 2 are represented the greatest number of veins that could *ex hypothesi* occur in any individual pair of wings. It has been constructed by combining in one figure the various variations that I have observed in both pairs of wings of eight individual males. The neuration of the upper wing shown in the figure agrees almost entirely with Krauss's figure (1911, p. 7) of the primitive hypothetical state of wing-neuration in Embiidæ, the only difference being the much greater number of transverse veins in *Embia major*. In the bifurcation of the lower stem (m_4) of the radial vein, as an occasional and apparently rare variation, we have a relic of an earlier condition. So far as I am aware, this only occurs as a constant character in the genus *Donaconethis*, Enderl., where it is present in both wings. Krauss (1911, Taf. 5. fig. 21 *d*) figures the right wings of a specimen of *E. savignyi*, Westw., in which the vein m_4 is similarly bifurcated, though it is not usually so in that species. In the lower wing of one specimen of *E. major* the radial vein passes directly to the margin of the wing, instead of uniting with the upper stem (m_1) of the median vein. This appears to be a reversion to a primitive condition which is found in the generalised genus *Clothoda*, Enderl., and one or two other forms.

The *legs* do not present any special features, with the exception of the *arolia* * or ventral pads of the tarsi. In relation with the hind pair of legs there are two such pads on the first tarsal joint (metatarsus), and in this respect *E. major* differs from its congeners and resembles the genus *Haploembia*, Verh. On the second tarsal joint there

* " Sohlenbläschen " of Verhoeff.

is a single pad, as is usual among Embiidæ (text-fig. 3). The arolia on both joints of the tarsi are completely glabrous. The *tarsal claws* (Pl. 38. fig. 13) of each pair of legs do not differ from one another in any essential points. Each claw is broad at the base, but narrows and becomes acuminate at its distal half. It carries a stiff obliquely-directed *seta*, which arises from the basal portion of the claw.

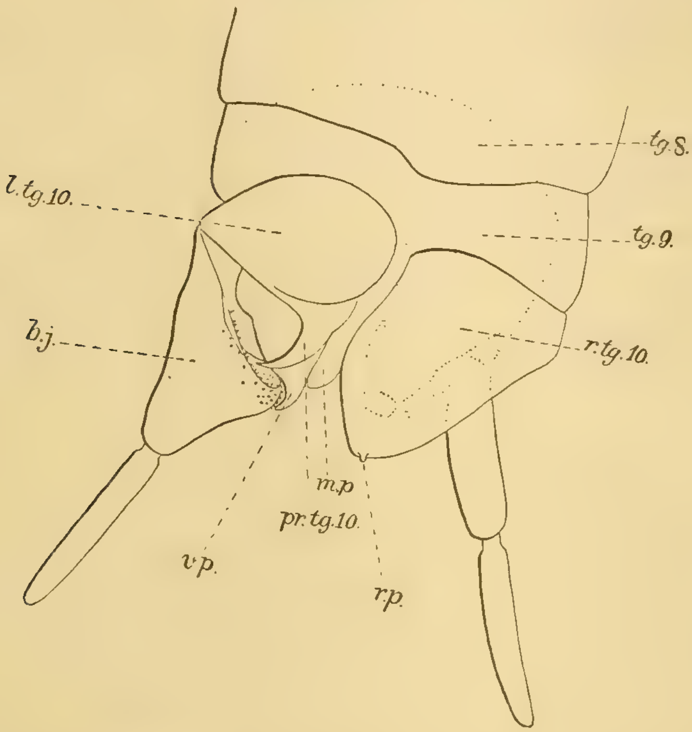
Text-fig. 3.



The right hind leg of the male, viewed from the outer aspect. *tr.* 1 and *tr.* 2, arolia or ventral pads of the first tarsal joint ("metatarsus"); *tr.* 3, arolium of the second tarsal joint. × circa 22. (From a preparation mounted in Canada balsam.) (Westwood Bequest.)

The ABDOMEN consists of ten terga, of which the first eight are almost glabrous. The pleura and the 9th and 10th terga are provided with brownish hairs. The first seven terga are subequal, the eighth is shorter than those of any of the preceding segments, and the ninth is asymmetrical and the smallest of all: it appears as if compressed between the 8th and 10th segments, and partly distorted in consequence, so that the right portion appears somewhat larger than the left (Pl. 37. fig. 3, *tg.*$_9$). The tenth tergum is completely divided into right and left plates, the right being larger than the left. The left plate is produced posteriorly into a stout curved process (*pr.tg.* 10 in text-fig. 4); the process of the right plate is only represented by a minute papilla (*r.p.*). The left-hand portion of the right plate (*m.p.* in text-fig. 4) is marked off by means of a suture from the rest of the plate. Ventrally, the abdomen consists of nine evident sterna. The first sternum is extremely small and firmly soldered to the posterior margin of the metathorax. The 2nd–8th sterna differ but little among themselves, the 2nd, 3rd, and 4th being somewhat longer than the succeeding sterna. The ninth sternum is the largest of all; it is asymmetrical, and forms the *subgenital plate*; it appears to be formed by the fusion together of the ninth sternum and the right plate of the tenth sternum. Whether the left-hand portion of the tenth sternum of the nymph participates also in its formation. is extremely doubtful. From a prolonged study of the insect, in different stages of development, I have come to the conclusion that the left plate of the 10th sternum becomes modified, but persists as *ventral process* (*v.p.* in Pl. 37. fig. 3 and in text-fig. 4). This process is hinged to the subgenital plate, and is attached to it in the large posterior

Text-fig. 4.



The three terminal abdominal segments of the adult male, viewed from the dorsal side. *b.j.*, enlarged basal joint of left cercus; *pr.tg.* 10, process of the left 10th tergal plate; *m.p.*, median plate; *r.p.*, vestige or rudiment of the process of the right 10th tergal plate; *l.tg.* 10, left tergal plate of the 10th segment; *r.tg.* 10, right tergal plate of the 10th segment; *tg.* 8, tergum of 8th segment; *tg.* 9, tergum of 9th segment; *v.p.*, "ventral process," which is probably formed from the left sternal shield of the 10th segment of the larva and nymph. × circa 28. (From a specimen treated with potash and mounted in Canada balsam.) (Westwood Bequest.)

concavity, which is shown in Pl. 37. fig. 2. Krauss, however, regards this structure as the "Grundplatte" (basal plate) of the left cercus (1911, p. 12). Enderlein (1912) describes it as the "Anhang" of the ninth sternite, which is in accordance with the morphological explanation suggested above.

The basal joint of the left cercus is sub-conical in shape (Pl. 37. figs. 2 & 3, and text-fig. 4). Its greatest diameter is at the proximal end and measures double that of the corresponding joint of the left cercus. The proximal surface is excavated to form a prominent concavity (fig. 2), over which are distributed a number of small denticles (text-fig. 4). The inner wall of the concavity is strongly rounded and is situated beneath the ventral process already referred to. The distal joints of both cerci are elongate and cylindrical, and similar one to the other.

Coloration.—Seen from the dorsal side, the head, together with its appendages, the legs, the terminal and penultimate segments of the abdomen, and the cerci except at their apices, vary in coloration from deep brown-black to black, with pruinose reflections. The prothorax varies from chestnut-brown to black, but in most specimens it is usually brown-black in colour. The remaining thoracic and abdominal segments are dark pruinose-brown. The claws of the feet are yellowish-white, but fuscous distally. The articulations between the joints of the legs, of the tarsi except the first pair, of the antennæ, and of the labial and maxillary palpi are cream-coloured. The ante-clypeus is usually light brown and very conspicuous for that reason, and the apices of the cerci are yellowish-white or cream-coloured. The intersegmental regions between the head and the prothorax, and between the prothorax and the mesothorax are well defined, membranous, and yellowish-white in colour. The pleuræ of the metathorax and the fist eight abdominal segments are similarly membranous, and form a whitish sinuous line along each side of the body, but are less conspicuous than in the female.

Ventrally the coloration is very much the same as it is dorsally. The cervical region is a very conspicuous, yellowish-white, membranous area, and the region between the prothorax and mesothorax is similarly membranous.

The wings are fuscous, striped with a series of longitudinal hyaline areas (Pl. 37. fig. 1). These areas have a definite arrangement with reference to the various longitudinal veins, and are, furthermore, devoid of the longer setæ which are distributed over the rest of the wings. As already mentioned (p. 171) the newly formed wing, after the last ecdysis, is at first hyaline, the darkening and full chitinisation taking place subsequently, leaving only these longitudinal areas unaltered. The latter remain unmodified and undarkened throughout life. In this connection it is worthy of note that Wood-Mason (1883, p. 633) suggested that these areas represent the original hyaline colour of the wings; and it gives me great pleasure in being able to confirm his suggestion. The hyaline areas are disposed in the following manner:—(*a*) An extremely narrow strip bordering both the anterior and posterior radial lines (p. 171); (*b*) a prominent area situated midway between the two branches m_1 and m_2 of the median vein; (*c*) a short area lying between the two veins m_2 and m_3, formed by the division of the lower branch of the upper stem of the median vein; (*d*) a very long and conspicuous area situated about midway between the two stems m and m_4 of the median vein and extending outwards so as to almost reach the outer margin of the wing; (*e*) a very similar area situated between m_4 and the cubital vein; (*f*) one or two very short lines lying within the fork formed by the bifurcation of the cubital vein; (*g*) a short area between the much thickened stem of the cubital vein and the anal vein. In those cases where the lower stem m_4 of the median vein is bifurcated, an additional hyaline area is present between the two branches of the fork. This, however, is a rare variation. At the points where certain of the transverse veins cross the hyaline areas (Pl. 37. fig. 1) they become bordered with a minute hyaline strip, producing the appearance of cross-pieces on the wing-membrane.

3. Description of the Female.

Deep brown to brown-black, clothed with lighter brown hairs, longer and more numerous than in the male. The antennæ 23–29-jointed, shorter than the thorax. The head, thorax, and abdomen mutually related in length in the proportion of 3 : 7 : 10. The first joint of the hind tarsi with two arolia. The 8th and 9th abdominal terga subequal, but shorter than those of any of the preceding segments. The 10th tergum longer than the ninth, narrowing posteriorly with the hind margin prominently rounded.

Length 14·75–20·75 mm.

The Head differs from that of the male in that it attains its maximum width just behind the eyes. The *eyes*, moreover, are smaller and less markedly reniform. The *antennæ* (Pl. 38. fig. 3) measure from 5–6 mm. in length, and are shorter than the thorax. The number of joints varies from 23–29 and, for the most part, they are shorter and more annular than the corresponding joints in the male. The combined length of the 4th, 5th, and 6th joints is less than that of the first two joints. The *labrum* only differs from that of the male in that the hairs of the *epipharynx* are more numerous and rather more elongate; they are similarly disposed in two longitudinal rows as in the male. The *mandibles* (Pl. 38. fig. 6) are much more massive than in the male, and their biting-edges are armed with four prominent teeth (1–4 in fig. 6). Two of the teeth are situated close together at the apex of the jaw. These are followed by a large and usually bilobed tooth, occupying the middle of the biting-edge of the jaw. Near the inner angle there is a fourth and somewhat smaller tooth which in some individuals is greatly reduced or absent entirely. Immediately below this tooth (no. 4) is a basal process (*add.*) which provides attachment for the *adductor muscle* of the mandible. The *ginglymus* (*ging.*) is very prominent and is produced outwards on a stout pedicel. To the outside of the ginglymus is the *condyle* (*cond.*), and at the extreme outer angle of the mandible is situated the point of attachment of the *abductor muscle* (*abd.*). The *first maxillæ* only differ from those of the male in that the two apical teeth are considerably longer and more prominent. The dorsal tooth is rather longer and more slender than the ventral one. The *maxillary palpi* are five-jointed, and exhibit no appreciable differences in the two sexes. The *hypopharynx*, in the majority of specimens examined, was found to be slightly larger than that of the male, but does not appear to exhibit any essential differences.

The Thorax is longer than in the male, and consists of three annular segments whose terga are extremely simple in structure, differing but little from those of the abdomen except in size. The deep transverse suture of the prothorax is situated, in some specimens, rather further forward than in the male. The median longitudinal groove is frequently produced beyond the transverse groove to the anterior margin of the prothorax. The *legs* do not differ from those of the male in any essential features. The *tarsal claws* are similar in both sexes and, in relation with the hind pair of legs, there are two ventral pads or *arolia* present on the first tarsal joint ("metatarsus") and a single such pad on the second tarsal joint (text-fig. 3).

The Abdomen has its dorsal surface more hairy than in the male, this feature being apparently correlated with the absence of wings. The tergal plates of the 8th and 9th segments are subequal in size, shorter than those of any of the preceding segments, and the 9th tergite, moreover, exhibits no asymmetry. The 10th tergum is somewhat longer than the 9th; it narrows posteriorly and the hind margin is prominently rounded (Pl. 38. fig. 1). The 8th sternum is the *subgenital plate*. It has a median transverse incision in its posterior margin, which marks the position of the *genital aperture* (*g.ap.* in Pl. 38. fig. 4). The sterna of the 1st and 8th segments are smaller than any of the remaining sterna. The 9th sternum varies from 2–2½ times the length of the 8th, and its posterior margin has a small shallow median notch. The 10th sternum, unlike that of the male, is divided longitudinally into two symmetrical plates ($st._{10}$ in fig. 4). The right and left cerci are similar to one another, and at the base of each cercus there is an annular vestige, which may possibly represent the *basal plate* *, present in relation with each cercus in the primitive genus *Clothoda*, Enderl., and well developed in most Embiid larvæ.

Coloration.—Dorsally the coloration varies from uniform dark brown to almost black, and in some lights it appears quite black. The intersegmental regions between the head and the prothorax, between the prothorax and mesothorax, and between the mesothorax and metathorax, are membranous, flexible, and whitish in colour. The pleural region commences from the basal half of the metathorax and extends backwards to the extremity of the 8th abdominal segment, and is similarly membranous. It appears as a prominent whitish line running along each side of the body, and visible dorsally as a pair of lateral streaks (Pl. 38. fig. 1). The antennæ are similar in colour to the head, with the articulations between the individual joints paler. The distal half of the clypeus (*ante-clypeus*), the labial and maxillary palpi, the region around the articulations between each of the joints of the legs, the two apical joints of the anterior tarsi, and the tibiæ and tarsi of the middle and posterior pairs of legs are lighter in colour than the rest of the body. The claws of the feet are yellowish-white with piceous apices, and the cerci are yellowish-white at their extremities. Ventrally the coloration is paler than dorsally, with a slight primrose tinge in many individuals. The sternum of the 8th, with the exception of its median portion, and the sterna of the 9th and 10th segments are darker in colour than those of the preceding abdominal segments.

* "Cercus basipodite" or "Grundplatte" of the German authors.

4. *A Table of Comparison of the Principal Differences between the Sexes.*

MALE. *Winged.*	FEMALE. *Wingless.*
Body-hairs brown-black or black, absent for the most part from the dorsal surface of the thorax and abdomen.	Body-hairs light brown, longer than in male, present to some extent on the dorsal surface of the thorax and abdomen.
Maximum length 18 mm.	Maximum length 20·75 mm.
Head, thorax, and abdomen related in length as 3 : 5 : 8.	Head, thorax, and abdomen related in length as 3 : 7 : 10.
Eyes reniform.	Eyes smaller, less markedly reniform.
Antennæ 6–7·5 mm. in length, longer than the thorax. Joints 20–29; the combined length of 4th–6th joints exceeds that of the first two joints.	Antennæ 5–6 mm. in length, shorter than the thorax. Joints 23–29; the combined length of 4th–6th joints less than that of the first two joints. All the joints shorter and more annular than in male.
Mandibles slender, biting-edge but little developed.	Mandibles massive, biting-edge armed with four prominent teeth.
Apical teeth of lacinia of 1st maxilla small.	Apical teeth of 1st maxilla larger and more prominent.
Thoracic segments short; the terga of the meso- and metathorax modified in correlation with the presence of wings.	Thoracic segments elongate; the terga of the meso- and metathorax simple and unmodified.
Abdomen consists of ten tergal and nine evident sternal plates.	Abdomen consists of ten tergal and ten sternal plates.
The 10th tergum divided into two asymmetrical shields. The 9th tergum also asymmetrical.	The 10th tergum undivided; both it and the 9th tergum symmetrical.
The 9th sternum enlarged and markedly asymmetrical. It is probably a composite structure formed by the right plate of the 10th sternum becoming fused with it. The left plate of the 10th sternum is probably represented by the "ventral process."	The 9th sternum not enlarged, symmetrical. The 10th sternum in the form of two symmetrical shields.
The basal joint of the left cercus much enlarged.	The basal joint of the left cercus not enlarged, similar to that of the right side.
The genital aperture terminal in position, the 9th sternum forming the subgenital plate.	The genital aperture ventral in position, the 8th sternum forming the subgenital plate.
The external genitalia formed by the curved process of the left shield of the 10th tergum and the "ventral process" attached to the 9th sternum.	External genitalia absent.

5. Systematic Position of the Species.

Embia major is more closely allied to *E. sabulosa*, Enderlein (Denskr. med. Naturw. Ges. Jena, Bd. 13, 1908, pp. 347–48, with 2 figs.), from South Africa, than to any other species of its genus. The male of *major* agrees with that of *sabulosa* in the form of the basal joint of the left cercus, in the absence of any evident process to the right plate of the 10th tergite, and in the completeness of the neuration of the wings, all the longitudinal veins attaining the wing-margin. The following characters, among others, readily separate the two species:—

E. major, Imms.	*E. sabulosa*, Enderlein.
Male measures 12·75–18 mm. in length. Female measures 14·75–20·75 mm. in length.	Male measures 7·5–8·5 mm. in length. Female measures 10–11 mm. in length.
Number of antennal joints varies from 20–29.	Number of antennal joints varies from 17–21.
10th abdominal tergite of the male completely divided into right and left plates. The process of the left plate short and very much curved.	In the male the line of division between the right and left plates of the 10th abdominal tergite does not quite extend back to the anterior margin of that segment. The process of the left plate long, and only slightly curved at its apex.
The 1st tarsal joint of the hind pair of legs provided with two ventral pads or *arolia* in both sexes.	The 1st tarsal joint of the hind pair of legs provided with a single arolium.

6. The Ova.

The eggs are oval in form, with a smooth and faintly glistening appearance, and are pale cream-white in colour. In average size they measure approximately 1 mm. in length and ·5 mm. in diameter. Below are recorded the actual measurements made on 21 eggs deposited by five different females:—

Length	1·07	1·17	1·05	1·05	1·12	1·22	1·15	1·10	1·07	1·05	1·17
Diameter	·55	·55	·55	·57	·65	·60	·55	·55	·52	·52	·65
Length	1·20	1·12	1·12	1·15	1·05	1·02	1·07	1·05	1·07	1·05	
Diameter	·55	·60	·52	·52	·55	·52	·55	·50	·55	·55	

It will be noted that the eggs vary from 1·02 mm.–1·22 mm. in length and from ·52 mm.–·65 mm. in diameter.

At one extremity of the egg is a large prominent operculum (Pl. 38. fig. 12). This operculum is broadly pyriform in shape, and where it comes in contact with the rest of the chorion there is a well-defined rim or margin. The general surface of the chorion is finely sculptured into a series of irregular hexagons. The diameter of these figures, measured between two opposite faces, varies between ·031–·05 mm. (fig. 10). Over the surface of the operculum the sculpturing is of a somewhat different character; it takes the form of a series of irregular polygonal areas bounded by very thick walls (fig. 9). The inside diameter of these areas, the measurements being taken between opposite faces, varies from ·012–·018 mm.

The number of eggs deposited by each female was found to vary from about 60 to 100. The eggs laid by eleven females, each inhabiting a separate nest, were counted, and their numbers were as follows:—59, 69, 70, 71, 73, 77, 79, 82, 97, 98, and 106 respectively. Oviposition takes place within the tunnels of the nests. In those instances where a nest is occupied by more than one female, the latter keep their eggs separate and apart from those of their companions. Each female deposits her eggs all together in an irregular heap loosely bound by fine silken threads. Additional threads also secure the eggs to the wall of the tunnel. The incubation period was found to vary from three weeks to one month, or a little longer, according to the prevailing climatic conditions.

Between June 20th and July 4th, I visited the locality where *Embia major* occurs, but after a prolonged search was unable to discover any eggs. On the latter date I had to leave the locality and travel to Dehra Dun. I brought along with me, in a small zinc breeding-cage, two females and two males. The insects were afterwards separated as two pairs, comprising a male and a female each, and placed in separate vessels along with some soil and clumps of grass. The vessels employed were a pair of crystallising dishes used by chemists, each dish being covered by a circular metal plate and kept in a moderately cool room out of the direct rays of the sun. These females commenced depositing their ova on July 9th and 10th. The first insect hatched out on August 1st, one hatched out on August 4th, three more on August 5th, and the remainder were all hatched by August 7th, the incubation period in these instances varying between 23 and 30 days. During the process of development the eggs did not undergo any change of colour. During the second week in August 1912, I again had occasion to visit the Naini Tal district, and devoted one afternoon (August 8th) to an examination of some thirty nests of this insect. In every nest females, along with their ova, were in evidence. Except in three nests, where a few first-stage larvæ were found, none of the eggs had hatched out. Dehra Dun is situated at the foot of the Himalayas, at an altitude of 2200 feet and has a correspondingly higher mean temperature. This higher temperature accounts for the captive larvæ emerging at an earlier date than in their usual habitat.

Four batches of ova were brought from Sat Tal, and from these eleven specimens of a new species of parasite of the family Scelionidæ, belonging to the genus *Embidobia*, Ashm., were bred out in Dehra Dun. This parasite, when it is about to emerge, eats its way out of the egg by gnawing a hole through the chorion, towards the end of the egg opposite to that which bears the operculum (Pl. 38. fig. 12).

During the incubation period the female *Embia* constantly guards her eggs, resting with them lying beneath her body. A more detailed account of this instinct is given on p. 189.

7. The Newly Hatched Larva.

The newly hatched larva is entirely white, with the exception of the eyes, which appear as a pair of purple-brown dots, and the brown strongly chitinised edges of the mandibles. On one occasion the larva was observed in the act of emerging from the egg. It issues head foremost and forces open the operculum, which remains attached along a small portion of its periphery to the remainder of the chorion (Pl. 38. fig. 12). In total length the newly hatched larva varies between 1·6 and 1·8 mm., the measurements being taken from the apex of the labrum to the extremity of the last abdominal tergite. It is a relatively specialised example of the Campodeiform type of larva, and exhibits no primitive features in its organisation which do not also occur in the female imago. The head, thorax, and abdomen are related in length in the proportion of 5 : 4 : 7 respectively. The most striking feature in the external morphology of the young larva is the relatively great size of the head; it is ovoid, and exceeds the thorax both in length and diameter (Pl. 37. fig. 7). The head, body, and appendages are clothed with rather long thinly-distributed hairs. The antennæ are 9-jointed, and as long as or a little longer than the abdomen. The thoracic segments are extremely simple in character, and are much shorter in proportion to their breadth than in the adult. There is no marked indication of the transverse suture of the prothorax, which is a prominent feature in the adult insect. The legs are remarkably large, and the hind pair when extended backwards reach to a little beyond the apex of the abdomen. They differ very little in form from those of the adult, both the enlarged first joint of the fore tarsi and the swollen hind femora being evident. The abdomen consists of nine apparent segments, the ninth and tenth segments not being completely differentiated from one another. The cerci are two-jointed; the basal joint is very small and annular, and measures only one-eighth of the length of the second joint. The larvæ are all similar to each other, no external traces of sexual differentiation being noticeable. When removed from the protection of the parent, the young larvæ were observed to weave delicate tunnels within a few hours after emergence from the egg.

8. The Second-Stage Larva.

In larvæ measuring from 3–3·5 mm. in length, certain differences are noticeable, and by which they are readily distinguished from the newly hatched larva. At this stage in post-embryonic development the larva was from 21–23 days old. It is pale pinkish brown in colour, with the head and the margins of the thoracic and abdominal segments somewhat darker. The appendages and the whole of the ventral surface of the animal are pale and very little pigmented. The head no longer dominates the rest of the body, it being shorter than the thorax. The antennæ are 12-jointed, shorter in length than the abdomen, and only a very little longer than the thorax. The thorax has increased very much in length, and the transverse suture of the prothorax is completely formed. The head, thorax, and abdomen are mutually related in length in the proportion of 5 : 7 : 10. The legs have grown comparatively little, and the posterior pair when extended can no longer reach to the apex of the abdomen. There are ten evident abdominal segments, and the 10th sternum is longitudinally divided into two lobes. The mouth-parts closely resemble those of the adult in their general structure. The mandibles are stout and broad, but partake more of the characters of those of the female than the male.

9. The Half-grown Larva.

During the beginning of December the larva has passed through the first half of its life. Measurements of these half-grown larvæ were made, and their length was found to average 9 mm. The antennæ at this period have 21 joints, and are of equal length to the thorax. In colour the larvæ are chestnut-brown, with the appendages and ventral surface pale. I was not able to detect any external sexual differences among larvæ of this age. Ten abdominal segments are present, and the last sternum is longitudinally divided into a pair of symmetrical plates. These persist throughout life in the female insect, but are no longer evident in the male at the close of the nymphal period. The basal plates of the cerci are relatively large and well developed. They are covered by the 10th tergal shield and are consequently not visible dorsally. They are in contact with one another on the mid-ventral line, and appear to be serially homologous with the paired plates of the 10th sternum already referred to. That they are to be regarded as the representatives of an 11th somite was first suggested by Enderlein (1903, p. 430).

The mouth-parts do not differ in any details, except in size, from those of the younger larva. During the cold weather months up to March, the half-grown larva undergoes very little growth, and remains to a large extent dormant. Individuals extracted from their tunnels were observed to be much longer, and more sluggish over the construction of new tunnels than they are at other periods in their life-history.

10. The Male Nymph.

The nymphal condition in the male is characterised by the presence of wing-rudiments, otherwise it only differs from the larva in its greater size. Its period of duration is about two months commencing during the first half of May, when the young insect is from 9–9½ months old. The youngest nymph observed measured 11·5 mm. in length, with wing-rudiments 1·25 mm. long. At the close of the nymphal instar, examples 15–17 mm. in length are frequent. A nymph 15 mm. long has wing-rudiments measuring 2·25 mm. in length.

Viewed dorsally, the body and appendages are light chestnut-brown in colour, the head and the extremity of the abdomen being slightly darker than the rest. Ventrally the insect is of a much paler colour. The number of antennal joints varies from about 23–25, and correlated with the development of the wing-rudiments the tergal plates of the meso- and metathorax have assumed their triangular form seen in the fully-fledged adult.

The asymmetrical condition of the cerci and apical abdominal segments in the male is acquired very late in development, and for this reason is probably a phylogenetically recent acquisition. In the early nymph no indications are apparent at all (Pl. 37. figs. 5 & 6), but in a fully-grown nymph the 10th tergite of the adult is clearly visible beneath the cuticle. It has undergone division into two unequal plates, which are seen in process of development (Pl. 37. fig. 4). Unlike the adult male, the nymph possesses ten abdominal sterna. The 1st sternum is much reduced and soldered to the posterior margin of the metathorax. The remaining sterna differ but little from their condition in the adult, excepting those of the two terminal segments (Pl. 37. fig. 6). The 9th sternum is still unmodified, and exhibits no traces of asymmetry. The 10th sternite resembles that of the adult female in being longitudinally divided into two similar shields (*st.* 10 in fig. 6). The 9th and the right plate of the 10th sterna subsequently become fused to form the large asymmetrical *subgenital plate.* In relation with the base of each cercus are two *basal plates* (*b.p.* in Pl. 37. fig. 6).

The mandibles differ from those of the adult male in being relatively stouter and more massive, and resemble closely those of the female.

11. The Female Nymph.

A nymphal instar in the female can scarcely be said to exist. It is indistinguishable from the larva except in point of size and in the development of the genital aperture. It, furthermore, only differs externally from the adult in being paler in colour (light pruinose or chestnut-brown) and with the cuticle less chitinised. The largest female nymph measured 19·25 mm. long, and had 23 joints to the antennæ.

12. Observations on the Biology of the Species.

The nests of *Embia major* were only met with in a restricted area between the village or "basti" of Bhowali and the Sat Tal lakes, in the Naini Tal district of the Kumaon Himalaya. Sat Tal is one of a series of five lakes or "tals" found in this district of Kumaon. According to Theobald they owe their origin to obstructions in the local drainage caused by the débris of old moraines when the glaciers receded at the close of the glacial epoch *. The name Sat Tal means "seven lakes," and in former times seven small lakes actually existed. At the present day, however, only two lakes of appreciable size remain, and the larger of these, Sat Tal proper, is situated at an altitude of 4500 feet above sea-level. The nests of the *Embia* were found at elevations varying between about 4900 and 5100 feet, and $1\frac{3}{4}$ miles distant from the lake. They occurred under loose flat pieces of stone which lie scattered in the form of débris over a hill-side and open valley (text-fig. 5). Such situations are neither very dry nor very moist. The area within which *Embia* was found is very thinly forested, and the trees consist for the most part of "chir" pine (*Pinus longifolia*), Himalayan oak (*Quercus incana*), and *Rhododendron arboreum.* Flat stones were selected almost without exception as the sites for the nests. Between the lower surface of such stones and the ground, the Embiids weave the silken tunnels which form their nests. The shape of the nests depends upon the form, length, and number of these tunnels. In eight nests the ground beneath such stones was found to be occupied both by the *Embia* and an undetermined species of Termite. The tunnels of the Termite were alongside and in close contact with those

* Theobald, "The Kumaon Lakes." Rec. Geol. Survey India, xiii. 1880, p. 161.

of the *Embia*. It is noteworthy that the two species of insect appeared to be on perfectly amicable terms with one another, resembling symbiosis. Furthermore, it may be mentioned that Wasmann (1904, p. 17) records an Embiid, *Oligotoma termitophila*, occurring in nests of *Termes natalensis* in the Soudan.

The restricted distribution of the *Embia* is difficult to account for, especially as apparently similar localities are plentiful in the surrounding country. Altogether 211 nests of the species were met with, and they occurred over an area about 1½ miles in length. An examination of 130 nests was made with the object of obtaining information with regard to number of individuals inhabiting each nest, and the relative

Text-fig. 5.

A. D. Imms Photo.

View near Sat Tal, Kumaon. The nests of *E. major* occur under the stones scattered along the valley and hill-side. (Westwood Bequest.)

proportions of the sexes. Contrary to what would be anticipated from previous observations on Embiidæ, the female was found to be of much more frequent occurrence than the male. From an examination of 130 nests, made from June 27th until July 3rd, 88 of them (or 67·6 per cent.) were found to contain females only, 30 nests (or 23 per cent.) contained both males and females, while 12 nests (or 9·2 per cent.) contained male individuals only. From these figures it will be noted that males were only found in 32 per cent. of the nests that were examined. Some 268 individuals were found inhabiting these 130 nests (*vide* table on p. 188), and of these 109 (or 40 per cent.) were males and 159 females. This relatively high percentage among the males is somewhat remarkable, and is mostly owing to the fact that three nests (nos. 68, 89, and 125) contained no fewer than 39 male individuals among them; in no other instances were more than five males found in a single nest. The females have a marked tendency to be solitary, which is indicated by the fact that 73 nests, or 61 per cent. of the total number examined, contained single individuals only. In the cases of the males this tendency does not appear to be evident. Out of 42 nests containing males, in only 9 (or 14 per cent.) were single specimens found.

The form assumed by the nests is very variable (Pl. 36). As a general rule, at least three secondary or side tunnels are constructed, and these communicate with the larger main tunnels of the nest. Certain of the side tunnels serve as entrance or exit passages, while others terminate blindly. In most nests there is usually a hole or aperture present, leading from one of the tunnels into the ground. This hole is the entrance to a subterranean passage or chamber (*u.c.* in Pl. 36); in some instances this chamber was found to be lined with silk, while in others no silk was present. When disturbed the occupants of a nest frequently take refuge in these subterranean passages, but it is by no means always the case. I believe that their primary function is that of a place of retreat during the dry hot weather. The nests further vary very much in size, and this to a large extent depends upon the number of occupants therein. In the case of nests inhabited by a single individual, or in some cases two individuals, only one or two elongate tunnels of loosely woven silk are constructed, and the contained Embiids show clearly from within. In those instances where several Embiids exist in association with one another, they all participate in the formation of a common nest. The latter then assumes the form of a somewhat complex meshwork of tunnels. In the most complex nests a series of superposed tunnels is present, the lowest layer extending for a short distance into the earth. Such nests are the result of the combined efforts of a large number of occupants. Much more silk is expended on their construction, and the walls of the tunnels are denser and whiter in appearance. A typical large nest is shown in text-fig. 6. The largest number of individuals found inhabiting any single nest was 21. Nest no. 47 (Pl. 36. fig. 2) contained four females and one male, and measured 1 foot 4 inches in length. Nest no. 20 (fig. 3) contained a single female only, and was exceptionally large for the work of one individual; it measured $11\frac{1}{4}$ inches in greatest length and $5\frac{1}{2}$ inches in maximum width. Nest no. 26 (fig. 4) contained one male and one female. Nest no. 39 (fig. 5) contained two females; and nest no. 85 (fig. 8) contained one male, one female, and one immature male.

The first step in the construction of a nest consists in the spinning of a tolerably straight silken tunnel about 3 or 4 inches in length (fig. 1), and many nests occupied by single individuals remain in this simple condition. From a reference to the table given on p. 188, it will be noted that nests nos. 68, 76, 89, and 125 contained 21, 10, 19, and 12 occupants respectively. Such nests attain a relatively high degree of complexity (*vide* text-fig. 6). The various individuals contribute towards the construction of these large nests, and exhibit in this respect something more than a simple gregarious instinct. I regard these nests as a manifestation of an incipient tendency to colony formation, which has undergone little or no evolutionary development. Captive Embiids, when placed in a glass phial together, do not weave separate and distinct tunnels, but manufacture one common structure which shelters them all. This faculty of producing silk is developed equally in both sexes. When a nest is disturbed the occupants run rapidly along the tunnels either in a forward or backward direction with equal facility, and frequently take refuge in the underground chamber already referred to. Sometimes when much disturbed they desert their nests and take shelter under neighbouring stones or in surrounding herbage. They are capable of running very rapidly along the ground,

Text-fig. 6.

A. D. Imms Photo.

A large and complex nest (no. 76) showing the superposed series of tunnels. The nest was inhabited by ten individuals. The minute black particles overlying the tunnels are the excrementa or "frass" ejected by the insects. (A little less than one-half natural size.) (Westwood Bequest.)

but in no instance did the males make any attempt to take refuge in flight. In habits they are most probably exclusively nocturnal. Although the herbage was explored by sweeping, no individuals were met with in the daytime outside the nests.

From frequent observations I believe that the primary function of the silken tunnels of the Embiidæ is protective. Any predaceous insect which attacks the *Embia* while within the walls of its tunnel becomes entangled in the silken threads of the latter, allowing the *Embia* to make good its escape. Grassi and Sandias (1897, p. 64) consider that these tunnels serve to protect the body from too excessive transpiration, and to retain about the *Embia* an atmosphere not too dry. It is difficult, however, to imagine what difference these delicate tunnels could make in this respect—for instance, during the intensely hot weather that prevails from March to June in the Punjab and United Provinces. At such times of the year the amount of humidity in the air is negligible;

TABLE showing the number of individuals and the proportion of the sexes in 130 nests of *Embia major*.

Nest Number.	Males. Adult.	Males. Immature.	Females. Adult.	Females. Immature.	Total
1	..	1	..	..	1
2	..	1	1	..	2
3	1	..	..	..	1
4	..	..	1	..	1
5	..	..	1	..	1
6	..	..	1	..	1
7	..	..	1	..	1
8	..	..	1	..	1
9	1	..	..	..	1
10	..	..	1	..	1
11	..	..	1	..	1
12	1	..	1	..	2
13	..	..	1	..	1
14	..	..	1	..	1
15	..	..	1	..	1
16	3	..	1	..	4
17	..	..	1	..	1
18	4	..	1	..	5
19	..	..	2	..	2
20	..	..	1	..	1
21	..	..	1	..	1
22	..	..	1	..	1
23	..	..	1	..	1
24	1	..	..	..	1
25	1	..	..	..	1
26	1	..	1	..	2
27	..	..	1	..	1
28	1	..	1	..	2
29	..	..	1	..	1
30	..	..	1	..	1
31	1	..	1	..	2
32	..	1	1	..	2
33	..	..	1	..	1
34	..	..	1	..	1
35	..	..	1	..	1
36	..	..	1	..	1
37	2	..	1	..	3
38	..	..	1	..	1
39	..	..	2	..	2
40	1	..	1	..	2
41	..	..	1	..	1
42	..	..	1	..	1
43	..	..	1	..	1
44	1	..	..	..	1
45	..	..	1	..	1
46	..	..	1	..	1
47	1	..	4	..	5
48	..	..	2	..	2
49	..	..	1	..	1
50	3	..	..	..	3
51	1	..	..	..	1
52	..	..	1	..	1
53	..	..	1	..	1
54	..	..	1	..	1
55	..	..	1	..	1
56	..	..	1	..	1
57	..	..	1	..	1
58	3	2	1	..	6
59	..	..	2	..	2
60	..	..	1	..	1
61	..	..	1	..	1
62	..	..	1	..	1
63	..	..	1	..	1
64	4	1	1	2	8
65	..	..	1	..	1
66	..	..	1	..	1
67	1	..	..	1	2
68	6	3	8	4	21
69	..	..	1	..	1
70	..	..	1	..	1
71	1	..	1	..	2
72	1	..	1	..	2
73	..	..	1	..	1
74	..	..	1	..	1
75	..	..	1	..	1
76	3	2	4	1	10
77	..	..	1	..	1
78	..	..	2	..	2
79	..	..	2	..	2
80	..	..	1	..	1
81	..	..	1	..	1
82	..	..	2	..	2
83	..	..	1	..	1
84	..	..	1	..	1
85	1	1	1	..	3
86	1	..	..	..	1
87	2	..	3	..	5
88	5	..	1	..	6
89	17	2	..	..	19
90	..	..	1	..	1
91	..	..	2	..	2
92	..	..	1	..	1
93	..	..	1	..	1
94	1	1	1	..	3
95	..	..	1	..	1
96	..	..	1	..	1
97	..	..	1	..	1
98	..	..	2	..	2
99	..	..	1	..	1
100	..	..	2	..	2
101	..	..	1	..	1
102	..	..	2	..	2
103	..	..	1	..	1
104	1	..	1	..	2
105	..	..	1	..	1
106	1	..	2	..	3
107	..	..	1	..	1
108	1	..	1	..	2
109	..	..	1	..	1
110	1	..	2	..	3
111	..	..	2	..	2
112	..	..	1	..	1
113	..	..	1	..	1
114	2	..	1	..	3
115	1	..	1	..	2
116	..	..	1	..	1
117	1	..	..	..	1
118	4	..	..	..	4
119	..	..	1	..	1
120	..	..	1	..	1
121	..	..	2	..	2
122	..	..	1	..	1
123	..	..	1	..	1
124	..	..	2	..	2
125	10	1	1	..	12
126	..	..	2	..	2
127	..	..	1	..	1
128	..	..	1	..	1
129	1	..	..	1	2
130	..	..	..	1	1
Complete totals ...	93	16	149	10	268

nevertheless Embiidæ flourish in those regions. Melander (1902, p. 22) believes that the tunnels probably serve merely as a retreat.

Individuals placed in captivity are at first agitated, but they very soon settle down and become seemingly adapted to new surroundings. On June 5th three females were taken from three separate nests and placed in a glass phial closed with a cork stopper. When examined two hours after capture they had spun a straggling silken tunnel and were reposing within it. On another occasion a captive male was observed to have already commenced manufacturing its tunnel within half an hour of its being captured. During the process of weaving these tunnels the fore-legs are in active motion, the insect at the same time occasionally turning about on the long axis of its body. In order to construct the roof of its tunnel it turns over on to its back, presenting its ventral surface towards the observer. Newly hatched larvæ, when removed from the proximity of the parent female, were observed to weave tunnels with equal facility to older individuals. Insects in the act of spinning were observed with the aid of a Zeiss binocular microscope, which allows of their movements being tolerably readily followed. The silk is extruded at the apices of long glandular hairs situated on the ventral surface of the enlarged first tarsal joint of the anterior pair of legs. These threads are extremely fine and can only be observed when the Embiids are retained in a glass vessel lined on the bottom with non-glazed black paper. The fact that a number of such threads are produced simultaneously accounts for the rapidity with which these insects weave their tunnels. I hope to publish in a later paper the results of a prolonged series of observations dealing with the much debated problem of the mechanism of silk production in the Embiidæ. A full discussion of this subject will be found in the memoirs of Grassi and Sandias (1898, Appendix II. p. 62), Rimsky-Korsakow (1910, p. 153), Krauss (1911, p. 15), and Enderlein (1912, p. 12).

Maternal care on behalf of the ova and young larvæ is strongly exhibited by the females, in very much the same manner as has been long known to occur among the Dermaptera from the observations of Frisch, De Geer, Xambeu, Green, and others. The female *Embia major* shows very marked solicitude for the welfare of her offspring after her first few eggs have been deposited. She takes up her position in close proximity to the ova and usually concealing them, so far as possible, by means of her body. If alarmed and driven away, she returns sooner or later to take up the same attitude. When the young larvæ are hatched they remain around the parent female, who conceals them, so far as she is able, by means of her body, very much after the same manner as a hen guarding her brood of chickens. A female and her brood were kept in a small glass trough and observed daily living in intimate association. When separated from the parent the larvæ were observed the next day to have regained their former position. As the larvæ approach their second stage in growth (p. 182), they exhibit a tendency to wander away from the female and construct small tunnels for themselves. They are markedly social, the whole of a brood living together within a complex silken meshwork of tubes.

Embia major was found to be both easy to rear and observe in captivity. Females were kept in crystallising dishes such as are used by chemists, and measuring 10 inches in diameter. A layer of fine earth, after being carefully sifted and examined for other insects, Arachnids, &c., was spread for a depth of half an inch on the bottom, and a lid of metal was placed on the top to prevent the Embiids from making their escape. In this simple contrivance the females laid their eggs and the young brood developed to maturity. The only dangers to be guarded against are mould and too great an amount of dryness. The moisture sufficient for their welfare was afforded by lightly distributing some fresh grass (pulled up along with the roots) over the surface of the soil in the vessel. This device, furthermore, prevented the development of mould. The grass was changed once a week during the cold weather and hot weather seasons, and once a fortnight during the monsoon season. The females were found to be vegetarian in diet and thrived on the grass supplied, no animal matter of any kind being given to them. When enclosed in glass tubes they eat their way very readily through the cork stoppers and escape. Whether the male is carnivorous, as has been suggested by Friedrichs (1906) in the case of European species, I am unable to say. The great differences in the structure of the mandibles in the two sexes certainly supports Friedrich's suggestion. Those of the male are slender and devoid of any crushing-edge, and in this respect bear a considerable resemblance to those of carnivorous insects. On the other hand, I have reared the insect from the egg-stage up to the nymphs of both sexes entirely on vegetable food. It is a remarkable fact, however, if the male imago alone is carnivorous. This point is certainly in need of further investigation, which I hope to pursue at a subsequent opportunity.

The females lived in captivity for $6\frac{1}{2}$ months after oviposition; the males, however, only survived for a short time after the eggs had been laid.

The complete life-history of the insect may be summarised as follows:—

Life-history of *Embia major* as observed in the Kumaon Himalayas during the years 1910–12.

Cold Weather Season.			Hot Weather Season.			Monsoon Season.			Cold Weather Season.		
January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
						○○○	○○				
●●●●	●●●●	●●●●	●●●●	●●			●●●●	●●●●	●●●●	●●●●	●●●●
				⊕⊕⊕	⊕⊕⊕⊕	⊕⊕					
					♀♀	♀♀♀♀	♀♀♀♀	♀♀♀♀	♀♀♀♀	♀♀♀♀	♀♀
					♂♂	♂♂♂♂	♂♂♂♂				

○ = Egg Stage; ● = Larval Period; ⊕ = Nymphal Period; ♀ = Period of Female Imago; ♂ = Period of Male Imago.

In this table it will be noted that the signs are grouped in fours, representing the weeks in each month. As an example, it will be seen that the earliest date the eggs were found is the second week in July, and that they have been met with up to the second week in August. Similarly, the earliest observed date of the emergence of the larva is the first week in August, and so on.

Expressed in a few words, it may be said that during the monsoon season the eggs are laid and early larval development takes place. It is, furthermore, a period of rapid growth. During the cold weather months growth is comparatively slow, and the larva for a portion of the time remains partially dormant. In the hot weather season growth takes place more rapidly than at any other time. During this period the larval stage is completed, the nymphal condition passed through, and the imaginal state attained—all taking place within a period of approximately two months.

13. Summary of Conclusions.

Embia major, sp. nov., is the largest species of Embiidæ hitherto discovered, and the first member of its genus to be found within the limits of the Oriental zoo-geographical region. It is more closely related to *E. sabulosa*, End., from South Africa than to any other species.

It occurs plentifully under pieces of stone scattered over a hill-side and an open valley in the Naini Tal district of the Kumaon Himalayas, such situations being neither very dry nor very moist. It is very local and occurred between elevations of 4900 and 5100 feet.

Females are more prevalent than males. Some 130 nests were examined and 67 per cent. contained females only, 23 per cent. contained individuals of both sexes, and 9 per cent. males only.

The nests are very variable in form and composed of a network of silken tunnels. The silk is produced by glands situated in the enlarged tarsal joint of the anterior pair of legs. The faculty of weaving nests is possessed equally by both sexes, and also by the larvæ and nymphs.

The size of the nests depends to a large extent upon the number of individuals inhabiting them. The largest number of individuals found in a single nest was 21. Where several individuals are associated together in a nest it is to be regarded as the manifestation of an incipient tendency to colony formation, which has undergone little or no evolutionary development.

Maternal care on behalf of the ova and young larvæ is strongly exhibited by the females, in very much the same manner as occurs among Dermaptera. The female lives for at least 6½ months after fertilisation; the male, however, is much shorter lived.

The eggs measure 1 mm. long and ·5 mm. broad; they are oval, cream-white, and have a smooth, faintly glistening appearance. The number of eggs laid by a single female varies between about 60 and a little more than 100. They are laid during July and August in the monsoon season, and are placed in an irregular heap within one of the silken tunnels of the nest.

The incubation period of the eggs varies between about 23 and 30 days. They are parasitised by a minute Hymenopteron of the genus *Embidobia*, Ashm., family Scelionidæ.

The newly hatched larva is 1·6 mm.–1·8 mm. long, and entirely white, with the exception of the eyes and the strongly chitinised apices of the mandibles. It is a relatively specialised example of the Campodeiform type of larva, and exhibits no primitive features which do not also occur in the female imago. The chief characteristics are the relatively great size of the head, nine evident abdominal segments, and 9-jointed antennæ. The enlarged 1st joint of the anterior tarsi is present as in the imago.

Larval growth consists chiefly in increase in size, increase in the length of the abdomen, the adding of numerous joints to the antennæ, and the darkening of the coloration. The larval period lasts from the end of July or the beginning of August until the following May.

The nymph stages last about two months during May, June, and July. The female nymph does not differ from the adult except in colour and degree of chitinisation. The male nymph is chiefly characterised by the presence of wing-pads.

The characteristic asymmetry of the terminal abdominal segments of the adult male is acquired very late in development, not being evident until the end of the nymphal period. For this reason it is probably a phylogenetically recent acquisition. In the larvæ, the female, and the nymphs of both sexes a well-defined 10th sternum, consisting of a pair of symmetrical plates, is present. The subgenital plate of the adult male is probably formed by the fusion of the right 10th sternal plate with the 9th sternum, the left 10th sternal plate persisting as the "ventral process."

A study of the wing-neuration shows a remarkable degree of variation, no two specimens being identical. Many of the variations are reversions to a generalised state exhibited in more primitive genera.

The larvæ, nymphs of both sexes, and females are vegetable feeders, and the mandibles of the larvæ and nymphs closely resemble those of the females; they differ from those of the male in being much stouter and provided with a crushing-edge. The possibility of the male alone being carnivorous requires further research.

14. Bibliography.

Comstock, J. H., & Needham, J. G. (1898).—The Wings of Insects. Amer. Nat. vol. xxxii. pp. 423–424.

Enderlein, G. (1903).—Ueber die Morphologie, Gruppierung, und systematische Stellung der Corrodentien. Zool. Anz. Bd. xxiv. pp. 423–37.

—— (1909).—Die Klassification der Embiiden, nebst morphologischen und physiologischen Bemerkungen, besonders über das Spinnen derselben. Zool. Anz. Bd. xxxv. pp. 166–91, 3 figs.

—— (1912).—Embiiden. In:—Collections Zoologiques du Baron Edm. de Sélys-Longchamps, Fasc. iii. No. 5, pp. 1–121, pls. 1–4, and 76 text-figs.

Friedrichs, K. (1906).—Zur Biologie der Embiiden. Neue Untersuchungen und Uebersicht des Bekannten mit Beitragen über die Systematik und Postembryonalen Entwicklung mediterraner Arten. Mitt. Zool. Mus. Berlin, iii. pp. 213–40, with 19 text-figs.

—— (1907).—Zur Systematik der Embiiden. Verh. zool.-bot. Ges. Wien, Bd. lvii. pp. 270–75.

GRASSI, B., & SANDIAS, A. (1897–98).—The Constitution and Development of the Society of Termites: Observations on their Habits; with Appendices on the Parasitic Protozoa of the Termitidæ, and on the Embiidæ. Quart. Journ. Micr. Sci. vol. xl. pt. I. pp. 55–75, pl. 19 (in vol. xxxix.). (English translation by W. F. H. Blandford of the original memoir in Atti Accad. Gioen. Catania, 1894.)

HAGEN, H. (1885).—Monograph of the Embidina. Canadian Entom. vol. xvii. pp. 141–155, 171–178, 190–199.

KRAUSS, H. A. (1911).—Monographie der Embien. Zoologica, Bd. xxiii. Heft 60, pp. 1–78, pls. 1–5, and 7 text-figs.

KUSNEZOV, N. J. (1904).—Observations on *Embia taurica*, Kusnezov (1903), from the southern coast of the Crimea. Horæ Soc. Entom. Ross. Bd. xxxvii. pp. 138–73. (In Russian, but with an abstract in English, pp. 166–69.)

LUCAS, H. (1859).—Quelques remarques sur la propriété que possède la larve de l'*Embia mauritanica* sécréter une matière soyeuse destinée à construire des fourreaux dans lesquels elle subit ses divers changements de peau. Ann. Soc. Ent. France, Sér. 3, Tome vii. pp. 441–444.

MACLACHLAN, R. (1877).—On the Nymph-stage of the Embidæ, with notes on the habits of the Family. Journ. Linn. Soc. Lond., Zool. vol. xiii. pp. 373–84, pl. 21.

MELANDER, A. (1902).—Two new Embiidæ. Biol. Bull. vol. iii. pp. 16–26, with 4 text-figs.

—— (1903).—Notes on the Structure and Development of *Embia texana*. Biol. Bull. vol. iv. pp. 99–118, with 6 text-figs.

PERKINS, R. C. L. (1897).—Notes on *Oligotoma insularis*, McLachl. (Embiidæ), and its immature conditions. Entom. Month. Mag. vol. xxxiii. pp. 56–58.

RIMSKY-KORSAKOW, M. (1905).—Beitrag zur Kenntnis der Embiiden. Zool. Anz. Bd. xxix. pp. 433–42, with 6 text-figs.

—— (1910).—Ueber das Spinnen der Embiiden. Zool. Anz. Bd. xxxvi. pp. 153–56, with 2 text-figs.

SAUSSURE, H. DE (1896).—Note sur la tribu des Embiens. Mitt. Schweiz. Entom. Ges. Bd. ix. pp. 339–55, 1 pl. (For a summary *vide* Zool. Centralbl. 1896, p. 697.)

VERHŒFF, K. W. (1904).—Zur vergleichenden Morphologie und Systematik der Embiiden, zugleich 3[ter] Beitrag zur Kenntnis des Thorax der Insekten. Acta Acad. Cæs. Leop.-Carol. Halle, lxxxii. pp. 145–205, Taf. 4–7.

WASMANN, E. (1904).—Termitophilen aus dem Sudan. Res. Swed. Zool. Exp. White Nile 1901, No. 13, pp. 17–20, Taf. 1. fig. 6.

WESTWOOD, J. O. (1837).—Characters of *Embia*, a genus of Insects allied to the White Ant (Termites), with a description of the species of which it is composed. Trans. Linn. Soc. Lond. vol. xvii. pp. 369–374, pl. 11.

WOOD-MASON, J. (1883).—A Contribution to our Knowledge of the Embiidæ, a family of Orthopterous Insects. Proc. Zool. Soc. Lond. pp. 628–34, pl. 56.

EXPLANATION OF THE PLATES.

Reference Lettering.

abd. .... Point of attachment of abductor muscle.
a.cl. .... Ante-clypeus.
add. .... Point of attachment of adductor muscle.
b.j. .... Modified proximal joint of left cercus.
b.p. .... Basal plate of cercus.
car. .... Cardo.
cl. ...... Clypeus.
cond. .. Condyle.
g. ...... Outer lobe or paraglossa of 2nd maxilla (labium).
gal. .... Galea.
g.ap. .... Female genital aperture.
ging. .... Ginglymus.
l. ...... Inner lobe of 2nd maxilla (labium).
lac. .... Lacinia.
lb. ...... Labrum.
l.p. .... Labial palp (left).
l.tg.$_{10}$ .. Left plate of 10th tergite.
m.$_1$ .... Mentum.
m.$_2$ .... Submentum.
mp. .... Median plate.
mx.p. .. Maxillary palp.
p.cl. .... Post-clypeus.
pgr. .... Rudiment of palpiger.
pl. .... Pleuron.
rt.g.$_{10}$ .. Right plate of 10th tergite.
st. ...... Stipes.
st.$_7$ .... Seventh sternite.
st.$_8$ .... Eighth do.
st.$_9$ .... Ninth do.
st.$_{10}$ .... Tenth do.
tg.$_1$ .... First tergite.
tg.$_8$ .... Eighth do.
tg.$_9$ .... Ninth do.
tg.$_{10}$ .... Tenth do.
tr.$_1$ .. } *tr.*$_2$ .. } Arolia of 1st tarsal joint ("metatarsus").
tr.$_3$ .... Arolium of 2nd tarsal joint.
u.c. .... Entrance to underground chamber.
v.p. .... Ventral process of 9th sternum.
v.r.tg.$_{10}$.. Ventral aspect of right plate of 10th tergite.

Plate 36.

The figures on this plate are from rapid pencil-sketches drawn from Nature out in the field. They represent the various types of nests made by *Embia major*, and are rather smaller than natural size. The nest numbers refer to those enumerated in the table on p. 188.

Fig. 1. The simplest form of nest, consisting of a single tunnel and no underground chamber. Nest no. 6.

2. A complex type of nest, containing two underground chambers. The total length of this nest was 1 foot 4 inches. Nest no. 47.
3. A relatively large nest of simple construction, measuring 11¼ inches in length and 5½ inches in breadth. Nest no. 20.
4. A small nest without an underground chamber. Nest no. 26.
5. A very usual type of small nest. Nest no. 39.
6. A simple branched nest with no underground chamber. Nest no. 35.
7. A simple "looped" nest with underground chamber. Nest no. 29.
8. A small much branched nest without an underground chamber. Nest no. 85.
9. A small branched nest with underground chamber. Nest no. 110.
10. A relatively complex type of nest, containing a long underground chamber lined with silk and provided with two entrances.

PLATE 37.

With the exception of figs. 1 and 4 all were first drawn in outline with the aid of an Abbe drawing apparatus.

Fig. 1. An adult male viewed dorsally. × circa $5\frac{1}{2}$.

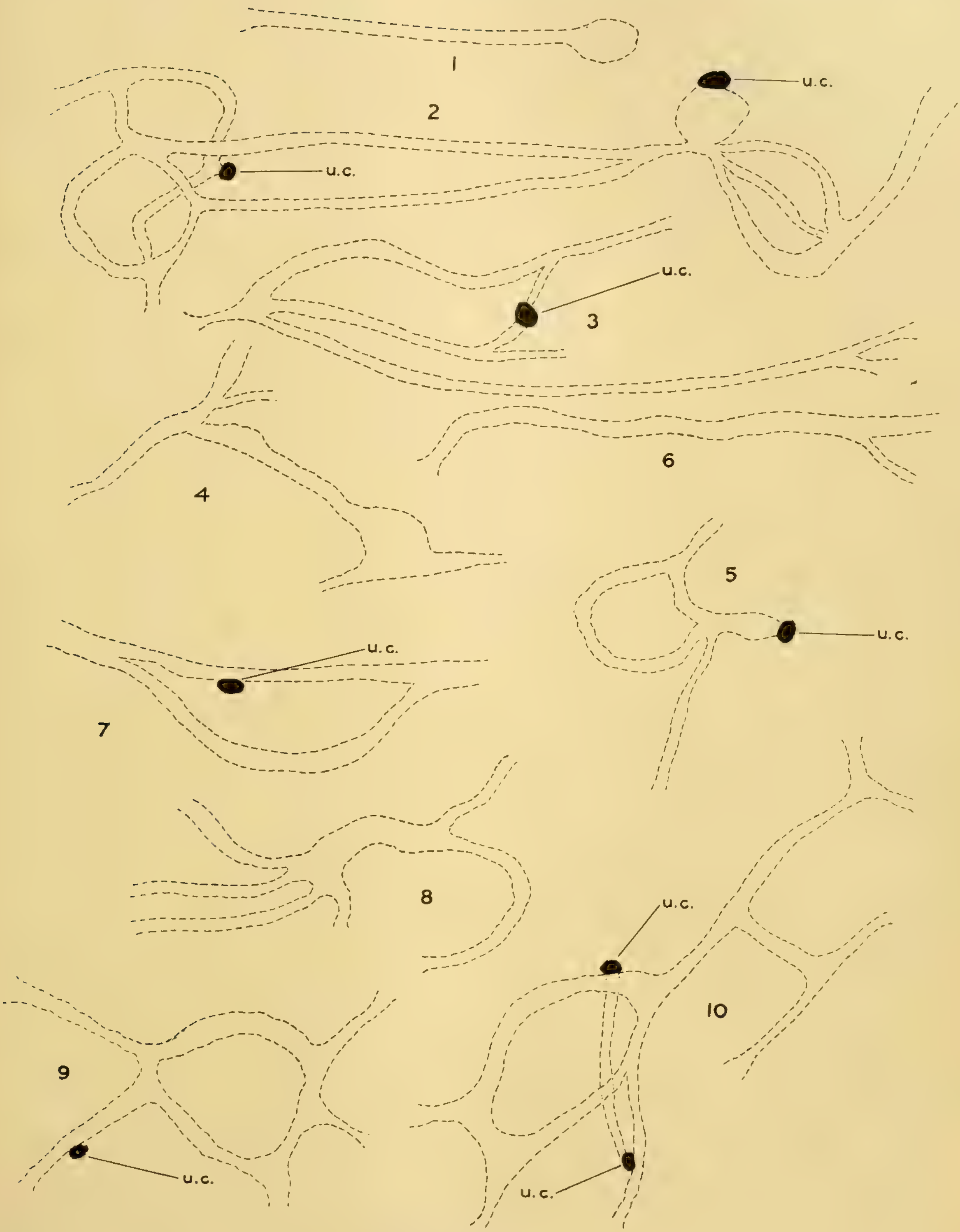
2. The apex of the ventral aspect of the abdomen in the adult male. × 16.
3. The apex of the dorsal aspect of the abdomen in the adult male. × 16.
4. A fully grown male nymph. The unequally divided 10th tergite of the adult is seen showing through the nymphal cuticle. × 7.
5. The apical three abdominal segments of a young male nymph seen from the dorsal aspect. × 16.
6. The apex of the abdomen of a young male nymph seen from the ventral aspect. The pair of small plates representing the 10th sternite are clearly visible. × 16.
7. A newly hatched larva seen from the dorsal aspect. × circa 38.

PLATE 38.

With the exception of fig. 1 all were first drawn in outline with the aid of an Abbe drawing apparatus.

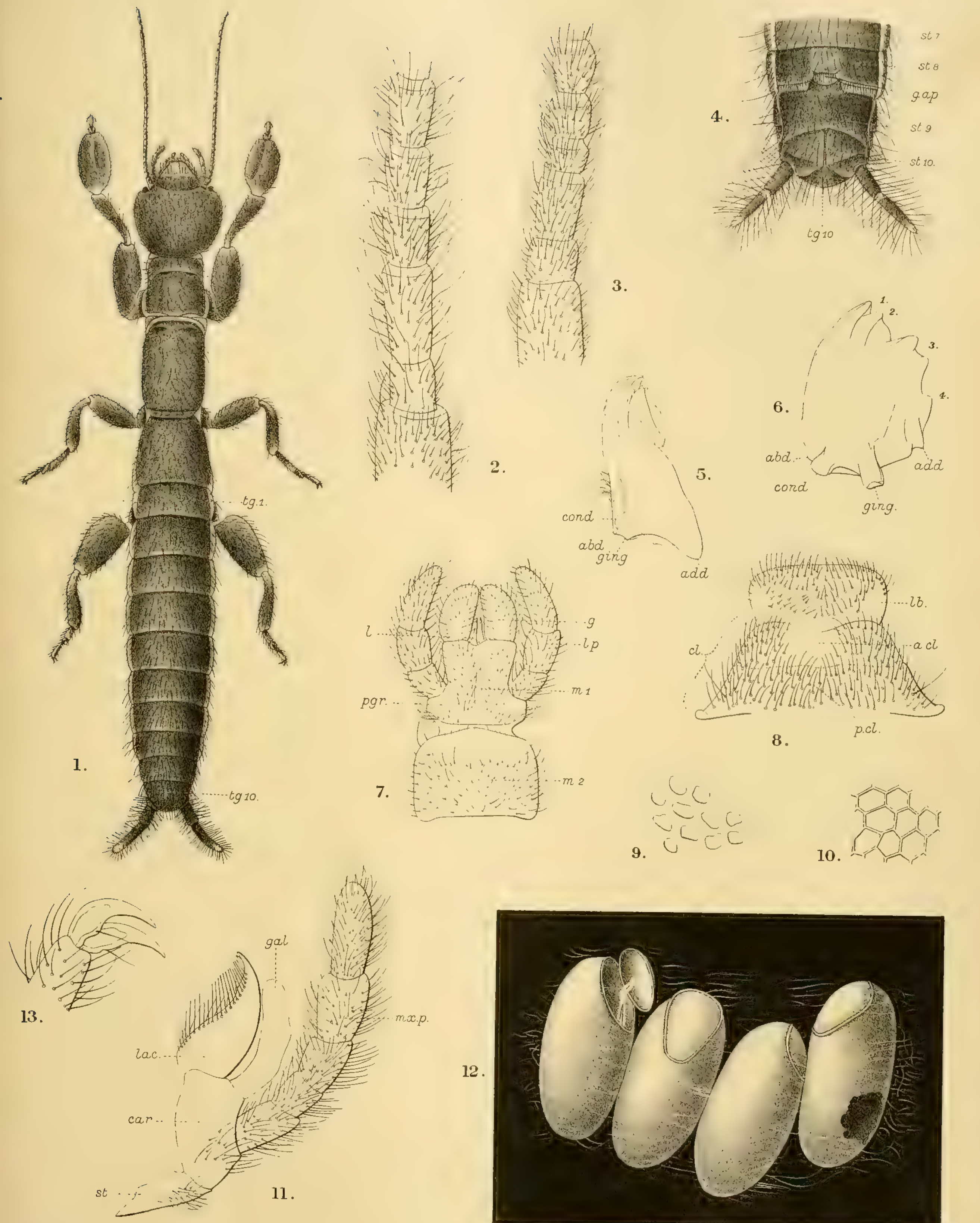
Fig. 1. An adult female viewed dorsally. × circa $7\frac{1}{2}$.

2. The first six joints of the left antenna of the male. (From a preparation mounted in Canada balsam.) × 28.
3. The first six joints of the left antenna of the female. (From a preparation mounted in Canada balsam.) × 28.
4. The last four abdominal segments of the adult female seen from the ventral side. × 10.
5. Left mandible of the male. (From a specimen mounted in Canada balsam.) × 28.
6. Left mandible of the female. (From a specimen mounted in Canada balsam.) × 28.
7. The 2nd maxillæ (labium) of the male seen from the ventral (external) surface. (From a specimen mounted in Canada balsam.) × 28.
8. The labium and clypeus of the male. The dotted line marks the division between the membranous *ante-clypeus* and the more strongly chitinised *post-clypeus.* (From a specimen mounted in Canada balsam.) × 28.
9. A portion of the surface of the operculum of the egg showing the sculpturing of the chitin. (From a specimen mounted in Canada balsam.) × 103.
10. A portion of the general surface of the chorion of the egg showing the sculpturing of the chitin. (From a specimen mounted in Canada balsam.) × 103.
11. The right 1st maxilla of the male. (From a specimen mounted in Canada balsam.) × 28.
12. A group of four eggs showing the fine silken threads that bind them together. The young larva has emerged from the egg on the left, and a portion of the egg membrane is seen attached to the operculum. The two eggs in the middle of the group have not yet hatched. The egg on the right shows the exit hole made by a minute egg-parasite of the family Scelionidæ and belonging to the genus *Embidobia,* Ashm., or a closely allied form. × 37.
13. The claws of the right middle leg of the adult male. (From a specimen mounted in Canada balsam.) × 51.



A. D. I., del.

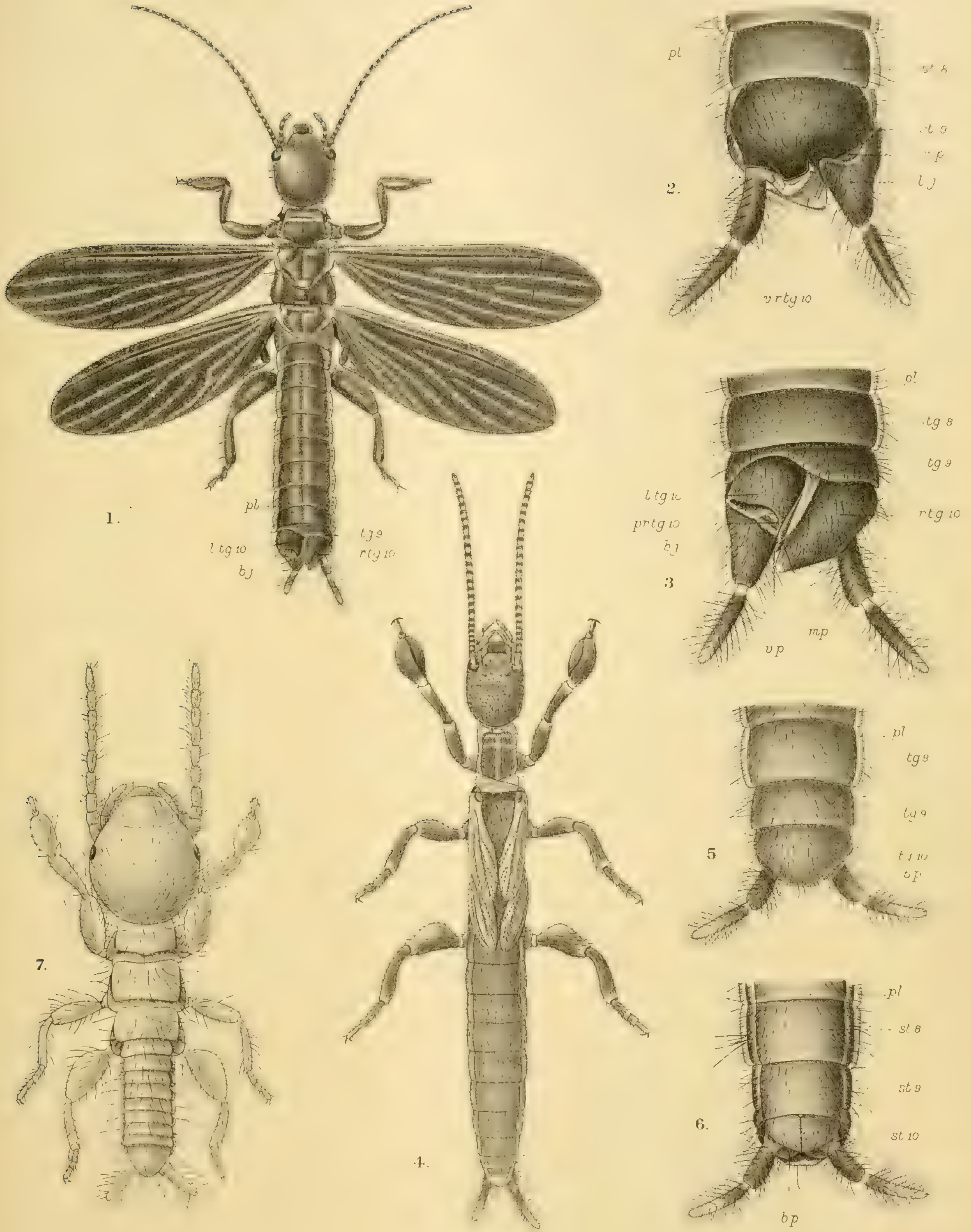
EMBIA MAJOR, sp. nov.



Westwood Bequest

EMBIA MAJOR, sp. nov.

University Press, Cambridge.



Westwood Bequest

University Press, Cambridge

EMBIA MAJOR, sp. nov.

XIII. *The Foraminifera of the West of Scotland. Collected by* Prof. W. A. Herdman, *F.R.S., on the Cruise of the S.Y. 'Runa,' July–Sept.* 1913. *Being a Contribution to 'Spolia Runiana.'*

By Edward Heron-Allen, *F.L.S., F.Z.S., F.R.M.S., and* Arthur Earland, *F.R.M.S.*

(Plates 39–43 and Map.)

Read 4th November, 1915.

Introduction.

The cruise of Professor Herdman's Steam Yacht 'Runa' for the year 1913 provided us with twenty-five bags of Foraminiferous material, both dredgings and shore-sands, collected by Miss Catherine Herdman between the 10th of July and the 3rd of September. In addition, there were a few small samples of mud washed from Invertebrata which had been preserved in alcohol.

The original intention of the Collectors was to supply us with a series of samples linking up in some measure our Clare Island (W. of Ireland) material and the dredgings of the International Fisheries Commission (Scotland) Cruiser 'Goldseeker,' for the purposes of the 'Monograph of the British Recent Foraminifera' upon which we are engaged. The examination of the first four samples in Register (not Geographical) order, however, made it clear to us that we were confronted with an extremely valuable series of gatherings, which would add many important records to the list of hitherto-identified British species, and we consequently laid our other work aside and devoted the period from October 1913 to November 1914 to the examination of the material with a view to the production of this Monograph, regarding it as an important contribution to our larger work.

The results have amply justified our anticipations, for, though we only record one (? two) species and one (? two) varieties new to Science, no less than twenty-seven species are now recorded for the first time from the British Area *, whilst a very considerable number make their appearance for the second time only, in a British List. The total number of species and varieties identified in the gatherings is 324. The material consisted, with the exception of the small samples in spirit, of dried fine sands and muds, without, as a rule, any notable admixture of shells or stones. Had these been present in any quantity we have no doubt that the list of normally adherent arenaceous and other forms might have been considerably extended. The dredgings, again, were made in comparatively shallow waters, the greatest depth being 60 fathoms (at Stns. 16 and 21), which accounts for the absence of many deeper-water forms which might have been expected from the area.

The bags were filled with great discretion by Miss Herdman, whenever the material

* See note on p. 204.

looked promising, both on the outward and homeward journeys, with the result that the Registered order is in no sense Geographical. We have therefore drawn up a geographical list from north to south which runs as follows:—

'*Runa*' (1913) *Stns. from North to South.*

No. 11. Loch Shell, Island of Lewis. Dredging, 25 fms.
,, 10. Shiant, East Bank. Dredging, 30 fms.
,, 20. Between Ru Ruag and Carr Point, Ross. Dredging, 20 fms.
,, 12. Loch Dunvegan, Skye. Dredging, 50 fms.
,, 13. Off Neist Point, Skye. Dredging, 50 fms.
,, 19. Off Croulin Beg, Ross. Dredging, 20–30 fms.
,, 14. Off mouth of Loch Ainneart, Skye. Dredging, 30 fms.
,, 26. (Various localities round Skye (ex alcohol), 30–50 fms.)
,, 21. Loch Hourn, Inverness. Dredging, 60 fms.
,, 8. Sandy Island, Canna. Shore-sand.
,, 17. Loch Scresort, Rhum. Dredging, 3 fms.
,, 16. Between Rhum and Eigg. Dredging, low water to 60 fms.
,, 18. Off S. of Eigg. Dredging, 30 fms.
,, 3. Off Ardnamurchan, Inverness. Dredging (shell-bank), 30 fms.
,, 9. Laga Bay, Loch Sunart. Dredging, 5–12 fms.
,, 4. Loch Sunart. Dredging, 12 fms.
,, 15. Tobermory Bay, south entrance. Coralline sand. Dredging, low water to 1 fm.
,, 2. Sound of Mull. Dredging, 20 fms.
,, 7. Gott Bay, Tiree. Shore-sand.
,, 5. Soriby Bay, Loch Tuadh, Ulva. Dredging, 18 fms.
,, 6. Iona, Atlantic shore. Shore-sand.
,, 22. Oronsay, S.E. Shore-sand.
,, 25. Eilean Gartmeal, Oronsay. Shore-sand.
,, 1. Lowlandman's Bay, Jura. Anchorage, 5 fms.
,, 23. Near Port Erin, Isle of Man. Dredging, off Bradda Head, 20 fms.

Stations 1, 2, 3, and 4 were examined first, and 259 species and varieties were provisionally noted from them, and a list published in the 'Annual Report of the Liverpool Marine Biology Committee for 1913' (pp. 26–32). The list suffers from the drawbacks inseparable from such hasty work; a few species have been abandoned in the light of a larger series of specimens since to hand, and other specific names have taken their places in the present Monograph *. *Sagrina nodosa*, P. & J., was a *lapsus calami* for *Sagrina dimorpha*, P. & J. In the Annual Report for 1914 we gave

* The determinations which have been abandoned, or other determinations substituted for them, are:—*Saccammina sphærica*, *Reophax findens*, *Verneuilina pygmæa*, *Bolivina beyrichi* var. *alata*, *Bolivina porrecta*, *Lagena auriculata*, *chasteri*, *schlichti*, and *stewartii*, *Nodosaria vertebralis*, *Uvigerina canariensis*, *Sagrina nodosa*, *Spirillina limbata* and *margaritifera*, *Discorbina vilardeboana* and *wrightii*.

Prof. Herdman a list of 112 species and varieties from Stn. 23, "Off Bradda Head, near Port Erin, 20 fms.," as being of special local interest.

The subjoined list of Stations, and descriptions of the material examined, is arranged in Geographical order, proceeding from the northernmost gathering to the southernmost:—

No. 11. (*Label*) "Loch Shell, Island of Lewis. Dredging, 25 fms. 5 Aug. 1913."

A block of dried grey mud, 2 lbs. 10 oz., with molluscan fragments and débris. $10\frac{1}{2}$ oz. of grey granite and quartz-pebbles and a few shells removed on 1/10 inch sieve. Washed on 250-mesh silk. Residue, 150 cc. Floatings, 4·5 cc. Elutriated material, 9 cc. 122 spp. and vars.

Noteworthy forms: *Nodosaria proxima*, *Vaginulina linearis*.

No. 10. (*Label*) "Shiant, East Bank. Dredging, 30 fms. 4 Aug. 1913."

(*a*) 2 lbs. 6 oz. of muddy shell-débris. Shells removed on 1/10 inch sieve, 1 lb. 6 oz. Residue, 1 lb. (420 cc.). Washed on 250 mesh silk. Residue, 370 cc. Floatings, 8 cc.

(*b*) Muddy débris washed from Invertebrata preserved in alcohol. (Label) "Shiant Bank. 13 Aug. 1913." Residue after washing, 8·5 cc. Floatings, ·25 cc. (very rich).

A considerable quantity of the shell-débris examined and many adherent arenaceous forms found. 170 spp. and vars.

Noteworthy forms: *Miliolina suborbicularis*, *Planispirina sigmoidea*, *Pelosina variabilis*, *Hyperammina vagans*, *Bulimina minutissima*, *Orbulina universa*.

No. 20. (*Label*) "Between Ru Ruag and Carr Point (off Gairloch), Ross. Dredging, 20 fms. 16 Aug. 1913."

Grey sandy mud, $7\frac{1}{4}$ lbs. (3 lbs. examined). Shells removed on 1/10 sieve, $9\frac{1}{2}$ oz. Residue after washing, 760 cc. Floatings, 15 cc. (very rich). Fine specimens of *Jaculella obtusa*, Br., *Jaculella acuta*, Br., *Cornuspira foliacea* (Philippi), and *Botellina labyrinthica*, Br., common in the coarse siftings. Also fine fistulose Polymorphinæ and *Biloculina sphæra*, d'Orbigny. 164 spp. and vars.

Noteworthy forms: *Miliolina bucculenta*, *Psammosphæra bowmanni*, *Lagena pulchella* var. *hexagona*, nov., *Truncatulina tenera*.

No. 12. (*Label*) "Loch Dunvegan, Skye. Dredging, 50 fms. 7 Aug. 1913."

Dredge refuse: $3\frac{1}{2}$ lbs. of shells, whole and in fragments; sponges, corals, and matted Polyzoa. Many small grey rolled granite-pebbles with adherent Foraminifera and other organisms. Sticky, difficult material. Washed several times on 1/10 sieve in water and hot soda. Residue, light stuff full of Polyzoa 60 cc., heavier 145 cc. Floatings, principally from heavier residue, 7·5 cc. 142 spp. and vars.

Noteworthy forms: *Miliolina labiosa*, *Haliphysema tumanowiczii*, *Trochammina inflata* and *nitida*, *Nodosaria pauperata*.

No. 13. (*Label*) "Off Neist Point, Skye. Dredging, 50 fms. 8 Aug. 1913."

Black coarse gravel, 2830 cc., with much yellow-brown worn shell-débris (very like an Eocene fossil clay washing). A small echinoderm (*Echinocyamus pusillus*) very common. Siftings through 1/10 sieve, 1350 cc. Fine material only 20 cc., 615 cc. of coarse and all the fine material floated. Floatings (poor), 22 cc. 87 spp. and vars.

Noteworthy forms: *Bulimina minutissima, Discorbina chasteri* var. *bispinosa.*

No. 19. (*Label*) "Off Croulin Beg, Ross. Dredging, 20–30 fms. 13 Aug. 1913."

(*a*) Coarse shell-detritus and stones, $2\frac{1}{4}$ lbs. Shells and stones removed on 1/10 sieve, 1 lb. $7\frac{1}{2}$ oz. Residue after washing, 300 cc. Floatings (very rich), 11·5 cc. (95 °/ₒ Buliminæ).

(*b*) A small sample of mud and shell-detritus washed from Invertebrata preserved in spirit. Same label and date. Residue after washing, 1 cc.

(*c*) Same as (*b*), 14–15 Aug. 1913, 5 cc. Residue after washing, 4 cc.

141 spp. and vars.

Noteworthy form: *Bulimina ovata.*

No. 14. (*Label*) "Off mouth of Loch Ainneart, Skye. Dredging, 30 fms. 9 Aug. 1913."

Dark grey sandy mud, 250 cc. with shells, whole and in fragments. *Turritella*, *Trochus*, and various Lamellibranchs removed on 1/10 sieve, 50 cc. Residue, 115 cc. Floatings (poor) and Elutriation (richer) mixed together, 7 cc. 136 spp. and vars.

Noteworthy forms: *Psammosphæra bowmanni, Textularia fusiformis* and *concava* var. *heterostoma, Lagena cymbula, Sphæroidina* sp. nov., *Nonionina orbicularis.*

No. 26. (*Label*) "General. From several localities round Skye. 30–50 fms. No date."

About 7–8 cc. of light grey sand-material, principally fragments of Polyzoa (*Sertularia* etc.) with adherent Foraminifera. Washings from Invertebrata preserved in alcohol.

Many fine adherent forms. 94 spp. and vars.

Noteworthy forms: *Placopsilina vesicularis, Frondicularia tenera.*

No. 21. (*Label*) "Loch Hourn, Inverness. Dredging, 60 fms. 20 Aug. 1913."

A solid block of hard grey sandy mud with molluscan fragments and whole shells, $3\frac{1}{4}$ lbs. Shell-débris removed on 1/10 sieve, $6\frac{1}{2}$ oz. Very fine and sticky material. After soaking in hot soda and washing, dry residue, 365 cc. Floatings (very rich), 8 cc. (Buliminæ, 98 °/ₒ.) Elutriation (very rich), 12 cc. 94 spp. and vars.

No. 8. (*Label*) "Sandy Island, Canna. Shore-scraping. Low water. 24 July, 1913."

Fine grey-white sand with finely pounded molluscan débris. Floatings, 9 cc. (pure Foraminifera). 66 spp. and vars.

Noteworthy form: *Discorbina parisiensis.*

No. 17. (*Label*) "Loch Scresort, Rhum. Dredging, 3 fms. 13 Aug. 1913."

Grey sandy mud with shells; stones with adherent forms and molluscan débris. Residue after washing, 350 cc. Floatings (very rich), 15·5 cc. Elutriation from 120 cc. of washed material (very rich), 9 cc. Fine siftings through 150-mesh silk (very rich), 1·2 cc. 109 spp. and vars.

Noteworthy forms: *Haplophragmium rumianum*, nov., *Lagena aspera* and *reniformis*, *Lingulina carinata*, *Cristellaria variabilis*.

No. 16. (*Label*) "Off East Coast of Rhum, between Rhum and Eigg. Dredging, low water to 60 fms. 12 Aug. 1913."

A nut-brown detrital shell-sand (very like No. 3, *post*), 3 lbs. Coarse material removed on 1/10 sieve, 750 cc. Residue, 1080 cc. A few grey granite-pebbles with adherent forms. Floatings (poor), ·5 cc. Elutriation (fair), 6·5 cc. 107 spp. and vars.

Fine fistulose Polymorphinæ in the coarse siftings.

Noteworthy forms: *Textularia sagittula* var. *jugosa*, *Truncatulina akneriana*, *Pulvinulina brongniartii*.

No. 18. (*Label*) "Off South of Eigg. Dredging, 30 fms. 13 Aug. 1913."

Loose grey sandy mud with shells and molluscan fragments, 3¾ lbs. Much algal detritus and small stones. Whole bulk, 1300 cc. Shell-débris and stones removed on 1/10 sieve, 150 cc. Residue after washing, 175 cc. Floatings (pure Foraminifera), 5 cc. Elutriation (very rich), 13 cc. 169 spp. and vars.

Noteworthy forms: *Storthosphæra albida*, *Lagena semilineata* and *formosa*, *Globigerina dubia*.

No. 3. (*Label*) "Off Ardnamurchan, Inverness. Shell-bank. Dredging, 30 fms. 14 July, 1913."

A nut-brown shell and coral detritus, 2335 cc. Very clean and coarse. Very like No. 16 (*ante*). Coarsest material retained on 1/10 sieve, 1100 cc. Floatings from residue (very rich), 13 cc. 123 spp. and vars.

(See Rep. Liverpool Marine Biol. Com. 1913, p. 27, figs. 12, 13.)

The coarse siftings very rich in gigantic forms of *Polymorphina* (fistulose), *Gypsina*, *Miliolina*, *Pulvinulina*, etc.

Noteworthy forms: *Spiroplecta fusca*, *Lagena marginata* var. *semimarginata*, *Pulvinulina elegans*.

No. 9. (*Label*) "Laga Bay, Loch Sunart. Dredging, 5–12 fms. 26 July, 1913."

(*a*) A small sample of grey-black muddy dredge-débris, with large shells (*Pecten*, *Venus*, *Donax*, etc.). Sponge and algal refuse and masses of cilia of a crinoid (*Antedon bifida*, Penn.). Bulk of the whole (by displacement), 30 cc. Residue after washing and removing shells etc. on 1/10 sieve, 18 cc. Floatings (very rich), 10·5 cc. (accounted for by *Antedon* and Polyzoa).

(*b*) A small sample of washings from Invertebrata preserved in alcohol. Same label and date, "5–10 fms." Residue after washing, 3–4 cc. Very few Foraminifera. 113 spp. and vars.

Noteworthy form: *Lagena semilineata.*

No. 4. (*Label*) "Loch Sunart. Dredging, 12 fms. 15 July, 1913."

(*a*) A solid lump ($3\frac{1}{2}$ lbs.) of light grey sandy mud, with fragments of mollusca. Bulk, 1000 cc. Very sticky, difficult material. First residue after washing, 525 cc. Floatings (rich), 9 cc. Soaked for ten days. Second residue after washing, 348 cc. Floatings (very rich), 11 cc. The finest and richest of the 'Runa' 1913 dredgings. 203 spp. and vars.

(See Rep. Liverpool Marine Biol. Com. 1913, p. 27.)

(*b*) A small sample of mud washed from Invertebrata preserved in alcohol. Residue after washing (matted with byssus and algal refuse), 2·5 cc., fairly rich.

Noteworthy forms: *Spiroloculina acutimargo* var. *concava*, *Valvulina conica*, *Bulimina echinata*, *Bolivina tortuosa*, *Lagena aspera*, *striato-punctata*, *falcata*, and *reniformis*, *Nodosaria calomorpha* and *proxima*, *Lingulina carinata* var. *bicarinata* and var. *seminuda*, *Frondicularia spathulata.*

No. 15. (*Label*) "Coralline sand. South entrance to Tobermory Bay, Mull. Low water to 1 fm. 10 Aug. 1913."

A large bag of very light dredge-débris, $5\frac{1}{2}$ lbs., sponges, calcareous algæ, molluscan fragments, and small black worn pebbles with adherent Foraminifera. Principally calcareous algæ. Finer material, through 1/10 sieve, 1260 cc. ($2\frac{1}{2}$ lbs.). Floatings (poor), 16 cc. (a mass of dried Copepods and Isopods). 71 spp. and vars.

Noteworthy forms: *Ammodiscus shoneanus*, *Lagena orbignyana* var. *walleriana*, *Discorbina orbicularis.*

No. 2. (*Label*) "Sound of Mull. Dredging, 20 fms. 12 July, 1913."

A solid block of dried black mud with molluscan fragments. Bulk (by displacement), 254 cc. When wetted, a sticky plastic clay. Soaked ten days in water and boiled in soda. Residue after washing shells and small stones 5 cc.; fine material (rich) 5 cc. 102 spp. and vars.

Notable for abundance of *Ammodiscus charoides* (J. & P.).

(See Rep. Liverpool Marine Biol. Com. 1913, p. 26, fig. 10.)

Noteworthy forms: *Cornuspira angigyra*, *Lagena spumosa.*

No. 7. (*Label*) "Gott Bay, Tiree. Shore-scraping. Low water. 23 July, 1913."

A light grey, highly molluscan, fine sand, 1680 cc. Floatings, 21 cc. (pure Foraminifera). Elutriation, 30 cc. (almost pure Foraminifera). Coarse siftings, almost pure *Massilina secans* (d'Orb.) and *Truncatulina lobatula* (d'Orb.). 66 spp. and vars.

Noteworthy form: *Globigerina inflata.*

No. 5. (*Label*) "Soriby Bay, Loch Tuadh, Ulva. Dredging, 18 fms. 18 July, 1913."

Hard and "harsh" pale grey mud, with much fine algal débris and molluscan fragments. *Turritella* and various Lamellibranchs, 800 cc. Residue after first washing, 270 cc. Shell-fragments removed on 1/10 sieve, 15 cc. Residue after second washing, 215 cc. Floatings (fair), 3 cc. 88 spp. and vars.

Noteworthy forms: *Nubecularia lucifuga*, *Nodosaria mucronata*.

No. 6. (*Label*) "Atlantic Shore. Iona. Shore-scraping. Low water. 18 July, 1913."

Brilliantly white quartz-sand, of high sp. gr., 2075 cc. Very "obstinate" material. First floatings, almost entirely molluscan fragments, raised by surface-tension. Final floatings (poor), 1·5 cc. Elutriation (poor), 9·5 cc. 72 spp. and vars.

Noteworthy forms: *Bolivina tortuosa*, *Rotalia schroeteriana*.

No. 22. (*Label*) "Oronsay. Shore-scraping. Low water. 27 Aug. 1913."

Pale grey shore-sand, 5 lbs. Bulk, 1720 cc. Floatings (fair), 2·5 cc. 77 spp. and vars.

Noteworthy forms: *Rhabdammina abyssorum*, *Polymorphina cylindroides*, *Globigerina pachyderma* and *linnæana*, *Orbulina universa*.

No. 25. (*Label*) "Eilean Gartmeal. Oronsay. Shore-sand. 11 July, 1913."

A small sample (40 cc.) of highly molluscan grey sand. Floatings (very poor), 1·5 cc. 42 spp. and vars.

No. 1. (*Label*) "Lowlandman's Bay, Jura. Anchorage, dredging, 5 fms. 10 July, 1913."

A dark grey sandy mud, with shells and molluscan fragments, 500 cc. Shells of *Turritella*, *Trochus*, and various Lamellibranchs, removed on 1/10 sieve, 50 cc. Residue after washing, 115 cc. Floatings (fair), 1 cc. Elutriation (better), 3·5 cc. (mixed together). 90 spp. and vars.

(See Rep. Liverpool Marine Biol. Com. 1913, p. 26, fig. 11.)

Noteworthy forms: *Hyperammina ramosa*, *Bulimina echinata*.

No. 24. (*Label*) "Port Erin, Isle of Man. Shore-scraping. Low-water. 3 Sept. 1913."

Rather dark and dirty grey sand, 1450 cc. Washed, dried, and floated three times. Practically no Foraminifera. A few Polystomellidæ and *Miliolina seminulum* (d'Orb.) only. No type-slide or list made.

No. 23. (*Label*) "Port Erin, Isle of Man. Dredging off Bradda Head, 20 fms. 2 Sept. 1913."

Muddy shell and algal débris, 1 lb. 10 oz., with large shells (*Pecten*, *Cardium*, *Donax*, etc.). Shells removed on 1/10 sieve, 1 lb. Residue after washing, 100 cc., (full of fragments of minute crustaceans). Floatings (fair), 6·5 cc. 112 spp. and vars.

(See Rep. Liverpool Marine Biol. Com. 1914, p. 21.)

Noteworthy forms: *Polymorphina amygdaloides* and *cylindroides.*

The most cursory glance at the above catalogue of material makes it immediately plain that the Collectors have assembled a series of samples of the most diverse possible kind and under the most diverse possible conditions, and a series which has consequently amply repaid the amount of labour that has been devoted to it. Bearing in mind therefore what has been said as to deep-water and attached arenaceous and other forms, the subjoined list of species may properly lay claim to being practically exhaustive for the area under examination.

Species and Varieties recorded as New to Britain *.

Spiroloculina acutimargo, *var.* concava, *Wiesner.*
„ dorsata, *Reuss* *.
„ grata, *Terquem.*
Miliolina anconensis (*Schulze*) *.
Planispirina sigmoidea, *Brady.*
Cornuspira angigyra (*Reuss*).
Rhizammina algæformis, *Brady.*
Haplophragmium canariense, *var.* pauperata, *Chapman.*
Textularia candeiana, *d'Orbigny* *.
„ concava, *var.* heterostoma (*Karrer*).
„ sagittula, *var.* jugosa (*Brady*).
Bulimina echinata, *d'Orbigny.*
Bolivina beyrichi, *Reuss.*
Lagena annectens, *Burrows & Holland.*
„ lacunata, *Burrows & Holland.*
„ marginata, *var.* semimarginata, *Reuss.*
„ spumosa, *Millett.*
Nodosaria proxima, *Silvestri.*
„ roemeri, *Neugeboren.*
Frondicularia tenera, *Bornemann.*
Polymorphina amygdaloides (*Reuss*) *.
Globigerina dubia, *Egger.*
Truncatulina akneriana (*d'Orbigny*).
„ tenera, *Brady.*
Rotalia schroeteriana, *Parker & Jones.*
Polystomella decipiens, *Costa* *.
„ faba, *Fichtel & Moll* *.

* These species have, no doubt, been frequently included under other specific names in British lists.

(*See* NOTE *on the Synonymies*, p. 291.)

Family MILIOLIDÆ.

Subfamily NUBECULARIINÆ.

NUBECULARIA, Defrance.

1. **Nubecularia lucifuga,** Defrance.

Nubecularia lucifuga, Defrance, 1825, Dict. Sci. Nat. (Strasb. 1816–1830) vol. xxxv. p. 210; Atlas Zooph. pl. xliv. fig. 3.
„ „ Brady, 1884, FC. p. 134, pl. i. figs. 9–16.

1 *Station.*

One specimen only from Stn. 5 which has evidently been adherent, the under surface being flattened. It shows the spiral arrangement of the earlier chambers remarkably well.

Subfamily MILIOLININÆ.

BILOCULINA, d'Orbigny.

2. **Biloculina ringens** (Lamarck).

Miliolites ringens, Lamarck, 1804, AM. vol. v. p. 351. No. 1 ; vol. ix. pl. xvii. fig. 1.
Biloculina ringens, Brady, 1884, FC. p. 142, pl. ii. figs. 7, 8.

3 *Stations.*

Very rare, but large and fine examples at Stn. 20 and almost equally good ones at Stn. 19.

3. **Biloculina bulloides,** d'Orbigny.

Biloculina bulloides, d'Orbigny, 1826, TMC. p. 297. No. 1, pl. xvi. figs. 1–4, Modèle No. 90.
„ „ Brady, 1884, FC. p. 142, pl. ii. figs. 5, 6.

11 *Stations.*

Rare on the whole in the dredgings, but common at Stns. 12 and 14.

4. **Biloculina elongata,** d'Orbigny.

Biloculina elongata, d'Orbigny, 1826, TMC. p. 298. No. 4.
„ „ Brady, 1884, FC. p. 144, pl. ii. fig. 9.

14 *Stations.*

Generally distributed, often abundant. There is very little variation, except in the occurrence of a long narrow type at Stns. 4, 18, 20, and 21.

5. **Biloculina depressa,** d'Orbigny.

Biloculina depressa, d'Orbigny, 1826, TMC. p. 298. No. 7, Modèle No. 91.
„ „ Brady, 1884, FC. p. 145, pl. ii. figs. 12, 15–17, pl. iii. figs. 1, 2.

15 *Stations.*

Fairly generally distributed; common at some Stns., the best at Stns. 2, 14, 18, and 19. Specimens with the tail-plate as figured by us (H.-A. & E. 1913, CI. pl. i. fig. 6) occur at several Stns.

6. **Biloculina inflata,** Wright.

Biloculina ringens, Lamarck, var. nov., Balkwill & Wright, 1885, DIS. p. 322, pl. xii. figs. 6, 7.
„ *inflata*, Wright, 1902, GFL. p. 183, pl. xiii. figs. 1–4.

2 *Stations.*

A few specimens at Stn. 19 and many at Stn. 18. The specimens at Stn. 18, which are the best, are rather more compressed than is indicated in Wright's figure—nearer, in fact, to the specimens figured by Millett as biloculine forms of *Miliolina valvularis* (Reuss) (M. 1898, etc., FM. 1898, p. 501, pl. xi. fig. 6). Wright, in first publishing this little form, placed it with *B. ringens*, but it appears to us to be more closely related to *B. irregularis*, the aperture in the young forms of that species being similar but much smaller.

7. **Biloculina irregularis,** d'Orbigny.

Biloculina irregularis, d'Orbigny, 1839, FAM. p. 67, pl. viii. figs. 20, 21.
„ „ Brady, 1884, FC. p. 140, pl. i. figs. 17, 18.

11 *Stations.*

Generally distributed, common at several Stns. The specimens are subject to great variation. D'Orbigny's original figure represents a shell laterally compressed (as contrasted with facial compression such as reaches its limit in *B. depressa*); Brady's examples show this compression in a less marked degree. The 'Runa' specimens are perhaps even more globular than Brady's figures, although at many Stns. specimens occur of a compressed habit; some of these show distinct traces of a third chamber indicated externally, thus constituting a passage-form into *Miliolina.* The young specimens have, as a rule, characteristically small apertures with a slightly projecting lip.

8. **Biloculina sphæra,** d'Orbigny.

Biloculina sphæra, d'Orbigny, 1839, FAM. p. 66, pl. viii. figs. 13–16.
„ „ Brady, 1884, FC. p. 141 (fig.), pl. ii. fig. 4 *a, b.*

3 *Stations.*

Occurs at only three Stns., but is abundant at Stns. 2 and 20, where the specimens are fully developed, and extremely typical and of all sizes.

The species was transferred by Schlumberger (S. 1891, BGF. p. 190, figs. 45, 46) to the genus *Planispirina* on the ground of its internal structure, but in the present state of our knowledge of the Miliolidæ the transference does not appear to us to be desirable.

SPIROLOCULINA, d'Orbigny.

9. **Spiroloculina nitida,** d'Orbigny.

Spiroloculina nitida, d'Orbigny, 1826, TMC. p. 298. No. 4.
„ „ Brady, 1884, FC. p. 149, pl. ix. figs. 9, 10.

3 *Stations.*

Extremely rare. The specimens poor and tending towards *S. planulata.* As a recent British form, it has only been recorded by us from Selsey Bill and Clare Island (H.-A. & E. 1908, etc., SB. 1911, p. 302; and 1913, CI. p. 24).

10. **Spiroloculina grata,** Terquem. (New to Britain.)

Spiroloculina grata, Terquem, 1878, FIR. p. 55, pl. v. figs. 14 *a*–15 *b*.
„ „ Brady, 1884, FC. p. 155, pl. x. figs. 16, 17, 22, 23.

2 *Stations.*

Extremely rare, but one comparatively large and typical specimen occurred at Stn. 20. We have recorded it as an Eocene fossil from Selsey Bill (H.-A. & E. 1908, etc., SB. 1909, p. 311).

11. **Spiroloculina excavata,** d'Orbigny.

Spiroloculina excavata, d'Orbigny, 1846, FFV. p. 271, pl. xvi. figs. 19–27.
„ „ Brady, 1884, FC. p. 151, pl. ix. figs. 5, 6.

21 *Stations.*

Widely distributed and common at many Stns., attaining extremely fine development at Stns. 10, 18, 19, and 20.

12. **Spiroloculina planulata** (Lamarck).

Miliolites planulata, Lamarck, 1804, AM. vol. v. p. 352. No. 4; 1816, etc., Animaux sans vertèbres, Paris, 1822, vol. vii. p. 613. No. 4.
Spiroloculina planulata, Brady, 1884, FC. p. 148, pl. ix. fig. 11 *a*, *b*.

14 *Stations.*

Fairly widely distributed, but not so abundant as *S. excavata.* A very fine series at Stns. 10 and 18; there is, as usual, a tendency to run into *S. dorsata* on the one hand and *S. excavata* on the other. At Stn. 15 a series of specimens running entirely into *S. excavata.*

13. **Spiroloculina dorsata,** Reuss. (New to Britain.)

Spiroloculina dorsata, Reuss, 1870, FSP. p. 464; Schlicht, 1870, FSP. pl. xxxvii. figs. 24–32.
„ „ Jones, Parker, & Brady, 1866, etc., MFC. 1895, p. 110, figs. 4, 8.
„ „ Heron-Allen & Earland, 1914, etc., FKA. 1915, p. 554.

5 *Stations.*

Very rare. The best specimens at Stn. 20. All the specimens are of an excavate type. The species is recorded as new to Britain, but no doubt the numerous British records of *S. limbata* (d'Orbigny) refer entirely or principally to this species. We have discriminated between the two forms in our Kerimba Monograph, *ut supra.*

14. **Spiroloculina acutimargo,** Brady.

Spiroloculina acutimargo, Brady, 1884, FC. p. 154, pl. x. figs. 12–15.
" " Heron-Allen & Earland, 1913, CI. p. 24, pl. i. fig. 8.

5 *Stations.*

Very rare. The best specimens at Stns. 10 and 12. They all show a tendency of the later chambers to enfold and envelop the earlier ones.

15. **Spiroloculina acutimargo,** var. **concava,** Wiesner. (Plate 39. figs. 1-3.) (New to Britain.)

Spiroloculina acutimargo, var. *concava*, Wiesner, 1913, FAR. p. 521, No. 22.

1 *Station.* A single specimen only.

Wiesner in his paper (*ut supra*) records this beautiful little variety, and, so far as we are aware, it has not been figured or described in print. He was good enough to send us specimens of his variety from the Adriatic Sea, and its occurrence in these dredgings is very noteworthy. As will be seen from our figure, the variety is very striking and distinctive, being strongly convex on the one side and correspondingly concave on the other. The whole test is exceedingly thin and delicate in structure. The line of curvature is in the direction of the short axis of the shell. Wiesner regards his specimens as a variety of *S. acutimargo*, Brady; from the curvature of the chambers it might equally be regarded as allied to *S. tenuis*. The reason for the curvature of the chambers is entirely obscure; it may possibly be due to the specimens growing adherent to algæ in the earlier stages of growth.

16. **Spiroloculina tenuis** (Czjzek).

Quinqueloculina tenuis, Czjzek, 1848, FWB. p. 149, pl. xiii. figs. 31–34.
Spiroloculina tenuis, Brady, 1884, FC. p. 152, pl. x. figs. 7–11.

2 *Stations.*

Truly typical examples are very rare, but they occur at two Stns., the best at Stn. 14.

Miliolina, Williamson.

17. **Miliolina bucculenta,** Brady. (Plate 39. figs. 4–6.)

Miliolina bucculenta, Brady, 1884, FC. p. 170, pl. cxiv. fig. 3 *a, b*.
" " Goës, 1894, ASF. p. 118, pl. xxiii. figs. 890–903.

1 *Station.*

One specimen assigned with some hesitation to this species, the aperture being much wider than is the case in any of the deep-water specimens we have seen. This may be due to the breaking away of the shelly plate attached to the penultimate chamber which normally restricts the aperture in this species. It is extremely abundant and attains a very large size in the deep water of the Faroe Channel, from which locality Brady's is the only previous British record.

18. **Miliolina circularis** (Bornemann).

Triloculina circularis, Bornemann, 1855, FSH. p. 349, pl. xix. fig. 4.
Miliolina circularis, Brady, 1884, FC. p. 169, pl. iv. fig. 3; pl. v. figs. 13, 14 (?).

19 *Stations.*

Almost universally distributed, often common, but not attaining any very large or robust growth. The best specimens at Stns. 4, 12, 14, and 18. Wild-growing or Nubecularine individuals, probably referable to this species, were found at Stns. 3 and 15.

19. **Miliolina labiosa** (d'Orbigny).

Triloculina labiosa, d'Orbigny, 1839, FC. p. 178, pl. x. figs. 12–14.
Miliolina labiosa, Brady, 1884, FC, p. 170, pl. vi. figs. 3–5.

1 *Station.*

One good specimen.

20. **Miliolina subrotunda** (Montagu).

Vermiculum subrotundum, Montagu, 1803–8, TB. pt. 2, p. 521.
Miliolina subrotunda, Brady, 1884, FC. p. 168, pl. v. figs. 10, 11.

21 *Stations.*

Almost universally distributed, often abundant, and as usual very variable in character. At some of the Stns., especially Stns. 6, 7, 8, 11, and 15, the specimens are very large. At Stns. 7, 12, and 15 they run wild, and at Stn. 12 this leads to the formation of articuline forms, which also occur at Stn. 20. Similar articuline forms first attracted the attention of Ehrenberg, who separated them under the name *Ceratospirulina sprattii* (Monatsb. K. Ak. Wiss. Berlin, 1858, p. 19, and Abh. K. Ak. Wiss. Berlin, 1872), and of Seguenza, who named them *Quinqueloculina tubulosa* (S. 1862, RPC. p. 35, pl. ii. fig. 8). Subsequently Silvestri figured such forms under Ehrenberg's name (Att. Pont. Acc. Nuovi Lincei, Ann. 57, 1904, p. 139, fig. 1 *a–c*). They are of fairly frequent occurrence in dredgings in which the genus *Miliolina* is prominent.

21. **Miliolina seminuda** (Reuss).

Quinqueloculina seminuda, Reuss, 1865–6, FABS. p. 125, pl. i. fig. 11.
Miliolina seminuda, Heron-Allen & Earland, 1913, CI. p. 27.

5 *Stations.*

Very rare, but a good many specimens at Stns. 7 and 10. The finest and most strongly marked, however, were at Stn. 23.

22. **Miliolina suborbicularis** (d'Orbigny). (Plate 39. figs. 7–9.)

Triloculina suborbicularis, d'Orbigny, 1839, FC. p. 176, pl. x. figs. 9–11.
Miliolina suborbicularis, Heron-Allen & Earland, 1908, etc., SB. 1911, p. 304.

1 *Station.*

A single specimen, which we figure, from Stn. 10. Its occurrence serves to clear up any doubt which we implied in recording the species as recent from Selsey Bill, which was the first British record.

23. **Miliolina trigonula** (Lamarck).

Miliolites trigonula, Lamarck, 1804, AM. vol. v. p. 351. No. 3.
Miliolina trigonula, Brady, 1884, FC. p. 164, pl. iii. figs. 14–16.

15 *Stations.*

Generally distributed and very abundant and finely developed at Stns. 10, 14, and 19. Throughout the dredgings the specimens are remarkably consistent in character, agreeing perfectly with d'Orbigny's figure and Modèle No. 94 (d'O. 1826, TMC. p. 299. No. 7).

24. **Miliolina tricarinata** (d'Orbigny).

Triloculina tricarinata, d'Orbigny, 1826, TMC. p. 299. No. 7, Modèle No. 94.
Miliolina tricarinata, Brady, 1884, FC. p. 165, pl. iii. fig. 17.

13 *Stations.*

Fairly generally distributed. All the specimens are of the regular sharp-edged type, except at Stn. 18, where the species is most abundant and reaches good dimensions. At this Stn. also, and at Stn. 6, some of the individuals show a tendency to depart from the usual regularity of construction and to approach *M.* (*Triloculina*) *plicata* of Terquem (T. 1878, FIR. p. 61, pl. vi. fig. 3), recently figured by us from East Africa (H.-A. & E. 1914, etc., FKA. 1915, p. 562, pl. xli. figs. 17–22).

25. **Miliolina bosciana** (d'Orbigny).

Quinqueloculina bosciana, d'Orbigny, 1839, FC. p. 191, pl. xi. figs. 22–24.
Miliolina bosciana, Millett, 1898, etc., FM. 1898, p. 267, pl. vi. fig. 1.

8 *Stations.*

Much less abundant or widely distributed than the allied species *M. oblonga*, but good and typical examples occur at many Stns., especially Stn. 4. A thin-shelled opalescent type occurs at Stn. 12, and more rarely at Stn. 18, similar to the hyaline specimens of *M. oblonga* referred to under that species. Previously recorded as British only by Mills from the Humber (Trans. Hull Sci. etc. Soc. vol. i. p. 144, pl. x. fig. 17) and by us from Clare Island (H.-A. & E. 1913, CI. p. 25), but has no doubt been included by many authors under *M. oblonga*.

26. **Miliolina oblonga** (Montagu).

Vermiculum oblongum, Montagu, 1803–8, TB. p. 522, pl. xiv. fig. 9.
Miliolina oblonga, Brady, 1884, FC. p. 160, pl. v. fig. 4 *a*, *b*.

15 *Stations.*

Generally distributed, but not common, except at Stn. 18. At practically all the Stns., except Stn. 18, the majority of the specimens are typical, *i. e.* they are of the square-edged type foreshadowed in Montagu's poor figure and represented by d'Orbigny's Modèle No. 95. At Stns. 7, 10, and 18 the curious "lidded" type figured by Williamson (W. 1858, RFGB. pl. vii. figs. 186, 187) and referred to by us (H.-A. & E. 1913, CI. p. 25) occurs. At Stn. 18 great numbers occur of a very thin-walled opalescent form, in company with the other types, but in greater number than either of them. In this the aperture is flush with the ends, somewhat rounded and constricted, sutures flush, and the whole shell practically cylindrical in section. The calcareous matter must form a very small constituent of the test in this variety as they are practically transparent, and apt to fall to pieces at the sutural lines when wetted or handled. This same type occurs in many of the deeper 'Goldseeker' dredgings off the west of Scotland and elsewhere.

27. **Miliolina pygmæa** (Reuss). (Plate 39. figs. 10–18.)

Quinqueloculina pygmæa, Reuss, 1849–50, FOT. p. 384, pl. xlvi. (i.) fig. 3.
Miliolina pygmæa, Brady, 1884, FC. p. 163, pl. cxiii. fig. 16.

16 *Stations.*

Generally distributed and often common. The best specimens at Stn. 20, where a complete range from typically quinqueloculine to spiroloculine specimens was obtained. At all the other Stns. the specimens were milioline, though occasional compressed individuals approaching the spiroloculine form were obtained. The spiroloculine forms appear to be practically inseparable from *Quinqueloculina tenuis* (Czjzek), under which name they have been recorded (cf. *Spiroloculina tenuis,* ante) for purposes of reference. There can be no doubt that the two species are closely related. The species has hitherto only been recorded as British by us from Clare Island (H.-A. & E. 1913, CI. p. 29).

28. **Miliolina rotunda** (d'Orbigny).

Triloculina rotunda, d'Orbigny, 1826, TMC. p. 299. No. 4.
Miliolina rotunda, Millett, 1898, etc., FM. 1898, p. 267, pl. v. figs. 15, 16.

2 *Stations.*

Very rare, one or two typical examples only. The species has been recorded as British only by us from Selsey Bill and Clare Island (H.-A. & E. 1908, etc., SB. p. 303; and 1913, CI. p. 25), but has possibly been included by other authors under *M. seminulum* or *M. circularis.*

29. **Miliolina anconensis** (Schultze). (New to Britain.)

Miliolina anconensis, Schultze, 1854, OP. p. 58, pl. ii. figs. 12, 13.
„ „ Heron-Allen & Earland, 1914, etc., FKA. 1915, p. 568.

5 *Stations.*

The species occurs in company with its allied species, *M. seminulum*, at several Stns., but it is not generally distributed.

Though now recorded for the first time as British, this species must often have occurred, and has no doubt been included (with other varieties) under records of *M. seminulum* (Linné).

30. **Miliolina vulgaris** (d'Orbigny).

Quinqueloculina vulgaris, d'Orbigny, 1826, TMC. p. 302. No. 33.
" " Schlumberger, 1893, MGM. p. 65, pl. ii. figs. 65, 66, and woodcut figs. 13, 14.
Miliolina vulgaris, Heron-Allen & Earland, 1913, CI. p. 28.

4 *Stations.*

A few doubtful specimens of this doubtful species, which was first recorded by us as British (*ut supra*).

31. **Miliolina seminulum** (Linné).

Serpula seminulum, Linné, 1788, SN. p. 3739. No. 2.
Miliolina seminulum, Brady, 1884, FC. p. 157, pl. v. fig. 6.

25 *Stations.*

Universally distributed, often abundant, and attaining very fine proportions, the best perhaps at Stn. 1. Very good and variable at Stn. 17, both round-edged and angular forms occurring.

32. **Miliolina candeiana** (d'Orbigny). (Plate 39. figs. 19–27.)

Quinqueloculina candeiana, d'Orbigny, 1839, FC. p. 199, pl. xii. figs. 24–26.
Miliolina candeiana, Heron-Allen & Earland, 1913, CI. p. 29, pl. ii. figs. 1–4.

10 *Stations.*

The little form, which in the Clare Island report we assigned with some reservations to d'Orbigny's species, occurs at a good many Stns., most abundantly at Stns. 10 and 18. We still feel some uncertainty as to the affinities of the form, but we see no reason to vary the views we then expressed (*ut supra*). If anything, the 'Runa' specimens have a greater tendency to a spiroloculine form than the Irish shells, but the specimens are so variable (while preserving a superficial similarity of general characteristics) that we prefer to retain the species. We are not at all satisfied with the Clare Island figures, which fail to reproduce the opalescent character of the shell, and we take this opportunity of figuring the species again.

We have failed to trace Brady's type-specimens, on which the species was added to the British list; they are not to be found either on the Brackish-water and Tidal River slides (or, indeed, on any of the slides) at Cambridge, nor does the species occur on the Brady type-slides in the British Museum. He quotes it as recorded by Siddall from the River Dee, but we have searched the Siddall collection (which is now in our hands) also in vain for the specimens on which the records rest.

33. Miliolina auberiana (d'Orbigny).

Quinqueloculina auberiana, d'Orbigny, 1839, FC. p. 193, pl. xii. figs. 1–3.
Miliolina auberiana, Brady, 1884, FC. p. 162, pl. v. figs. 8, 9.

15 *Stations.*

Generally distributed, but very rare. The best at Stn. 11, where a single, very large, and typical specimen was found. Other good ones at Stns. 6 and 17. As a rule, they are small and obscure.

34. Miliolina undosa (Karrer).

Quinqueloculina undosa, Karrer, 1867, FO. p. 361, pl. iii. fig. 3.
Miliolina undosa, Brady, 1884, FC. p. 176, pl. vi. figs. 6–8.

2 *Stations.*

A few small specimens at Stns. 8 and 12. They are faintly striate at the edges, agreeing in this respect with the specimens recorded by Sidebottom from Delos (S. 1904, etc., RFD. 1905, p. 13). It has previously been recorded by us as British from Selsey Bill (H.-A. & E. 1908, etc., SB. 1911, p. 304).

35. Miliolina agglutinans (d'Orbigny).

Quinqueloculina agglutinans, d'Orbigny, 1839, FC. p. 195, pl. xii. figs. 11–13.
Miliolina agglutinans, Brady, 1884, FC. p. 180, pl. viii. figs. 6, 7.

4 *Stations.*

Very rare, but a few good examples at Stn. 22.

36. Miliolina fusca (Brady).

Quinqueloculina fusca, Brady, 1870, FTR. p. 286, pl. xi. fig. 2.
Miliolina fusca, Heron-Allen & Earland, 1913, CI. p. 31.

8 *Stations.*

Very rare. A few good examples at Stns. 8, 17, and 22.

37. Miliolina contorta (d'Orbigny).

Quinqueloculina contorta, d'Orbigny, 1846, FFV. p. 298, pl. xx. figs. 4–6.
Miliolina contorta, Goës, 1894, ASF. p. 111, pl. xx. figs. 851, 852.

6 *Stations.*

Scantily represented, but good specimens at several Stns. The square-edged type occurs at all the Stns. except at Stn. 17, where the round-edged form occurs alone. Both types occur at Stn. 18.

38. Miliolina sclerotica (Karrer).

Quinqueloculina sclerotica, Karrer, 1868, MFKB. p. 152, pl. iii. fig. 5.
Miliolina sclerotica, Balkwill & Millett, 1884, FG. p. 24, pl. i. fig. 2.

10 *Stations.*

Fairly widely distributed, but never common, the best at Stn. 18. At most of the

Stns. the round-edged form occurs alone, the square-edged only at Stns. 7, 11, and 23. Both forms occur together at Stns. 1, 18, and 22.

39. **Miliolina ferussacii** (d'Orbigny). (Plate 40. figs. 1–9.)

Quinqueloculina ferussacii, d'Orbigny, 1826, TMC. p. 301. No. 18, Modèle No. 32.
Miliolina ferussacii, Brady, 1884, FC. p. 175, pl. cxiii. fig. 17.

5 *Stations.*

Scantily represented, but at some Stns. reaching quite exceptional size and development. D'Orbigny's "Modèle" is not very satisfactory from the point of view of recent records, as it exhibits an aperture situated on a produced neck, and with few and very strongly marked costæ. Recent specimens, however, have, as a rule, but a very slightly produced neck and numerous but not prominent costal ridges. The species is abundant in many British dredgings, and round the Shetland shores especially attains a larger size than any other Miliolid. The first British record of this species was by Williamson under the name *Miliolina bicornis*, var. *angulata* (W. 1858, RFGB. p. 88, pl. vii. fig. 196).

40. **Miliolina pulchella** (d'Orbigny).

Quinqueloculina pulchella, d'Orbigny, 1826, TMC, p. 303. No. 42.
Miliolina pulchella, Brady, 1884, FC. p. 174, pl. vi. figs. 13, 14, pl. iii. figs. 10–13.

4 *Stations.*

Very rare, but large and excellent individuals at Stn. 1.

41. **Miliolina brongniartii** (d'Orbigny).

Triloculina brongniartii, d'Orbigny, 1826, TMC. p. 300, No. 23.
Quinqueloculina brongniartii, syn. of *M. bicornis*, Brady, 1884, FC. p. 172, pl. vi. fig. 9.
Miliolina brongniartii, Heron-Allen & Earland, 1913, CI. p. 33.

21 *Stations.*

Much more widely distributed in these dredgings than its ally *M. bicornis*. Common at many Stns., the best at Stn. 15.

42. **Miliolina bicornis** (Walker & Jacob).

Serpula bicornis, Walker & Jacob, 1798, AEM. p. 633, pl. xiv. fig. 2.
Miliolina bicornis, Brady, 1884, FC. p. 171, pl. vi. figs. 11, 12.

12 *Stations.*

Widely distributed, but specimens are rare and seldom strongly developed. The best at Stns. 18 and 23. Adelosine examples at Stns. 1, 10, 18, 20, and 23.

43. **Miliolina lævigata** (d'Orbigny).

Adelosina lævigata, d'Orbigny, 1826, TMC. p. 304. No. 1.
" " d'Orbigny, 1846, FFV. p. 302, pl. xx. figs. 22–24.
" " Terquem, 1875, etc., APD. 1876, p. 86, pl. xii. figs. 11 *a*, *b*.
Miliolina lævigata, Heron-Allen & Earland, 1913, CI. p. 32, pl. i. figs. 12, 13.

8 *Stations.*

This little form, which appears to be nothing more than a smooth type of *M. bicornis*, is very sparingly represented in the dredgings, but good specimens and also adelosine examples occur occasionally, the best at Stn. 18.

It should be noted that the synonymy of this species as given by us in our Clare Island Report requires correction, the *Quinqueloculina lævigata* of d'Orbigny having been confounded with his *Adelosina lævigata* when the references were compiled. The first two references to d'Orbigny, 1826, TMC. (ASN.), and 1839, FIC., should be removed and the above synonymy substituted.

An examination of the d'Orbigny types in Paris shows that his species *Triloculina dubia* (d'O. 1826, TMC. p. 300. No. 24) is identical with this form.

44. **Miliolina stelligera** (Schlumberger). (Plate 39. figs. 28–31.)

Quinqueloculina stelligera, Schlumberger, 1893, MGM. p. 68, pl. ii. figs. 58, 59.
Miliolina stelligera, Heron-Allen & Earland, 1913, CI. p. 31, pl. i. figs. 14, 15.

6 *Stations.*

Very rare, the only Stn. where more than one or two specimens were observed being Stn. 18. The 'Runa' specimens are more strongly carinate and more deeply sunk in the sutural lines than is shown in Schlumberger's figure, and we take this opportunity of figuring the form, as the 'Runa' specimens are much stronger than those which we figured from Clare Island. The surface of the tests is uniformly dull and unpolished.

Subgenus Massilina, Schlumberger.

45. **Massilina secans** (d'Orbigny).

Quinqueloculina secans, d'Orbigny, 1826, TMC. p. 303, No. 43, Modèle No. 96.
Miliolina secans, Brady, 1884, FC. p. 167, pl. vi. figs. 1, 2.
Massilina secans, Schlumberger, 1893, MGM. p. 76 (woodcuts figs. 31–34), pl. iv. figs. 82, 83.

8 *Stations.*

Very rare, except at Stns. 7 and 8, where, however, the individuals were small and weak compared to those of the other Stns. where only one or two specimens were obtained, but these large and typical. The extraordinary rarity of this form down the West of Scotland is very noticeable, considering its abundance on the western English and Irish coasts. It is equally dominant in the shore-sands of Scapa, Orkney—the gaps in the distribution of the form are inexplicable.

Subfamily Hauerininæ.

Opthalmidium, Kübler.

46. **Opthalmidium carinatum,** Balkwill & Wright.

Opthalmidium carinatum, Balkwill & Wright, 1885, DIS. p. 326, pl. xii. figs. 13–16.
,, ,, Heron-Allen & Earland, 1913, CI. p. 34.

15 *Stations.*

Generally distributed, often common, the best specimens at Stns. 4 and 10. All the specimens are very true to the type of Balkwill and Wright's figure. Hardly any variation, except at Stn. 12, where the final chamber becomes very inflated.

PLANISPIRINA, Seguenza.

47. **Planispirina celata** (Costa).

Spiroloculina celata, Costa, 1855, FFMV. p. 126, pl. i. fig. 14; 1853, etc., PRN. 1856, pl. xxvi. fig. 5.

Planispirina celata, Brady, 1884, FC. p. 197, pl. viii. figs. 1–4.

10 *Stations.*

Sparingly distributed and rare, except at Stn. 18, where it is frequent, and at Stn. 2, where a good many specimens occur. The specimens are all small except at Stn. 18 where it attains normal size, and they are all of the type figured by Brady, which has been separated by Silvestri under the name *Sigmoilina schlumbergeri* on the grounds that the recent specimens differ structurally from the fossils originally described by Costa (S. 1904, TB. p. 267). As we have not had any opportunity of examining the fossil specimens, and the species is more generally known from the 'Challenger' figures, we see no present advantage in adopting Silvestri's name.

48. **Planispirina sigmoidea,** Brady. (Plate 39. figs. 32–34.) (New to Britain.)

Planispirina sigmoidea, Brady, 1884, FC. p. 197, pl. ii. figs. 1–3, and p. 194, fig. 5 *c*.

" " Brady, Parker, & Jones, 1888, AB. p. 216, pl. xl. fig. 16.

" " Schlumberger, 1887, Bull. Soc. Zool. France, vol. xii. pp. 478–483, figs. 1–5.

1 *Station.*

Two small but typical specimens of this rare species, which we take this opportunity of figuring.

Subfamily PENEROPLIDINÆ.

CORNUSPIRA, Schultze.

49. **Cornuspira foliacea** (Philippi).

Orbis foliaceus, Philippi, 1844, EMS. p. 147, pl. xxiv. fig. 25 (error for 26).

Cornuspira foliacea, Brady, 1884, FC. p. 199, pl. xi. figs. 5–9.

5 *Stations.*

Occurs at very few Stns., but at Stn. 20 large and typical examples of Philippi's original form, in which the width of the tube increases gradually and slowly. This Philippi type is everywhere predominant, but at Stns. 4 and 12 the form figured by Williamson, in which there is a rapid increase in the breadth of the last convolution, also occurs.

50. **Cornuspira diffusa,** Heron-Allen & Earland.

Cornuspira diffusa, Heron-Allen & Earland, 1912, etc., NSG. 1913, pp. 272–276, pl. xii.; 1913, CI. p. 37.

1 *Station.*

Two fragments, distinctly referable to this species.

51. **Cornuspira carinata** (Costa).

Operculina carinata, Costa, 1853, etc., PRN. 1856, p. 209, pl. xvii. fig. 1 A, B (error for 15).
Cornuspira carinata, Brady, 1884, FC. p. 201, pl. xi. fig. 4 *a, b.*

6 *Stations.*

Occurs very rarely, but fairly large individuals at Stns. 2 and 8. Only at the latter Stn. were the specimens at all strongly marked in the specific feature of the produced edge.

52. **Cornuspira selseyensis,** Heron-Allen & Earland.

Cornuspira —— ? Earland, 1905, FBS. p. 199, pl. xiii. figs. 2–4.
Cornuspira selseyensis, Heron-Allen & Earland, 1908, etc., SB. 1909, p. 319, pl. xv. figs. 9–11.

12 *Stations.*

Less widely distributed than *C. involvens,* and except at Stns. 12 and 20 far from numerous. Megalospheric individuals are exclusively found at all Stns., except 10, 12, 20, and 26.

53. **Cornuspira involvens** (Reuss).

Operculina involvens, Reuss, 1849–50, FOT. p. 370, pl. xlvi. (i.) fig. 30 (error for 20).
Cornuspira involvens, Brady, 1884, FC. p. 200, pl. xi. figs. 1–3.

15 *Stations.*

Generally distributed, the specimens all very small except at Stn. 14, and especially at Stn. 20. At these two Stns., and also at Stns. 10, 17, and 19, both megalospheric and microspheric forms occur. The proportions vary: at Stn. 10 the megalospheric, and at Stn. 20 the microspheric predominate. At all the other Stns., except Stns. 2 and 23, where single small microspheric individuals occur, the specimens are all megalospheric.

54. **Cornuspira angigyra** (Reuss). (Plate 40. figs. 10, 11.) (New to Britain.)

Operculina angigyra, Reuss, 1849–50, FOT. p. 370, pl. xlvi. (i.) fig. 19.
" " Quenstedt, 1885, Handb. Petref. Edn. 3, Abth. 5, p. 1052, pl. lxxxvi. fig. 21.

1 *Station.*

A single specimen from Stn. 2, which we figure, which in the flatness and regularity of its chambers and their even diameter and square sections appears to be referable to Reuss's species.

Family ASTRORHIZIDÆ.

Subfamily Astrorhizinæ.

Iridia, Heron-Allen & Earland.

55. **Iridia diaphana,** Heron-Allen & Earland.

Iridia diaphana, Heron-Allen & Earland, 1914, FKA. p. 371 (*q. v.* for earlier references).

5 *Stations.*

The primordial dome-shaped chambers occur attached at Stn. 19, detached at Stn. 16. Full-grown specimens, both attached and free, at Stn. 15 exhibiting the chitinous pellicle, and attached at Stn. 22.

Pelosina, Brady.

56. **Pelosina variabilis,** Brady.

Pelosina variabilis, Brady, 1879, etc., RRC. 1879, p. 30, pl. iii. figs. 1–3.
" " Brady, 1884, FC. p. 235, pl. xxvi. figs. 7–9.

1 *Station.*

A single specimen at Stn. 10.

Storthosphæra, Schulze.

57. **Storthosphæra albida,** Schulze.

Storthosphæra albida, Schulze, 1874, R. p. 113, pl. ii. fig. 9 *a–d.*
" " Brady, 1884, FC. p. 241, pl. xxv. figs. 15–17.

1 *Station.*

A good many specimens at Stn. 18, rather small and thinner-walled and less corrugated externally than in deep-water individuals.

Subfamily Pilulininæ.

Bathysiphon, Sars.

58. **Bathysiphon argenteus,** Heron-Allen & Earland.

Bathysiphon argenteus, Heron-Allen & Earland, 1913, CI. p. 38, pl. iii. figs. 1–3.

5 *Stations.*

Fragments of this very easily recognized organism occur in the dredgings, the largest being at Stns. 14 and 21. The peculiar metallic iridescence of the external surface renders the identification of this species possible even when only a minute fragment of the fragile test is forthcoming.

Subfamily SACCAMMININÆ.

PSAMMOSPHÆRA, Schulze.

59. **Psammosphæra fusca,** Schulze.

Psammosphæra fusca, Schulze, 1874, R. p. 113, pl. ii. fig. 8.
,, ,, Brady, 1884, FC. p. 249, pl. xviii. figs. 1–8.

4 *Stations.*

Extremely rare, but an occasional specimen, both free and adherent.

60. **Psammosphæra bowmanni,** Heron-Allen & Earland.

Psammosphæra bowmanni, Heron-Allen & Earland, 1912, etc., NSG. 1912, p. 385, pl. v. figs. 5, 6, pl. vi. fig. 5; 1913, CI. p. 39.

2 *Stations.*

One typical example at each Stn.

CRITHIONINA, Goës.

61. **Crithionina mamilla,** Goës.

Crithionina mamilla, Goës, 1894, ASF. p. 15, pl. iii. figs. 34–36.
,, ,, Heron-Allen & Earland, 1912, etc., NSG. 1913, p. 9, pl. iii.

6 *Stations.*

Occasional specimens, free or attached. Very rare, except at Stn. 4, where the specimens were numerous. As found by us they are nearly all detached, but have evidently been sessile when living. They are large, rather thick-walled, consisting of extremely fine and very friable white sandy material, the central cavity large and filled with dried protoplasm. At Stn. 4 hardly any sponge-spicules or shell-fragments are incorporated in the shell-wall, but at the other Stns. small foraminifera and sponge-spicules form, as usual, a large proportion of the bulk of the test.

The question of the validity of Goës's genus *Crithionina* as distinct from Schulze's earlier genus *Storthosphæra* seems somewhat doubtful. *Storthosphæra* is distinguished by thick shell-walls, built up of fine sand-grains and without visible aperture, the central cavity being large and undivided; *Crithionina*, on the other hand, is defined by Goës as having the central cavity either labyrinthic or undivided. As the character of the shell-wall is the same in the two genera, it would seem desirable that the species of *Crithionina* with undivided cavity should be transferred to *Storthosphæra.*

As a recent British species this has only been recorded by us from Clare Island and the North Sea (*ut supra*), but we have numerous records of it from 'Goldseeker' dredgings.

Subfamily RHABDAMMININÆ.

JACULELLA, Brady.

62. **Jaculella acuta,** Brady.

Jaculella acuta, Brady, 1879, etc., RRC. 1879, p. 35, pl. iii. figs. 12, 13.
,, ,, Brady, 1884, FC. p. 255, pl. xxii. figs. 14–18.

3 *Stations.*

Remarkably fine and perfect specimens of this species ranging up to nearly half an inch in length occur at Stn. 20. Fragments of more delicate specimens, which owing to their width are more probably referable to this species than to *J. obtusa*, occur at several other stations.

63. **Jaculella obtusa,** Brady.

Jaculella obtusa, Brady, 1882, BKE. p. 714.
„ „ Brady, 1884, FC. p. 256, pl. xxii. figs. 19–22.

6 *Stations.*

Recognizable fragments, but no perfect specimens, except at Stn. 20, where it was common in company with *J. acuta.*

HYPERAMMINA, Brady.

64. **Hyperammina friabilis,** Brady.

Hyperammina friabilis, Brady, 1884, FC. p. 258, pl. xxiii. figs. 1–3, 5, 6.
„ „ Pearcey, 1890, FC. p. 172.

5 *Stations.*

Small and imperfect specimens at Stn. 20 and fragments of larger individuals at the other Stns. The occurrence of this species in such shallow waters is noteworthy, the only previous records being by Pearcey (*ut supra*) and by Brady from the Faroe Channel (*ut supra*).

65. **Hyperammina elongata,** Brady.

Hyperammina elongata, Brady, 1878, RRNP. p. 433, pl. xx. fig. 2 *a*, *b*.
„ „ Brady, 1884, FC. p. 257, pl. xxiii. figs. 4, 7–10.

2 *Stations.*

A few small specimens of no great length, but showing the initial portions well.

66. **Hyperammina ramosa,** Brady.

Hyperammina ramosa, Brady, 1879, etc., RRC. 1879, p. 33, pl. iii. figs. 14, 15.
„ „ Brady, 1884, FC. p. 261, pl. xxiii. figs. 15–19.

1 *Station.*

One recognizable fragment only.

67. **Hyperammina arborescens** (Norman).

Psammatodendron arborescens (Norman MS.), Brady, 1881, HNPE. p. 98. No. 13.
Hyperammina arborescens, Brady, 1884, FC. p. 262, pl. xxviii. figs. 12, 13 (fig. 10, p. 263).

6 *Stations.*

Recognizable fragments of this very distinctive organism occur at several Stns. and good and typical examples at Stn. 14. The character of the material submitted to us rendered the finding of more fragments unlikely; it is probably very widely distributed down the West coast of Scotland. Large branching colonies are common under stones between tide-marks at Millport.

68. **Hyperammina vagans**, Brady.

Hyperammina vagans, Brady, 1879, etc., RRC. 1879, p. 33, pl. v. fig. 3.
„ „ Brady, 1884, FC. p. 260, pl. xxiv. figs. 1–9.

2 *Stations.*

Attached to shell-fragments at Stns. 10 and 26.

RHABDAMMINA, Brady.

69. **Rhabdammina abyssorum**, M. Sars.

Rhabdammina abyssorum, M. Sars, 1868, LUHD. p. 248.
„ „ Brady, 1884, FC. p. 266, pl. xxi. figs. 1–13.

1 *Station.*

One recognizable fragment only from the shore-sand at Oronsay—no doubt, washed in from deep water.

RHIZAMMINA, M. Sars.

70. **Rhizammina algæformis**, Brady. (New to Britain.)

Rhizammina algæformis, Brady, 1879, etc., RRC. 1879, p. 39, pl. iv. figs. 16, 17.
„ „ Brady, 1884, FC. p. 274, pl. xxviii. figs. 1–11.

2 *Stations.*

Single specimens from the two Stns. The species has not been previously recorded from British waters, but is common in deep water off the Irish and West Scottish coasts.

BOTELLINA, Carpenter.

71. **Botellina labyrinthica**, Brady.

Botellina labyrinthica, Brady, 1878, etc., RRC. 1881, p. 48.
„ „ Brady, 1884, FC. p. 279, pl. xxix. figs. 8–18.

3 *Stations.*

Fragments of this remarkable organism occur at Stns. 10 and 21. As this rare species, when present, usually occurs in abundance, it is possible that the fragments may have been derived from deeper water in the neighbourhood. At Stn. 20, however, the specimens were very numerous and large, and justify the assumption that a colony of the form occurred.

Apart from the 'Porcupine' record (Stn. No. 51) there are very few records of this curious form; we may mention that it occurs in enormous profusion in the 'Goldseeker' Dredging Haul 7791, two miles S. by E. off Burghead in the Moray Firth (55 metres), forming the bulk of the coarse material dredged at that Stn. It is apparently confined to this single locality in the whole area of the Moray Firth.

HALIPHYSEMA, Bowerbank.

72. Haliphysema tumanowiczii, Bowerbank.

Haliphysema tumanowiczii, Bowerbank, 1862, Phil. Trans. Roy. Soc. Lond. p. 1105, pl. lxxiii. fig. 3 ; 1864, Monogr. Brit. Sponges, vol. i. p. 179, pl. xxx. fig. 359; 1866, vol. ii. p. 76.

1 *Station.*

A single broken and detached specimen was found at Stn. 12, but was unfortunately lost later. No doubt, the species would be found if searched for in suitable material all down the West Coast. We had no undamaged polyzoan material for examination.

Family LITUOLIDÆ.

Subfamily LITUOLINÆ.

REOPHAX, Montfort.

73. Reophax difflugiformis, Brady.

Reophax difflugiformis, Brady, 1879, etc., RRC. 1879, p. 51, pl. iv. fig. 3.
,, ,, Brady, 1884, FC. p. 289, pl. xxx. figs. 1–5.

3 *Stations.*

Extremely rare, one specimen at each Stn.

74. Reophax fusiformis (Williamson).

Proteonina fusiformis, Williamson, 1858, RFGB. p. 1, pl. i. fig. 1.
Reophax fusiformis, Brady, 1884, FC. p. 290, pl. xxx. figs. 7–11.

6 *Stations.*

Very rare, most frequent and the best specimens at Stns. 14 and 18. At one or two Stns., notably Stn. 4, the organism utilizes mica exclusively in the formation of its test.

75. Reophax scorpiurus, Montfort.

Reophax scorpiurus, Montfort, 1808, CS. vol. i. p. 330, 83e genre.
,, ,, Brady, 1884, FC. p. 291, pl. xxx. figs. 12–17.

7 *Stations.*

Sparingly represented, and never common. The best at Stn. 18, the specimens are of a very neat and regular type.

76. Reophax scottii, Chaster.

Reophax nodulosa (?), Scott, 1890, 8th Ann. Rep. Fisheries Board Scotland, pt. iii. p. 314.
,, *scottii,* Chaster, 1892, FS. p. 57, pl. i. fig. 1.
,, ,, Millett, 1898, etc., FM. 1899, p. 255, pl. iv. fig. 13.

5 *Stations.*

Considering the muddy character of many of the dredgings, this species is singularly rare. Only an occasional specimen at any Stn., the best at Stn. 11.

77. Reophax moniliforme, Siddall.

Reophax (?) sp., Balkwill & Wright, 1885, DIS. p. 328, pl. xiii. figs. 9, 22–24.
„ *moniliforme,* Siddall, 1886, LMBC. p. 54, pl. i. fig. 2.
„ „ Heron-Allen & Earland, 1913, CI. p. 43, pl. ii. fig. 12.

3 *Stations.*

A single specimen at each Stn., all, as usual, imperfect. Both the oral and the bulbous aboral portions, however, are represented.

HAPLOPHRAGMIUM, Reuss.

78. Haplophragmium pseudospirale (Williamson). (Plate 40. fig. 14.)

Proteonina pseudospiralis, Williamson, 1858, RFGB. p. 2, pl. i. figs. 2, 3.
Haplophragmium pseudospirale, Brady, 1884, FC. p. 302, pl. xxxiii. figs. 1–4.

15 *Stations.*

Generally distributed and fairly abundant at many of the Stns. There is considerable variety of form. At the majority of Stns. the specimens are all of the involute form represented by Goës's figs. (G. 1894, ASF. pl. v. figs. 142–3). This is practically isomorphous with *Haplophragmium canariense*, differing only in the rough texture of the wall and the absence or obscurity of the septation. The umbilical part is usually strongly depressed. This may possibly represent the early stages of the test, but the entire absence of the elongate crozier-form at many Stns. where the circular form occurs is noticeable. The crozier-form occurs large and well developed at Stns. 2, 4, 9, 14, 18, and 26. At Stns. 4 and 26 another form occurs in which the circular portion is followed by a single sharply-pointed chamber; we figure this variety, which we have already met with in anchor-mud from Paranagua, Brazil. It appears to be isomorphous with *Cristellaria variabilis*, Reuss.

79. Haplophragmium canariense (d'Orbigny). (Plate 40. figs. 12, 13.)

Nonionina canariensis, d'Orbigny, 1839, FIC. p. 128, pl. ii. figs. 33, 34.
Haplophragmium canariense, Brady, 1884, FC. p. 310, pl. xxxv. figs. 1–5.

22 *Stations.*

Almost universally distributed, often very common. The specimens are almost without exception of a thin evolute type. At some Stns., however, they were very small and starved. At Stns. 10 and 16 these small specimens are almost entirely built up of small mica-plates as in *Reophax scottii*, Chaster. At Stns. 10, 18, and 20, where the species was abundant, abnormal specimens, one of which we figure, in which the initial spiral growth is succeeded by a series of irregularly Lituoline chambers, occurred; these may be compared in appearance and construction with *Truncatulina variabilis*, d'Orb. (Having found this again off the coast of Cornwall, we are naming it in our forthcoming paper.) The general colour throughout the dredgings is normally ferruginous, but occasional grey individuals occur at most Stns., and at Stns. 5 and 17 they largely predominate.

80. **Haplophragmium canariense,** var. **pauperata,** Chapman. (New to Britain.)

Haplophragmium canariense, var. *pauperata,* Chapman, 1913, EHH. p. 556, woodcuts figs. 1–4.

2 *Stations.*

A few specimens at Stns. 4 and 21, in which each chamber was deflated and collapsed. These specimens were constructed mainly of mica-flakes, in itself perhaps a sign of depauperation. Probably the micaceous examples of *H. canariensis* previously referred to would be liable to similar distortion in most instances when removed from water. Chapman's record was from the Eocene of Hengistbury Head. It seems a useful varietal name, as such depauperated individuals are widely distributed.

81. **Haplophragmium runianum,** sp. nov. (Plate 40. figs. 15–18.)

1 *Station.*

Test free, nautiloid, more or less depressed at the umbilicus, constructed of rather coarse sand-grains and grey cement. As a rule, no septation visible externally. In large specimens an occasional constriction indicates the presence of a suture. Marginal edge thick and rounded. Aperture simple, ranging between a fissure and a constricted terminal opening of irregular form. Viewed as an object in balsam the multilocular character of the test becomes apparent; it is then seen to consist of three to four convolutions divided into numerous chambers (thirteen or fourteen in the last convolution) by septal walls that are usually very thin in comparison with the thick outer wall of the test. The chambers are almost square in section.

This curious and obscure form occurs in some numbers at Stn. 17. It might easily be overlooked, and regarded as a thick-walled and obscure variety of *H. canariense* (d'Orb.), but the number and shape of the chambers when viewed in balsam removes it from any close relationship to that species. It bears considerable resemblance to the *Lituola nautiloidea*, var. (*Haplophragmium*) *depressa* of Rupert Jones in the paper on "The Deep Boring at Richmond" (Q. J. G. S. vol. xl. 1884, p. 765, pl. xxxiv. fig. 2), but differs in the fact that the sutural lines are visible in the later stages of the rather poor figure illustrating that variety, whereas in *H. runianum* they are only visible externally under exceptional conditions. The nearest affinities of both *H. runianum* and *H. nautiloidea* var. *depressa* are probably with *H. rotulatum*, Brady, as marked by the concavity of the shell on both sides in the umbilical region, the thick marginal edge and the obscurity of the septation, and numerous chambers.

Diameter ·5–·7 mm.; width of final convolution ·1; breadth of each chamber in final convolution ·1.

82. **Haplophragmium globigeriniforme** (Parker & Jones).

Lituola nautiloidea, var. *globigeriniformis,* Parker & Jones, 1865, NAAF. p. 407, pl. xv. figs. 46, 47, pl. xvii. figs. 96–98.

Haplophragmium globigeriniforme, Brady, FC. 1884, p. 312, pl. xxxv. figs. 10, 11.

15 *Stations.*

Generally distributed and fairly frequent at some Stns., notably Stns. 3 and 10.

Strongly marked isomorphs of *Globigerina bulloides* are rare, the majority of specimens being rather small and obscure, and comparatively flat on the superior face. Isomorphs of *Globigerina inflata* occur at Stns. 3 and 11. At Stn. 11 the best isomorph of *G. bulloides* occurs. The general facies of the specimens is that of figs. 131–133, pl. v. in Goës's memoir (G. 1894, ASF.).

83. **Haplophragmium glomeratum,** Brady.

Lituola glomerata, Brady, 1878, RRNP. p. 433, pl. xx. fig. 1.
Haplophragmium glomeratum, Brady, 1884, FC. p. 309, pl. xxxiv. figs. 15–18.

17 *Stations.*

Very generally distributed, often common. This little species appears to be one of the most fixed in its characteristics of the genus. Practically no variation is observable in the whole of these dredgings except in its relative abundance and its development as regards size; the number of chambers and their proportions are practically constant.

PLACOPSILINA, d'Orbigny.

84. **Placopsilina vesicularis,** Brady.

Placopsilina vesicularis, Brady, 1879, etc., RRC. 1879, p. 51, pl. v. fig. 2.
" " Brady, 1884, FC. p. 316, pl. xxxv. figs. 18, 19.

1 *Station.*

A few very small specimens attached to shell-fragments at Stn. 26.

Subfamily TROCHAMMININÆ.

THURAMMINA, Brady.

85. **Thurammina papillata,** Brady.

Thurammina papillata, Brady, 1879, etc., RRC. 1879, p. 45, pl. v. figs. 4–8.
" " Brady, 1884, FC. p. 321, pl. xxxvi. figs. 7–18.

4 *Stations.*

Very rare, but small typical specimens of the minutely arenaceous type occur at the Stns. At Stn. 4 a single chitinous specimen, dark brown in colour.

AMMODISCUS, Reuss.

86. **Ammodiscus incertus** (d'Orbigny).

Operculina incerta, d'Orbigny, 1839, FC. p. 49, pl. vi. figs. 16, 17.
Ammodiscus incertus, Brady, 1884, FC. p. 330, pl. xxxviii. figs. 1–3.

13 *Stations.*

Generally distributed, often very common, the best at Stns. 12, 14, 19. The colour varies at different Stns.: at some, notably Stn. 3, only light grey individuals; at others, notably Stns. 9 and 20, only ferruginous examples. At the other Stns. both types occur, either of them preponderating. The specimens are on the whole irregular in shape, with a tendency to concavity on one side at the expense of the other. At one or two Stns., *e. g.* No. 19, they were adherent to shell-fragments. Specimens once adherent, but now detached, occur frequently. These adherent individuals are more irregular in growth than the free ones, some being hardly separable from *A. gordialis.* The bulk of the specimens are noticeably microspheric, but megalospheric specimens referable to Brady's *A. tenuis* were noticed at Stns. 4, 12, and 19. The megalospheric individuals are, as a rule, very small in size and composed of only one or two convolutions. At Stn. 18 one individual with a semi-chitinous shell was observed.

87. **Ammodiscus gordialis** (Jones & Parker).

Trochammina squamata gordialis, Jones & Parker, 1860, RFM. p. 304.
Ammodiscus gordialis, Brady, 1884, FC. p. 333, pl. xxxviii. figs. 7–9.

15 *Stations.*

Generally distributed, but not abundant, except at Stns. 3, 12, and 19. At Stn. 3 the specimens were small; at Stn. 19 they were large, often irregular, and some of them nearly spherical, being formed of an intricate convolution of tubes. Both pale and ferruginous individuals at most Stns., but the ferruginous preponderate in numbers. The general form was, as is always the case when the species occurs in any abundance, protean.

88. **Ammodiscus charoides** (Jones & Parker).

Trochammina squamata charoides, Jones & Parker, 1860, RFM. p. 304.
Ammodiscus charoides, Brady, 1884, FC. p. 334, pl. xxxviii. figs. 10–16.

7 *Stations.*

Extremely common at Stn. 2, where the species occurs in all stages of development. The specimens are, on the whole, very regular and typical in the arrangement of the primary spiral, but at least one instance was seen at this Stn. in which the secondary spiral was suddenly diverted at a right angle before it had completely enveloped the central initial spiral, thus giving the test the appearance of a globe divided into four sections. A few specimens approached *A. gordialis* in the irregular disposition of the later convolutions. At Stn. 3 it was very rare and small. At Stn. 10 a single small specimen approaching *A. gordialis.* At Stn. 19 numerous specimens, many worn as if washed from some distance. At this particular Stn. the final convolutions in the large specimens were irregularly disposed. The comparison to *A. gordialis* must be considered as referring to the disposition of the chambers only; the constitution of the shell is quite dissimilar, *A. gordialis* being built up of fine sand-grains with an almost invisible proportion of cement, whereas in *A. charoides* the test is almost entirely constructed of cement, sand-grains never being observable, even when the convolutions are irregularly disposed.

89. **Ammodiscus shoneanus** (Siddall).

Trochammina shoneanus, Siddall, 1878, FRD. p. 46, figs. 1, 2.
Ammodiscus shoneanus, Brady, 1884, FC. p. 335, pl. xxxviii. figs. 17–19.

1 *Station.*

One typical individual of this minute but interesting species at Stn. 15, light grey in colour.

TROCHAMMINA, Parker & Jones.

90. **Trochammina inflata** (Montagu).

Nautilus inflatus, Montagu, 1803–8, TB. Suppl. p. 81, pl. xviii. fig. 3.
Trochammina inflata, Brady, 1884, FC. p. 338, pl. xli. fig. 4.

1 *Station.*

Very rare, and the specimens are rather weak, tending to collapse.

91. **Trochammina inflata,** var. **macrescens,** Brady.

Trochammina inflata, var. *macrescens*, Brady, 1870, FTR. p. 290, pl. xi. fig. 5.
„ „ „ Heron-Allen & Earland, 1913, CI. p. 52.

3 *Stations.*

Also very rare, the best and most typical specimens at Stn. 21.

92. **Trochammina ochracea** (Williamson).

Rotalina ochracea, Williamson, 1858, RFGB. p. 55, pl. iv. fig. 112, pl. v. fig. 113.
Trochammina ochracea, Balkwill & Millett, 1884, FG. p. 25, pl. i. fig. 7.

16 *Stations.*

Generally distributed, often common. The species varies greatly in the extent of its development. The thin and scale-like form (the original type of Williamson) is less widely distributed and less common than the thicker form intermediate between this species and *T. squamata*, to which we have referred in our Clare Island paper (H.-A. & E. 1913, CI. p. 51). A double or "budding" specimen was found at Stn. 15, and an attached specimen at Stn. 19.

93. **Trochammina plicata** (Terquem).

Patellina plicata, Terquem, 1875, etc., APD. 1876 (fasc. ii.), p. 72, pl. viii. fig. 9.
Trochammina plicata, Balkwill & Millett, 1884, FG. p. 26, pl. i. fig. 8.

6 *Stations.*

Very rare, but large and very fine specimens at several Stns., especially Stns. 3 and 20. Specimens which had evidently been sessile and had become detached, preserving the carinate periphery figured by us in the species *T. ochracea* from Kerimba (H.-A. & E. 1915, FKA. p. 619, pl. xlvi. figs. 27, 28), were found at Stn. 13. In these individuals the base was quite flat, the intervals between the wrinkled sutures being bridged with a thin chitinous pellicle.

94. **Trochammina squamata,** Jones & Parker.

Trochammina squamata, Jones & Parker, 1860, RFM. p. 304, table.
„ „ Brady, 1884, FC. p. 337, pl. xli. fig. 3 *a*, *b*, *c*.

17 *Stations.*

Almost universally distributed, often fairly common. There is a considerable amount of variation observable at different Stns. At the majority the specimens were rather small and were grey in colour. Large darkly ferruginous specimens occur at several Stns., notably at Stns. 3 and 10. A double specimen was found at Stn. 3.

95. **Trochammina rotaliformis,** Wright.

Trochammina inflata (Montagu), var. (Wright, MS.), Balkwill & Wright, 1885, DIS. p. 331, pl. xiii. figs. 11, 12.
„ *rotaliformis,* Heron-Allen & Earland, 1913, CI. p. 52, pl. iii. figs. 11–13.

10 *Stations.*

Fairly widely distributed and often not uncommon. There is a considerable amount of variation, especially in the texture of the shell, some being quite coarsely arenaceous, whilst others, notably at Stn. 3, are almost entirely composed of polished ferruginous cement giving a very smooth and regular outline to the shell.

96. **Trochammina nitida,** Brady. (Plate 40. figs. 19–21.)

Trochammina nitida, Brady, 1881, HNPE. p. 100. No. 25.
„ „ Brady, 1879, etc., RRC. 1881, p. 52.
„ „ Brady, 1884, FC. p. 339, pl. xli. figs. 5, 6.

1 *Station.*

A single specimen of this rare type, which we figure, from Stn. 12. It differs slightly from Brady's type in the greater number of chambers in the final convolution—ten, as against nine in the type. The central spire is somewhat depressed on the superior side. Colour dark brown, texture very finely arenaceous. *T. nitida,* according to Brady, is typically an arctic species, but Millett records it from shallow water in the Malay Archipelago (M. 1898, etc., FM. 1899, p. 363).

97. **Trochammina robertsoni,** Brady.

Trochammina robertsoni, Brady, 1887, SBRF. p. 893.
„ „ Wright, 1891, SWI. p. 469, pl. xx. fig. 4.

15 *Stations.*

Fairly widely distributed, often common, the only variation being in the size. This is one of the most typical West of Scotland species.

Family TEXTULARIIDÆ.

Subfamily TEXTULARIINÆ.

TEXTULARIA, Defrance.

98. **Textularia fusiformis**, Chaster.

Textularia fusiformis, Chaster, 1892, FS. p. 58, pl. i. fig. 3.
" " Heron-Allen & Earland, 1914, etc., FKA. 1915, p. 623.

1 *Station.*

One large and very typical example of this rare species at Stn. 14. Since Chaster's original record, this species has only been recorded by Wright from Post-tertiary deposits on the River Lune (W. 1902, GFL. p. 190).

99. **Textularia concava**, var. **heterostoma**, Fornasini. (Plate 40. figs. 22, 23.) (New to Britain.)

Sagraina affinis, Fornasini, 1883, FPS. p. 189, pl. ii. fig. 10.
" " Fornasini, 1888, TP. p. 45, pl. iii. fig. 1 *a–c*.
Textularia heterostoma, Fornasini, 1896, TC. p. 4, pl. O. figs. 6, 12, 13.
" *concava*, var. *heterostoma*, Millett, 1898, etc., FM. 1899, p. 560, pl. vii. figs. 6, 7.

1 *Station.*

Two characteristic examples, which we figure, at Stn. 14. They appear to be intermediate between the original figures of Fornasini and the somewhat depauperate examples figured by Millett from the Malay Peninsula. Both the 'Runa' specimens exhibit the tendency to a spiral twist of the axis which is observable in Millett's figures.

100. **Textularia sagittula**, Defrance.

Textularia sagittula, Defrance, 1824, Dict. Sci. Nat. vol. xxxii. p. 177, vol. liii. p. 344; Atlas Conch. pl. xiii. fig. 5.
" " Balkwill & Wright, 1885, DIS. p. 332, pl. xiii. figs. 15–17 (*pars*).

8 *Stations.*

Not common, but excellent and typical examples of this acutely pointed original type of Defrance occur at many Stns. At Stn. 10 many specimens of this species and also of *Spiroplecta wrightii* were found firmly adherent by their orifices to fragments of the chitinous tubes of a Campanularian.

101. **Textularia sagittula**, var. **jugosa**, Brady.

Textularia jugosa, Brady, 1884, FC. p. 358, pl. xlii. fig. 7 *a*, *b*.
" " Egger, 1893, FG. p. 273, pl. vi. figs. 19–21.
" *sagittula*, var. *jugosa*, Jones, Parker, & Brady, 1866, etc., MFC. 1895, p. 145, pl. v. fig. 19.
" " " Millett, 1898, etc., FM. 1899, p. 561, pl. vii. fig. 8.

1 *Station.*

One specimen at Stn. 16.

102. **Textularia agglutinans,** d'Orbigny.

Textularia agglutinans, d'Orbigny, 1839, FC. p. 144, pl. i. figs. 17, 18, 32–34.
" " Brady, 1884, FC. p. 363, pl. xliii. figs. 1–3.

7 *Stations.*

Rare, but good and large specimens at several Stns., the best at Stn. 19.

103. **Textularia candeiana,** d'Orbigny. (Plate 41. figs. 1, 2.) (New to Britain.)

Textularia candeiana, d'Orbigny, 1839, FC. p. 143, pl. i. figs. 25–27.
" *sagittula*, var. *candeiana*, Millett, 1898, etc., FM. 1899, p. 562, pl. vii. fig. 12.

5 *Stations.*

Though reluctant to add to the ever-increasing list of British Foraminifera, it seems impossible to avoid separating, under d'Orbigny's name, those specimens of *T. agglutinans* in which there is a sudden and abnormal increase in the depth of the later chambers. Typical specimens, which we figure, of this form were found at Stns. 19 and 20.

104. **Textularia gramen,** d'Orbigny.

Textularia gramen, d'Orbigny, 1846, FFV. p. 248, pl. xv. figs. 4–6.
" " Brady, 1884, FC. p. 365, pl. xliii. figs. 9, 10.

22 *Stations.*

Universally distributed, often very common, and presenting every type of variation between *T. conica* and *T. agglutinans*. Specimens indistinguishable from d'Orbigny's species, *T. haueri*, appear at several Stns., but, in view of the wide range of variations distributed throughout the dredgings, we have not followed the lines of our Kerimba Monograph in separating them (*cf.* d'O. 1846, FFV. p. 250, pl. xv. figs. 13–15, and H.-A. & E. 1914, etc., FKA. 1915, p. 628, pl. xlvii. figs. 21–23).

105. **Textularia conica,** d'Orbigny.

Textularia conica, d'Orbigny, 1839, FC. p. 143, pl. i. figs. 19, 20.
" " Brady, 1884, p. 365, pl. xliii. figs. 13, 14, pl. cxiii. fig. 1.

23 *Stations.*

Universally distributed, generally abundant, sometimes reaching considerable size, and of quite typical development.

106. **Textularia trochus,** d'Orbigny.

Textularia trochus, d'Orbigny, 1840, CBP. p. 45, pl. iv. figs. 25, 26.
" " Brady, 1884, FC. p. 366, pl. xliii. figs. 15–19, pl. xliv. figs. 1–3.

2 *Stations.*

Very good and typical specimens at both Stns.

107. Textularia turris, d'Orbigny.

Textularia turris, d'Orbigny, 1840, CBP. p. 46, pl. iv. figs. 27, 28.
„ „ Brady, 1884, FC. p. 366, pl. xliv. figs. 4, 5.

3 *Stations.*

Good and typical specimens at each Stn.

VERNEUILINA, d'Orbigny.

108. Verneuilina polystropha (Reuss).

Bulimina polystropha, Reuss, 1845, VBK. pt. ii. p. 109, pl. xxiv. fig. 53.
Verneuilina polystropha, Brady, 1884, FC. p. 386, pl. xlvii. figs. 15–17.
„ „ Heron-Allen & Earland, 1913, CI. p. 55, pl. iv. figs. 1–5.

21 *Stations.*

Almost universally distributed, and frequently common. The general type at most of the Stns. is a large, long, regularly constructed test, sometimes entirely grey at a particular Stn., sometimes ferruginous, and occasionally both tints together. The short broad form, with usually a much more roughly constructed test, occurs at comparatively few Stns., but is sometimes the sole representative of the species, as at Stns. 10, 12, 25, and 26. The little types figured by us from Clare Island (*ut supra*) occur at five Stns. only—2, 12, 14, 19, and 20.

BIGENERINA, d'Orbigny.

109. Bigenerina digitata, d'Orbigny.

Bigenerina (Gemmulina) digitata, d'Orbigny, 1826, TMC. p. 262. No. 4, Modèle No. 58.
„ *digitata*, Brady, 1884, FC. p. 370, pl. xliv. figs. 19–24.

6 *Stations.*

Sparingly distributed, but frequent at Stns. 14 and 19. All the individuals are strongly ferruginous except at Stn. 21, where the few specimens found were light grey.

SPIROPLECTA, Ehrenberg.

110. Spiroplecta biformis (Parker & Jones).

Textularia agglutinans, var. *biformis*, Parker & Jones, 1865, NAAF. p. 370, pl. xv. figs. 23, 24.
Spiroplecta biformis, Brady, 1884, FC. p. 376, pl. xlv. figs. 25–27.

4 *Stations.*

Very rare, the best and most typical specimens at Stn. 18.

111. Spiroplecta wrightii, Silvestri.

Spiroplecta sagittula, Wright, 1891, SWI. p. 471; 1902, FRI. p. 211, pl. iii.
Spiroplecta wrightii, Silvestri, 1903, S. pp. 59–64 (woodcuts).
„ „ Heron-Allen & Earland, 1913, CI. p. 56.

18 *Stations.*

Almost universally distributed and often very common, presenting all the well-known variations in the size and development of the spiroplectine commencement.

112. Spiroplecta fusca, Earland.

Spiroplecta fusca, Earland, 1905, FBS. p. 204, pl. xii. figs. 1–3.
„ „ Heron-Allen & Earland, 1908, etc., SB. 1909, p. 331.

1 *Station.*

One good specimen at Stn. 3, presenting the characteristic lobulate outline of the species, but lighter in colour than the original type.

GAUDRYINA, d'Orbigny.

113. Gaudryina filiformis, Berthelin.

Gaudryina filiformis, Berthelin, 1880, EAM. p. 25, pl. xxiv. (i.) fig. 8.
„ „ Brady, 1884, FC. p. 380, pl. xlvi. fig. 12.

8 *Stations.*

Neither widely distributed nor abundant. Numerous excellent specimens at several Stns., notably Stn. 17. Two distinct forms are noticeable, one being much shorter and broader than the other, possibly representing the megalospheric and microspheric stages. They are all grey in colour, the ferruginous tint being confined to the early part of the test.

Cushman (C. 1910, etc., FNP. 1911, p. 70, fig. 111) has separated the specimens figured by Brady from Berthelin's original type under the name *G. pseudo-filiformis,* apparently on the ground that the texture of the shell in Brady's specimens and in those dredged by the 'Albatross' are smoothly arenaceous. This appears to be entirely insufficient; the character of the chambers is practically identical with that shown in Berthelin's original figure, and the difference in the shell-texture of the 'Challenger' specimens with their increased proportion of cement is probably due to the greater depth from which the specimens were obtained.

The species has been adequately figured by Wright (W. 1880–81, SD. p. 180, pl. viii. fig. 3 *a–b*) and by ourselves (H.-A. & E. 1913, CI. p. 57, pl. iv. figs. 7, 8).

114. Gaudryina rudis, Wright.

Gaudryina rudis, Wright, 1900, DBC. p. 53, pl. ii. fig. 1.
„ „ Heron-Allen & Earland, 1913, CI. p. 58, pl. iii. figs. 14–17.

14 *Stations.*

Widely, but not universally, distributed, and, except at a few Stns., few in number and small. Remarkably large individuals occurred at Stns. 16, 19, and 26. The species is also remarkably abundant at Stn. 3. The species has only been recorded *ut supra,* but we have found it in shore-gatherings and soundings all round the British coasts.

VALVULINA, d'Orbigny.

115. Valvulina fusca (Williamson).

Rotalina fusca, Williamson, 1858, RFGB. p. 55, pl. v. figs. 114, 115.
Valvulina fusca, Brady, 1884, FC. p. 392, pl. xlix. figs. 13, 14.

11 *Stations.*

Generally distributed and often very common. All free except at Stns. 20 and 25, where attached individuals were found with the characteristic extension of white cement ramifying from the test.

116. **Valvulina conica,** Parker & Jones.

Valvulina triangularis, var. *conica,* Parker & Jones, 1865, NAAF. p. 406, pl. xv. fig. 37.
Valvulina conica, Brady, 1884, FC. p. 392, pl. xlix. figs. 15, 16.

1 *Station.*

One small free specimen at Stn. 4.

CLAVULINA, d'Orbigny.

117. **Clavulina obscura,** Chaster.

Verneuilina polystropha (Reuss), "dimorphous form," Wright, 1885–6, BLP. p. 320, pl. xxvi. fig. 2.
Clavulina obscura, Chaster, 1892, FS. p. 58, pl. i. fig. 4.
„ „ Heron-Allen & Earland, 1913, CI. p. 59, pl. iv. fig. 6.

4 *Stations.*

Occasional specimens of this rare little form at the Stns.

Subfamily BULIMININÆ.

BULIMINA, d'Orbigny.

118. **Bulimina pupoides,** d'Orbigny.

Bulimina pupoides, d'Orbigny, 1846, FFV. p. 185, pl. xi. figs. 11, 12.
„ „ Brady, 1884, FC. p. 400, pl. l. fig. 15.

19 *Stations.*

Almost universally distributed, but less abundant than *B. marginata* or *B. elegans.* Typical specimens are common, the best at Stns. 7, 22, 23, but intermediate forms linking this with *B. elegans* and *B. gibba,* Fornasini, also occur at most Stns.

119. **Bulimina elegans,** d'Orbigny.

Bulimina elegans, d'Orbigny, 1826, TMC. p. 270, No. 10, Modèle No. 9.
„ „ Brady, 1884, FC. p. 398, pl. l. figs. 1–4.

20 *Stations.*

If anyone wishes to realise the absolute impossibility of classifying Foraminifera on the strictly rigid specific lines aimed at by zoologists working at higher groups, they need only refer to the beautiful series of illustrations to Fornasini's paper on the Adriatic Buliminæ (MASIB. ser. 5, vol. ix. pp. 371–381). After studying this plate and working out such a series of dredgings as those under consideration, or, indeed, any series taken under similar conditions on a muddy bottom round the British Islands, the student will come to the conclusion that it would be just as easy to name and figure twice as many so-called "species." There are no definite and fixed features which can be laid hold of as marking definite lines of separation.

Bulimina elegans is, however, a good starting-point around which to attempt some classification of these protean forms.

The typical *B. elegans* is represented by a long and regularly tapering shell with three definite series of smooth inflated chambers. Such individuals occur but rarely, although present in limited numbers at most of the Stns. With a shortening of the spire and increased inflation of the chambers we arrive at a somewhat broad and stumpy form extremely common, and figured by Fornasini (*loc. cit.* pl. O. figs. 32, 34) under the name *B. gibba*. If the aboral margins of the inflated chambers become salient, we obtain a passage-form between *B. elegans* and *B. marginata*, to which Fornasini has given the name *B. gibba*, var. *marginata* (figs. 22, 26, 35, 42, *loc. cit.*).

More than one Stn. of the 'Runa' gatherings, notably Stns. 19 and 21, consisted almost of pure gatherings of Buliminæ. We took the trouble to count a certain section of the material from the latter Stn., and found the Buliminæ to represent 98 per cent. of the Foraminifera. Probably not 5 per cent. of the specimens could have been assigned definitely to any specific type.

120. **Bulimina elegans**, var. **exilis**, Brady. (Plate 41. figs. 4–9.)

Bulimina elegans, var. *exilis*, Brady, 1884, FC. p. 399, pl. l. figs. 5, 6.
,, ,, ,, Wright, 1889, SWI. p. 448.

6 *Stations.*

The variety *exilis* is characterized by an extremely elongated test of the regular triserial *B. elegans* type. Good and typical specimens occur at several Stns., the best at Stns. 11 and 17. They are, however, all small, compared with the development attained by the variety in deeper and colder waters. The best specimens we have seen were from comparatively shallow water in the estuary of the St. Lawrence River. The species has been recorded by Wright from S.W. Ireland, by Worth from Plymouth, and by Pearcey from the Faroe Channel; but, as it has not been figured as a British species, we take this opportunity of doing so (Wright, AMNH. ser. 6, vol. iv. p. 448; Worth, J. Mar. Biol. Ass. Plymouth, NS. vol. vii. 1904, p. 178; Pearcey, 1890, FC. p. 176).

121. **Bulimina elongata**, d'Orbigny.

Bulimina elongata, d'Orbigny, 1826, TMC. p. 269. No. 9.
,, ,, Brady, 1884, FC. p. 401, pl. li. figs. 1, 2 (?).

5 *Stations.*

Typical specimens of this elongate and parallel-sided form of *B. pupoides* occur at Stns. 4 and 19. At other Stns. the individuals, while probably referable to *B. elongata*, show weak marginate spines at the aboral end, indicating their affinity to *B. marginata*.

122. **Bulimina fusiformis,** Williamson.

Bulimina pupoides, var. *fusiformis,* Williamson, 1858, RFGB. p. 63, pl. v. figs. 129, 130.
Bulimina fusiformis, Millett, 1898, etc., FM. 1900, p. 275, pl. ii. fig. 2.

23 *Stations.*

Universally distributed, generally abundant. The typical *B. fusiformis* of Williamson, with an elongate test and a somewhat virguline aperture, though occurring at nearly every Stn., is far less abundant than a short and somewhat inflated type with terminal aperture. This short type appears to represent a passage-form into *B. ovata.*

123. **Bulimina ovata,** d'Orbigny.

Bulimina ovata, d'Orbigny, 1846, FFV. p. 185, pl. xi. figs. 13, 14.
„ „ Brady, 1884, FC. p. 400, pl. l. fig. 13 *a*, *b*.

3 *Stations.*

A single very large specimen at Stn. 17 and one or two small specimens at Stns. 19 and 20. The extraordinary rarity of this species in these gatherings is noticeable.

124. **Bulimina elegantissima,** d'Orbigny.

Bulimina elegantissima, d'Orbigny, 1839, FAM. p. 51, pl. vii. figs. 13, 14.
„ „ Brady, 1884, FC. p. 402, pl. l. figs. 20–22.

12 *Stations.*

This pretty little species, which appears to be more fixed in its characteristics than most of the Buliminæ, occurs at a good many Stns., but never very abundantly. The best were at Stns. 4 and 11. It is subject to very little variation, except in the comparative length and breadth of the shell. At Stn. 4 one abnormally long and attenuated individual was observed.

125. **Bulimina marginata,** d'Orbigny.

Bulimina marginata, d'Orbigny, 1826, TMC. p. 269. No. 4, pl. xii. figs. 10–12.
„ „ Brady, 1884, FC. p. 405, pl. li. figs. 3–5.

24 *Stations.*

Universally distributed and as abundant as *B. elegans*, subject to the same lines of variation—*i. e.*, apart from typical specimens resembling d'Orbigny's figure, we find marginate specimens which in the arrangement of their chambers are closer to *B. elegans*, d'Orbigny, and *B. gibba*, Fornasini. Abnormal specimens occur at Stns. 18, 20, and 21. At Stns. 18 and 20 they consisted of pairs of individuals fused by their aboral extremities. At Stn. 21 were several instances of individuals having double and treble apertures. Such deformities may generally be found in any dredging where Buliminæ preponderate.

126. **Bulimina echinata,** d'Orbigny. (Plate 41. fig. 3.) (New to Britain.)

Bulimina echinata, d'Orbigny, 1826, TMC. p. 269. No. 5.
„ „ Fornasini, 1901, BCI. p. 176, fig. 2.

2 *Stations.*

D'Orbigny's species, as reproduced (*ut supra*) from the "Planches inédites" by Fornasini, represents a *Bulimina* of the *B. affinis* type, in which the aboral half of the shell is covered with a dense growth of short blunt spines, the remainder of the shell being smooth. D'Orbigny's original finished "Planche inédite," which we have carefully examined, entirely justifies Fornasini's figure, but d'Orbigny's type-specimens, which we have also examined in Paris, are so disguised in gum as to render their identification with the "Planche" very difficult *.

127. **Bulimina aculeata**, d'Orbigny.

Bulimina aculeata, d'Orbigny, 1826, TMC. p. 269. No. 7.
" " Brady, 1884, FC. p. 406, pl. li. figs. 7–9.

12 *Stations.*

Really typical individuals characterized by long projecting spines are somewhat rare in the dredgings, but good specimens occur at Stns. 2 and 4, and weaker ones at several other Stns. The semi-aculeate forms, inseparable from either this species or its ally *B. marginata*, occur at practically all Stns. where either species occurs.

128. **Bulimina subteres**, Brady.

Bulimina subteres, Brady, 1884, FC. p. 403, pl. l. figs. 17, 18.
" " Heron-Allen & Earland, 1913, CI. p. 62, pl. iv. figs. 13, 14.

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* The relationship of Dr. Carlo Fornasini's "Specie Orbignyane" to the "Planches inédites" requires to be explained. D'Orbigny was an indefatigable and accomplished draughtsman, and left behind him not only the "Planches inédites" of the Foraminifera, but vast collections of similar drawings of fossils, all of which are now preserved in the Director's Cabinet at the Musée de Paléontologie in Paris. As early as 1819 we find his father writing to M. Fleuriau de Bellevue that his son was making drawings of the "céphalopodes microscopiques" which they had discovered in the sands near La Rochelle (*Journal de Physique*, 1819, vol. lxxxviii. p. 187). Later, when he began to receive material from all over the world, he made a practice of first drawing the outline of all species as he separated them, often roughly in pen and ink, under the microscope, indicating any surface-markings partially upon his sketch, and making notes on the rough slips containing the sketches. These sketches he subsequently elaborated in sepia or Indian ink, making fairly finished drawings, which he in turn copied, drawing most delicately and beautifully in pencil and water-colour on sheets intended, when complete, to illustrate all the species enumerated in the 'Tableau Méthodique.' These constitute the "Planches inédites," which since 1826 have remained to a great extent an unexplored and practically unavailable store of priceless information. We have made it our duty to examine these "Planches" in detail. Roughly speaking, there are 70 plates (7 unfinished) and materials for finishing 79 more plates. We hope before long to arrange for the completion and publication of these plates; when it is done the names in the TMC. 1826 will no longer be for the most part *nomina nuda*.

The outlines published by Dr. Fornasini, scattered through some twenty-three memoirs and papers published by him between 1898 and 1903, represent tracings made from the first rough working sketches (made by d'Orbigny under the microscope) by M. Berthelin, and bequeathed by him to Dr. Fornasini under circumstances which the latter has recorded (Rend. Sess. R. Acc. Sci. Ist. Bologna, 1897–8, vol. ii. p. 11, footnote). M. Berthelin appears to have selected about 320 outlines for tracing, and these tracings Dr. Fornasini has carefully reproduced on a fairly uniform scale. They cannot be said to compare for accuracy and beauty with the "Planches inédites," but they afford a most valuable indication of what was in d'Orbigny's mind when he founded his multitudinous and often unidentifiable species.

9 *Stations.*

This very beautiful species occurs in some numbers at Stns. 4, 10, and 12, and less abundantly at the other Stns. At Stns. 10 and 12 many individuals had been dredged in the living condition, and the protoplasmic body of the animal, which is of a bright orange-colour without metaplastic enclosures, has in nearly all instances dried in clots underneath the patches of clear shell-substance which mark the central portions of each chamber. This probably indicates that the pseudopodial foramina are more or less confined to these portions of the shell. *B. subteres* is, as a rule, very rare in British dredgings, but, judging from the examination of 'Goldseeker' material, it increases in frequency in the northern area.

129. **Bulimina minutissima,** Wright.

Bulimina minutissima, Wright, 1902, GFL. p. 190, pl. xiii. figs. 9–12.
,, ,, Heron-Allen & Earland, 1913, CI. p. 62, pl. iv. figs. 11, 12.

2 *Stations.*

A single individual at Stns. 10 and 13. Our experience goes to show that this species is widely distributed, but is never otherwise than very rare.

130. **Bulimina squammigera,** d'Orbigny.

Bulimina squammigera, d'Orbigny, 1839, FIC. p. 137, pl. i. figs. 22–24.
,, ,, Heron-Allen & Earland, 1914, etc., FKA. 1915, p. 642, pl. xlviii. figs. 31–35.

9 *Stations.*

Widely distributed, but never common. Numerous and excellent examples at Stns. 4, 17, and 18. All the specimens are large, well-grown, and typical. The species is, on the whole, much more abundant in these gatherings than is usually the case in British dredgings.

131. **Virgulina schreibersiana,** Czjzek.

Virgulina schreibersiana, Czjzek, 1848, FWB. p. 147, pl. xiii. figs. 18–21.
,, ,, Brady, 1884, FC. p. 414, pl. lii. figs. 1–3.

14 *Stations.*

The best specimens at Stns. 4 and 11; at the latter Stn. an abnormal individual with a double terminal chamber was observed.

BOLIVINA, d'Orbigny.

132. **Bolivina punctata,** d'Orbigny.

Bolivina punctata, d'Orbigny, 1839, FAM. p. 63, pl. viii. figs. 10–12.
,, ,, Brady, 1884, FC. p. 417, pl. lii. figs. 18, 19.

16 *Stations.*

Very generally distributed, often fairly common, the best at Stns. 4, 11, and 18. There is, as usual, much variation, most noticeable, perhaps, being the occurrence of an extra long variety at Stns. 4, 19, and 20. Weakly striate examples connecting this species with *B. nobilis* occur at many Stns.

133. Bolivina nobilis, Hantken.

Bolivina nobilis, Hantken, 1875, CSS. p. 65, pl. xv. fig. 4.
„ „ Brady, 1884, FC. p. 424, pl. liii. figs. 14, 15.

10 *Stations.*

Sparingly distributed, and not abundant except at Stn. 4, where the best individuals are found; but at nearly all the Stns. where it occurs the specimens are more strongly marked than is usual in British gatherings.

134. Bolivina textilarioides, Reuss. (Plate 41. figs. 10–14.)

Bolivina textilaroides, Reuss, 1862, NHG. p. 81, pl. x. fig. 1.
„ „ Brady, 1884, FC. p. 419, pl. lii. figs. 23–25.

17 *Stations.*

Generally distributed, never very common; very few strictly typical examples, the best being found at Stn. 11. At many of the Stns. a very strongly-marked variety, which we figure, occurs, characterized by a thickening of the shell-substance, accompanied in some instances by limbation of the sutures and coarse punctation. These features combined often render the septal lines very indistinct. The best individuals of this rough form occur at Stns. 4, 9, 14, and 18. Intermediate specimens, leading from typical *B. variabilis* to this rough variety, occurred at the same Stns. and also at many others.

135. Bolivina lævigata (Williamson).

Textularia variabilis, var. *lævigata*, Williamson, 1858, RFGB. p. 77, pl. vi. fig. 168.
Bolivina lævigata, Brady, 1887, SBRF. p. 900.

7 *Stations.*

Only an occasional specimen, except at Stn. 20, where many good individuals were observed.

136. Bolivina dilatata, Reuss.

Bolivina dilatata, Reuss, 1849–50, FOT. p. 381, pl. xlviii. (iii.) fig. 15.
„ „ Brady, 1884, FC. p. 418, pl. lii. figs. 20, 21.

19 *Stations.*

Almost universally distributed. This is one of the commonest and most typical Bolivinæ of the dredgings, as, indeed, of most dredgings round the British coast. Two very distinctive forms occur, nearly always in company: (i.) a long narrow form not far removed from *B. ænariensis*, and (ii.) a much shorter form which varies in two directions—a thinner carinate form often having a denticulate margin and approaching *B. difformis*, and a thick non-carinate type closely allied to *B. robusta*. The best individuals at Stns. 11 and 12.

137. **Bolivina difformis** (Williamson).

Textularia variabilis, var. *difformis*, Williamson, 1858, RFGB. p. 77, pl. vi. figs. 166, 167.
Bolivina difformis, Brady, 1887, SBRF. p. 899.
" " Heron-Allen & Earland, 1913, CI. p. 65.

14 *Stations.*

Fairly generally distributed, but not generally abundant, the best individuals at Stns. 3, 10, and 19. There is very little differentiation, but the specimens generally represent one or other of two types: (i.) a thin flat form closely allied to *B. dilatata*, and (ii.) a stouter form with limbate sutures often tending to obscurity of the surface.

138. **Bolivina gramen** (d'Orbigny).

Vulvulina gramen, d'Orbigny, 1839, FC. p. 148, pl i. figs. 30, 31.
Bolivina gramen, Heron-Allen & Earland, 1913, CI. p. 69, pl. v. figs. 4, 5.

5 *Stations.*

Very rare, only an occasional specimen being found, except at Stn. 4, where it is fairly frequent and typical. This species has been recorded from Britain by ourselves (*ut supra*), and this appears to be the only record since it was first described by d'Orbigny (*ut supra*) from Cuba.

139. **Bolivina beyrichi**, Reuss. (Plate 41. fig. 15.) (New to Britain.)

Bolivina beyrichi, Reuss, 1851, FSUB. p. 83, pl. vi. fig. 51.
" " Brady, 1884, FC. p. 422, pl. liii. fig. 1.

2 *Stations.*

Several fine and typical specimens at Stn. 4, characterized by the marginal processes and bands of clear shell-substance at the base of each chamber which mark this species. As a recent form, this is the first British record, but Wright records it from Post-tertiary deposits at Derry and Shellag (J. Isle of Man Nat. Hist. Soc. 1902, vol. iii. p. 628; and Proc. Belfast Nat. Field C. 1900–1, p. 604). The species is widely distributed all over the world, but, as a recent species, has not been recorded farther north than the coast of Portugal.

140. **Bolivina ænariensis** (Costa).

Brizalina ænariensis, Costa, 1853, etc., PRN. 1856, p. 297, pl. xv. figs. 1, 2.
Bolivina ænariensis, Brady, 1884, FC. p. 423, pl. liii. figs. 10, 11.

12 *Stations.*

Generally distributed, but not very abundant except at Stns. 2, 18, and 20. None of the individuals exhibit the parallel longitudinal costæ which mark the typical *B. ænariensis*. These costate specimens, however, appear generally to be confined to deeper water than any of these dredgings. The specimens run gradually into *B. dilatata*, Reuss. At several Stns. there is a tendency to form either a marginal keel or serrate processes at the extremities of the chambers; this is especially noticeable at Stn. 2. At this Stn., and also at Stn. 4, many individuals twisted along the long axis occur.

141. **Bolivina tortuosa,** Brady.

Bolivina tortuosa, Brady, 1879, etc., RRC. 1881, p. 57.
,, ,, Brady, 1884, FC. p. 420, pl. lii. figs. 31–34.

2 *Stations.*

A single specimen, referable to Brady's species, at Stns. 4 and 6. The question of the specific value of this so-called species is very doubtful. Tortuose specimens clearly referable to other species, such as *B. dilatata* and *B. ænariensis*, occur in the dredgings. This species has only been recorded as a recent British form by ourselves (H.-A. & E. 1908, etc., SB. 1911, p. 317; and 1913, CI. p. 66, pl. v. fig. 1).

142. **Bolivina plicata,** d'Orbigny.

Bolivina plicata, d'Orbigny, 1839, FAM. p. 62, pl. viii. figs. 4–7.
,, ,, Goës, 1894, ASF. p. 51, pl. ix. figs. 487, 488.

23 *Stations.*

Almost universally distributed, generally common. Good typical specimens at most Stns., the best at 4, 9, 10, 16, and 20. There are, as usual, at most Stns. a number of specimens intermediate between this species and *B. variabilis*.

143. **Bolivina variabilis** (Williamson).

Textularia variabilis (*typica*), Williamson, 1858, RFGB. p. 76, pl. vi. figs. 162, 163 (not 161 & 162).
Bolivina variabilis, Heron-Allen & Earland, 1913, CI. p. 68.

20 *Stations.*

Generally distributed, often abundant. This not very satisfactory species is, as usual, subject to great variation, the specimens running in a more or less complete series between *B. plicata* and *B. punctata*.

144. **Bolivina inflata,** Heron-Allen & Earland.

Bolivina inflata, Heron-Allen & Earland, 1913, CI. p. 68, pl. iv. figs. 16–19; 1915, FKA. p. 648.

9 *Stations.*

Poorly represented, the specimens being few and not very typical, the best at Stns. 11 and 18. This species, first recorded by us *ut supra*, is probably widely distributed.

Subfamily Cassidulininæ.

Cassidulina, d'Orbigny.

145. **Cassidulina lævigata,** d'Orbigny.

Cassidulina lævigata, d'Orbigny, 1826, TMC. p. 282. No. 1, pl. xv. figs. 4, 5, Modèle No. 41.
,, ,, Brady, 1884, FC. p. 428, pl. liv. figs. 1–3.

21 *Stations.*

Almost universally distributed. At all the Stns. but four where the species was recorded, the specimens belong to the familiar carinate type, differing only in the degree of development of the carina, but at Stns. 2, 3, and 4 a smaller form, entirely devoid of carina and with somewhat rounded marginal edge, occurs in company with the carinate specimens, though usually in smaller numbers. At Stn. 13 this type only was recorded. The carinate specimens everywhere are large as compared with the round-edged variety.

146. **Cassidulina crassa,** d'Orbigny.

Cassidulina crassa, d'Orbigny, 1839, FAM. p. 56, pl. vii. figs. 18–20.
„ „ Brady, 1884, FC. p. 429, pl. liv. figs. 4, 5.

22 *Stations.*

Almost universally distributed, never very abundant, the best at Stns. 4, 10, 16, and 20. There is a considerable range in form, depending primarily on the degree of inflation of the chambers. A very flat complanate form, exhibiting both series of chambers distinctly, was prominent at Stns. 10 and 16. At Stn. 3 and some others a very turgid type, closely approaching *C. subglobosa*, occurs. These inflated varieties are always much smaller than the compressed. At Stn. 4 the species exhibited a complete range between the two types.

147. **Cassidulina subglobosa,** Brady.

Cassidulina subglobosa, Brady, 1879, etc., RRC. 1881, p. 60.
„ „ Brady, 1884, FC. p. 430, pl. liv. fig. 17.

17 *Stations.*

Less widely distributed and less abundant than *C. crassa* or *C. lævigata*, but fairly numerous at many Stns. The specimens, as a whole, seem rather small and with a compressed tendency, linking them with *C. crassa*, but large and typical examples occur at Stns. 10 and 20, and, less frequently, at many others.

148. **Cassidulina bradyi,** Norman.

Cassidulina bradyi (Norman MS.), Wright, 1880, NEI. p. 152.
„ „ Brady, 1884, FC. p. 431, pl. liv. figs. 6–10.

5 *Stations.*

Only a few rather small and poor specimens, the best at Stn. 4.

149. **Cassidulina nitidula** (Chaster).

Pulvinulina nitidula, Chaster, 1892, FS. p. 66, pl. i. fig. 17.
Cassidulina nitidula, Heron-Allen & Earland, 1913, CI. p. 70, pl. v. figs. 6–9.

5 *Stations.*

An occasional excellent specimen, but the species is extremely rare in the dredgings. This species appears, from our experience, to be widely distributed, though never common. There are many records from Post-tertiary deposits, but it has only been recorded by us as a recent British form (*ut supra*) since Chaster's original record.

Family LAGENIDÆ.

Sub-family LAGENINÆ.

LAGENA, Walker & Boys.

150. **Lagena globosa** (Montagu).

Serpula (Lagena) lævis globosa, Walker & Boys, 1784, TMR. p. 3, pl. i. fig. 8.
Vermiculum globosum, Montagu, 1803–8, TB. p. 523.
Lagena globosa, Brady, 1884, FC. p. 452, pl. lvi. figs. 1–3.

20 *Stations.*

Almost universally distributed, and very variable in size and globularity of test, the finest specimens at Stns. 3, 7, and 22. At many Stns., notably Stns. 7, 18, and 22, abnormal individuals with two or more apertures in different parts of the shell occur, including some ento-ecto-solenian specimens. At Stn. 4 two double individuals were found, one having a pair of tests side by side, with a single aperture, the other a pair of tests joined by their bases. At Stn. 7 an individual with a fistulose crown round the aperture was found.

151. **Lagena ovum** (Ehrenberg).

Miliola ovum, Ehrenberg, 1843, MMO. p. 166; and 1854, M. pl. xxiii. fig. 2, pl. xxix. fig. 45, pl. xxxi. fig. 4.
Lagena ovum, Brady, 1884, FC. p. 454, pl. lvi. fig. 5.

2 *Stations.*

A single typical specimen at each Stn.

152. **Lagena apiculata** (Reuss).

Oolina apiculata, Reuss, 1851, FKL. p. 22, pl. i. fig. 1.
Lagena apiculata, Brady, 1884, FC. p. 453, pl. lvi. figs. 4, 15–18.

5 *Stations.*

This pointed variety of *L. globosa* is very rare in the dredgings, only an occasional specimen at the few Stns. where it occurs.

153. **Lagena botelliformis**, Brady.

Lagena botelliformis, Brady, 1879, etc., RRC. 1881, p. 60.
" " Brady, 1884, FC. p. 454, pl. lvi. fig. 6.

2 *Stations.*

Typical examples at the two Stns. Most of the records of this pretty little form are from deep water. It is common in the Faroe Channel.

154. **Lagena aspera,** Reuss.

Lagena aspera, Reuss, 1861, SAWW. vol. xliv. p. 305, pl. i. fig. 5.
" " Brady, 1884, FC. p. 457, pl. lvii. figs. 7–10.

2 *Stations.*

One small and nearly globular specimen at Stn. 4 and one normal oval specimen at Stn. 17.

155. **Lagena hispida,** Reuss. (Plate 41. fig. 16.)

Lagena hispida, Reuss, 1858, FP. p. 434.
" " Brady, 1884, FC. p. 459, pl. lvii. figs. 1–4, pl. lix. figs. 2–5.

9 *Stations.*

Very scantily represented, but a few excellent specimens at Stns. 2 and 20. From the examination of a long series of specimens at other localities, we have little doubt that *L. hispida* is one of those species of *Lagena* with compound shell-structure—*i. e.*, the shell-structure can be separated into distinctive layers. The internal layer is normally clothed with a dense "pile" of most delicate needles of equal length, and their points coalesce to form a rough or "mat" surface. The spirally ornamented neck is free from all exogenous growth. The "mat" outer surface is very easily destroyed; the spines then fall off, and only their bases are left, giving a faintly hispid surface to the test—this is the stage in which British specimens are usually found. A still further stage of attrition leaves practically no trace of the original spines, and a globular test with a dull surface remains. We figure a specimen from the North Sea, which illustrates the real nature of the test better than any of the 'Runa' examples, which are all in a more or less advanced stage of denudation of the outer layers.

156. **Lagena lineata** (Williamson).

Entosolenia lineata, Williamson, 1848, BSGL. p. 18, pl. ii. fig. 18.
Lagena lineata, Brady, 1884, FC. p. 461, pl. lvii. fig. 13.

16 *Stations.*

Generally distributed, but rather rare, the best at Stns. 7, 12, and 19. On the whole, the specimens are very feebly marked, but strong and typical individuals were found at Stns. 7 and 19. At Stn. 10 a double shell, the two individuals somewhat distorted and joined at their bases, and at the same Stn. was found a specimen rough or feebly hispid all over.

157. **Lagena costata** (Williamson). (Plate 41. figs. 17, 18.)

Entosolenia costata, Williamson, 1858, RFGB. p. 9, pl. i. fig. 18.
Lagena costata, Balkwill & Wright, 1885, DIS. p. 338, pl. xiv. figs. 3–5.

18 *Stations.*

Widely distributed and abundant at some Stns., notably Stns. 3, 7, and 10; at other Stns. the individuals are large and typical. At some of the other Stns. a small weak form occurs in which the aperture is broad, furnished with a thickened lip, and but slightly produced, contrasting with the short but stoutly built produced neck of the type. The number of costæ vary considerably. At Stn. 20 individuals with few and very weakly developed costæ occur in company with normal specimens.

158. **Lagena hexagona** (Williamson).

Entosolenia squamosa, var. *hexagona*, Williamson, 1848, BSGL. p. 20, pl. ii. fig. 23.
Lagena hexagona, Brady, 1884, FC. p. 472, pl. lviii. figs. 32, 33.

21 *Stations.*

Almost universally distributed and common at some Stns., the best at Stns. 10, 18, and 20. There is, as usual, great variation in the size and regularity of marking—very regularly hexagonal specimens at Stn. 10, coarser types at Stns. 2 and 4. Distorted and compressed individuals suggesting the same conditions of growth as have been separated in the allied species *L. squamosa* under the varietal name *montagui* (Alcock) occur in considerable numbers at Stns. 11 and 12, where the species is abundant and varied in form, and occasionally at other Stns.

159. **Lagena reticulata** (MacGillivray).

Lagenula reticulata, MacGillivray, 1843, HMAA. p. 38.
Lagena reticulata, Reuss, 1882, FFL. p. 333, pl. v. figs. 67, 68.

4 *Stations.*

Scantily represented, the best specimens at Stn. 10.

160. **Lagena squamosa** (Montagu).

Vermiculum squamosum, Montagu, 1803–8, TB. p. 526, pl. xiv. fig. 2.
Lagena squamosa, Brady, 1884, FC. p. 471, pl. lviii. figs. 28–31.

21 *Stations.*

Almost universally distributed, common at many Stns., the best at Stns. 7 and 8. There is, of course, great variation in the character and prominence of the markings. At many Stns. the specimens are very weak, but at Stns. 6 and 20 strongly costate forms occur. At Stn. 16 a specimen was found nearly approaching *L. melo* (d'Orbigny). Abnormal and distorted shells at Stn. 12, and a very curious abnormality at Stn. 10, the oral half of the shell being almost flat with a projecting tubular aperture.

161. **Lagena squamosa, var. montagui** (Alcock).

Entosolenia montagui, Alcock, 1865, NHC. p. 206.
Lagena squamosa, var. *montagui*, Wright, 1900, DBC. p. 54, pl. ii. fig. 2.
" " " Heron-Allen & Earland, 1913, CI. p. 76, pl. vii. figs. 11, 12.

5 *Stations.*

Sparingly distributed; the specimens are, however, quite typical in their absolute dissimilarity from the normal contour of *L. squamosa*.

162. **Lagena spumosa,** Millett. (Plate 41. figs. 19, 20.) (New to Britain.)

Lagena spumosa, Millett, 1898, etc., FM. 1901, p. 9, pl. i. fig. 9.
„ „ Heron-Allen & Earland, 1914, etc., FKA. 1915, p. 657.

1 *Station.*

Two excellent specimens at Stn. 2. This curious little double-shelled *Lagena*, originally described from the Malay Archipelago, is probably widely distributed. It occurs in considerable numbers in the deep water of the Faroe Channel ('Goldseeker,' Stn. 15 A, 1280 metres), and less abundantly in Hilte Fjord, Norway (260 metres, 'Goldseeker,' Haul 141). We have also records of it from Palermo, and from Vavau (Friendly Islands), Pacific, 16 fms. It is now recorded as British for the first time.

163. **Lagena lævis** (Montagu).

Serpula (Lagena) lævis ovalis, Walker & Boys, 1784, TMR. p. 3, pl. i. fig. 9.
Vermiculum læve, Montagu, 1803–8, TB. p. 524.
Lagena lævis, Brady, 1884, FC. p. 455, pl. lvi. figs. 7–14, 30.

19 *Stations.*

Almost universally distributed, very common at some Stns., the best at Stns. 12 and 17. There is the usual great range of variation, from true flask-shaped specimens with a produced neck to long tapering tests running into *L. clavata.* Abnormal and distorted shells are frequent at many Stns. The most constant abnormality is of the type which we figured in the Clare Island Report (H.-A. & E. 1913, CI. pl. vi. fig. 5), in which one-half of the shell is developed to a greater degree than the other, resulting in an arcuate test. At Stn. 11 a double specimen, consisting of two shells of different sizes fused into one neck, was found, and at the same Stn. a specimen of the curious abnormal type frequently found in the Lagenidæ in which the oral half of the shell was of greater diameter than the basal portion.

164. **Lagena lævis,** var. **distoma,** Silvestri.

Lagena distoma (*lævis* Montagu), Silvestri, 1900, FPNT. p. 245, pl. iv. fig. 43, pl. vi. figs. 74, 75.
„ *lævis*, var. *distoma*, Millett, 1898, etc., FM. 1901, p. 10, pl. i. fig. 10.
„ „ „ Heron-Allen & Earland, 1913, CI. p. 77, pl. vi. fig. 6.

3 *Stations.*

A few individuals of this rare variety at the three Stns.

165. **Lagena semistriata,** Williamson.

Lagena striata, var. *semistriata,* Williamson, 1848, BSGL. p. 14, pl. i. figs. 9, 10.
„ *semistriata,* Brady, 1884, FC. p. 465, pl. lvii. figs. 14, 16, 17 (? 18, 20).

14 *Stations.*

Generally distributed and often frequent, but, as a general rule, the specimens are very weakly marked. Excellent examples of the strongly costate type originally figured by Williamson (fig. 9) occur at Stn. 22 (a shore-sand). At Stn. 11 distorted individuals of the curved type occur.

166. **Lagena semilineata,** Wright. (Plate 41. figs. 21, 22.)

Lagena semilineata, Wright, 1885–6, BLP. p. 320, pl. xxvi. fig. 7.

2 *Stations.*

One weak specimen at Stn. 18 and a remarkably fine and typical example at Stn. 9, which we figure. The markings are gouged-out grooves, a feature which separates it from *L. semistriata*, under which name it may have been recorded elsewhere. This type is extremely rare, whereas *L. semistriata* is everywhere a common species.

167. **Lagena perlucida** (Montagu).

Lagena vulgaris, var. *perlucida,* Williamson, 1858, RFGB. p. 5, pl. i. figs. 7, 8.
„ *perlucida,* Heron-Allen & Earland, 1908, etc., SB. 1911, p. 320, pl. x. fig. 13.

4 *Stations.*

Feebly represented, only an occasional specimen, the best at Stn. 4.

168. **Lagena striata** (d'Orbigny).

Oolina striata, d'Orbigny, 1839, FAM. p. 21, pl. v. fig. 12.
Lagena striata Brady, 1884, FC. p. 460, pl. lvii. figs. 22, 24, 28, 29.

15 *Stations.*

Generally distributed, but not abundant except at Stns. 4 and 18. There are two very distinctly recognizable types—one in which the flask is very swollen and rotund and the other in which it is long, with more or less parallel sides. The two occur together at Stn. 4 and at one or two others, but, as a rule, the narrow form predominates. At Stn. 4 a specimen of the rotund type with a hispid base occurred. At this Stn. and also at Stn. 19 specimens were found in which there was a change in the diameter of the shell at about mid-growth.

169. **Lagena sulcata** (Walker & Jacob).

Serpula (Lagena) striata sulcata rotunda, Walker & Boys, 1784, TMR. p. 2, pl. i. fig. 6.
Lagena sulcata, Brady, 1884, FC. p. 462, pl. lvii. figs. 23, 26, 33, 34, pl. lviii. figs. 4, 17, 18.

20 *Stations.*

Almost universally distributed and often very common, the best at Stn. 7. Very variable both as to size and prominence and regularity of markings. The var. *interrupta* of Williamson occurs at many Stns. (W. 1848, BSGL. p. 14, pl. i. fig. 7), principally in the shallower dredgings and shore-sands. At Stn. 2 a distorted specimen, with the neck set almost at right angles to the body and with curved costæ suggesting *L. curvilineata*, Balkwill & Wright, was found; a somewhat similar specimen was found at Stn 10. At Stn. 19 a specimen in which the costæ formed hexagonal reticulations over the base. At Stn. 20 (and some others) a very small but strongly marked type occurs, with an almost globular body and costæ extending in sharp edges, and then coalescing into a produced ornamental neck.

170. Lagena lyellii (Seguenza).

Amphorina lyellii, Seguenza, 1862, FMMM. p. 52, pl. i. fig. 40.
„ *costata*, Seguenza, ibid. fig. 41.
Lagena lyellii, Heron-Allen & Earland, 1913, CI. p. 79, pl. vi. fig. 8.

7 *Stations.*

Occurs at few Stns., but plentifully at Stns. 2, 4, and 18. The majority of the specimens at all the Stns. are of the oval form represented by Seguenza's species *L. costata* (*ut supra*) rather than the spherical *L. lyellii.*

171. Lagena williamsoni (Alcock).

Entosolenia williamsoni, Alcock, 1865, NHC. p. 195.
Lagena williamsoni, Balkwill & Wright, 1885, DIS. p. 339, pl. xiv. figs. 6–8.

22 *Stations.*

Almost universally distributed, often very common, the best specimens at Stns. 7 and 8. At many other Stns. the specimens are rather small, obscure in their reticulate neck-markings, and sometimes distorted.

172. Lagena acuticosta, Reuss.

Lagena acuticosta, Reuss, 1862, FFL. p. 331, pl. v. fig. 63.
„ „ Brady, 1884, FC. p. 464, pl. lvii. figs. 31, 32, pl. lviii. figs. 20, 21.

8 *Stations.*

Less widely distributed and less abundant than *L. williamsoni*, except at a few Stns. None of the specimens present the very salient ridges found in deep-water examples, but at the same time the specimens as a whole are well and strongly marked, though varying, especially at Stn. 10, in the prominence of the costæ. *L. acuticosta* and *L. williamsoni* must be extremely closely allied, for practically the only recognizable distinction between the two forms lies in the fact that the neck in *L. acuticosta* is a solid cone of shell-substance, while in *L. williamsoni* this cone is more or less covered with hexagonal pits. Why the test with a solid neck should be more or less confined to deep water, while the reticulate type has its habitat in shore-sands, is one of those puzzling problems of distribution which baffle the student.

173. Lagena striato-punctata, Parker & Jones.

Lagena sulcata, var. *striato-punctata*, Parker & Jones, 1865, NAAF. p. 350, pl. xiii. figs. 25–27.
„ *striato-punctata*, Brady, 1884, FC. p. 468, pl. lviii. figs. 37, 40.

1 *Station.*

A single specimen at Stn. 4, chiefly noteworthy because it is not of the feeble type with few costæ such as is usually found in British gatherings, but of a strong multicostate type such as is usually confined to tropical waters. Messrs. Balkwill and Wright, however (B. & W. 1885, DIS. p. 339, pl. xiv. fig. 20), figure a similar specimen from the Irish Sea.

174. Lagena clavata (d'Orbigny).

Oolina clavata, d'Orbigny, 1846, FFV. p. 24, pl. i. figs. 2, 3.
Lagena clavata, Goës, 1894, ASF. p. 75, pl. xiii. figs. 725–727.

17 *Stations.*

Almost universally distributed, and fairly frequent at some Stns. The individuals are large, and on the whole well-grown and typical. At Stn. 2 a few individuals with a ring of small cusps round the base were found, comparable with Millett's var. *setigera* (M. 1898, etc., FM. 1901, p. 491. pl. viii. fig. 9), but the processes are extremely minute as compared with the long spines shown in the Malay figure. At Stn. 20 an abnormal example with the basal half of the shell expanded decanter fashion was found.

175. Lagena gracillima (Seguenza).

Amphorina gracillima, Seguenza, 1862, FMMM. p. 51, pl. i. fig. 37.
Lagena gracillima, Brady, 1884, FC. p. 456, pl. lvi. figs. 19–28.

13 *Stations.*

Fairly generally distributed, never very common, the best at Stns. 2, 5, and 20. There is, as usual, a considerable range of form, specimens passing imperceptibly into *L. clavata*, on the one hand, and into *L. elongata* (Ehrenberg), on the other. This latter form occurs at Stns. 9 and 14, very long and tubular, the sides practically parallel for the greater part of their length, but constricted at the extremities much more than in Ehrenberg's original figure of *Miliola elongata* (E. 1854, M. pl. xxv. fig. 1), which probably represents a broken test. Fornasini's note on this subject printed and issued in 1895, which unfortunately was not published in any scientific journal, discusses the affinities of this form.

176. Lagena gracilis, Williamson.

Lagena gracilis, Williamson, 1848, BSGL. p. 13, pl. i. fig. 5.
„ „ Brady, 1884, FC. p. 464, pl. lviii. figs. 2, 3, 7–10, 19, 22–24.

12 *Stations.*

Occurs at many Stns. in two very distinctive forms: a long, regularly tapering, finely striate shell like Brady's fig. 8 (*supra*) and a short costate type (Brady's fig. 2). Practically every stage between these two is represented, and often at the same Stn. The long form passes imperceptibly into *L. distoma* and the short into *L. sulcata.*

177. Lagena distoma, Parker & Jones MS.

Lagena distoma, Brady, 1864, RFS. p. 467, pl. xlviii. fig. 6.
„ „ Brady, 1884, FC. p. 461, pl. lviii. figs. 11–15.

7 *Stations.*

Very sparingly distributed, only an occasional specimen, and these comparatively small when compared with those from the 'Goldseeker' dredgings in the North Sea, where it attains quite a gigantic size (see our note on *L. gracilis*).

178. **Lagena lævigata** (Reuss). (Plate 41. figs. 23, 24.)

Fissurina lævigata, Reuss, 1849–50, FOT. p. 366, pl. xlvi. (i.) fig. 1.
Lagena lævigata, Brady, 1884, FC. p. 473, pl. cxiv. fig. 8, *a*, *b*.

23 *Stations.*

This ubiquitous species occurs at nearly every Stn. and in its usual profusion of forms. The best and most typical examples occur at Stns. 4, 10, and 20, where the species attains exceptionally large dimensions. Stn. 4 is also noteworthy for the presence of a coarsely punctate form, which also occurs in lesser profusion at Stns. 14, 19, 20, and 23. This punctate form is very handsome, the shell-wall being usually exceptionally hyaline. Trigonal specimens were recorded at Stns. 2, 5, 6, and 17, and a polygonal example at Stn. 4. At Stn. 4, also, a specimen occurred with a large lipped mouth opening on one side of the shell (compare the apertures in Sidebottom's *L. lævigata* (var.), S. 1912, etc., LSP. 1912, pl. xvii. fig. 7). Specimens with similar prominently lipped apertures occur in several of the 'Goldseeker' dredgings from the North of Scotland.

179. **Lagena acuta** (Reuss).

Fissurina acuta, Reuss, 1858, FP. p. 434; and 1862, FFL. p. 340, pl. vii. figs. 90, 91.
Lagena acuta, Brady, 1884, FC. p. 474, pl. lix. fig. 6.

16 *Stations.*

This pointed form of *L. lævigata* is widely distributed in the dredgings and very abundant at some Stns. Few of the specimens present terminal spines of any size, in the majority the base is merely ornamented with one or more blunted points. Two forms occur—the commonest is a broad inflated test with a thick opaline shell, the other narrow, long, and hyaline. A trigonal specimen occurred at Stn. 4.

180. **Lagena falcata,** Chaster. (Plate 41. fig. 25.)

Lagena falcata, Chaster, 1892, FS. p. 61, pl. i. fig. 7.
,, ,, Heron-Allen & Earland, 1913, CI. p. 82, pl. vi. figs. 12, 13.

1 *Station.*

Two specimens at Stn. 4, one representing Chaster's original elongate type and the other the short broad form as figured by us (*ut supra*). Previously only recorded *ut supra* and by Wright from post-Tertiary deposits at Altcar (Proc. Liverpool Geol. Soc. vol. ix. 1904, p. 364).

181. **Lagena lucida** (Williamson).

Entosolenia marginata, var. *lucida*, Williamson, 1858, RFGB. p. 10, pl. i. figs. 22, 23.
Lagena lucida, Balkwill & Millett, 1884, FG. p. 80, pl. ii. fig. 7, pl. iii. figs. 4, 5.

18 *Stations.*

Almost universally distributed, abundant at some Stns. There is considerable variation in the relative breadth of the shells. Trigonal specimens occur at Stns. 1, 2, and 22, and frequently at Stn. 17, which was the best Stn. for the species. A double specimen was found at this Stn.

182. Lagena fasciata (Egger).

Oolina fasciata, Egger, 1857, MSO. p. 270, pl. v. (i.) figs. 12–15.
Lagena fasciata, Reuss, 1862, FFL. p. 323, pl. ii. fig. 24.

10 *Stations.*

More widely distributed than *L. annectens* and much more abundant, but very few of the specimens are strongly marked. They run imperceptibly into the variety *faba*. Typical examples should possess curving raised bands of shell-substance near the marginal edge. Only one strongly-marked individual was found, at Stn. 21, and this was decorated with rudimentary costæ between the bands on the inferior portion of the shell. Pedunculate specimens occur at Stns. 3 and 4. The species has only been recorded by us as a recent British form (H.-A. & E. 1913, CI. p. 83; and 1913, NSH. p. 131), but it appears in Wright's list from Post-tertiary deposits at Magheramore (W. 1910–11, ECM. p. 15) and elsewhere. It has no doubt been included in the numerous records of *L. quadricostulata*, Reuss.

183. Lagena fasciata, var. faba, Balkwill & Millett.

Lagena faba, Balkwill & Millett, 1884, FG. p. 31, pl. ii. fig. 10.
Lagena fasciata, var. *faba*, Heron-Allen & Earland, 1913, CI. p. 84.

15 *Stations.*

This is the most widely distributed and abundant type of its group in the dredgings, occurring at most Stns. and often in considerable numbers. It differs from *L. fasciata* in the reduced prominence of the marginal costæ, which are but very slightly raised, and are of a milky texture as in *L. annectens*, thus occupying a position midway between *L. annectens* and *L. fasciata*, but its most permanent characteristic appears to be the surface-texture, which was compared by its author to orange-peel, and appears to be a constant feature.

184. Lagena annectens, Burrows & Holland. (New to Britain.)

Lagena annectens, Burrows & Holland in Jones, Parker, & Brady, 1866, etc., MFC. 1895, p. 203, pl. vii. fig. 11.
,, ,, Heron-Allen & Earland, 1914, etc., FKA. 1915, p. 662.

14 *Stations.*

This rather unsatisfactory little species, in which the marginal faces of the shell are decorated with curved bands of denser shell-substance, forming, as it were, a horseshoe-marking on the face of the shell, is scantily represented in the dredgings, and is often hardly separable from *L. fasciata* and its variety *faba*. The best specimens at Stn. 4, where trigonal examples were observed.

185. **Lagena quadrata** (Williamson).

Entosolenia marginata, var. *quadrata*, Williamson, 1858, RFGB. p. 11, pl. i. figs. 27, 28.
Lagena quadrata, Brady, 1884, FC. p. 475, pl. lix. figs. 3, 16, pl. lx. fig. 5.

9 *Stations.*

Sparingly distributed. Two distinct types occur, generally together—an oblong form similar to Williamson's original figure, and a shorter type which more decidedly deserves the specific name, the specimens being practically square in plan.

186. **Lagena malcomsonii**, Wright.

Lagena lævigata, var. *malcomsonii*, Wright, 1910–11, BCNI. p. 4, pl. i. figs. 1, 2.
Lagena malcomsonii, Heron-Allen & Earland, 1913, CI. p. 84, pl. vi. fig. 9.

7 *Stations.*

Very few records, and very rare at those Stns. The best single specimen at Stn. 10, the other specimens being very short.

187. **Lagena marginata** (Walker & Boys). (Plate 41. fig. 26.)

Serpula (*Lagena*) *marginata*, Walker & Boys, 1784, TMR. p. 2, pl. i. fig. 7.
Lagena marginata, Brady, 1884, FC. p. 476, pl. lix. figs. 21–23.

20 *Stations.*

Almost universally distributed, most abundant at Stn. 3. There is a considerable range in the development of the keel, from keel-less specimens comparable with Silvestri's *Fissurina schlichti* (S. 1902, LMT. p. 142, figs. 9–11) up to quite broad-keeled individuals, though these are comparatively rare. At Stn. 12, where the keel-less individuals predominate, and at Stn. 20 nearly all had the aperture on one side of the oral extremity, as in *F. schlichti.* At Stn. 11, two trigonal individuals were found, but no normal specimens, and at Stn. 3 a broad-keeled shell, which we figure, in which the posterior half of the keel was broken up into a fimbriate frill.

188. **Lagena marginata**, var. **inæquilateralis**, Wright.

Lagena marginata, var. *inæquilateralis*, Wright, 1886, BLP. p. 321, pl. xxvi. fig. 10.
„ „ „ Heron-Allen & Earland, 1913, CI. p. 85.

4 *Stations.*

Very rare, and the few individuals found show marked variation in the very distinctive aperture which distinguishes this variety. In Wright's figure the aperture is situated inside a little hood on the flat, or less convex, side of the test, but the 'Runa' specimens also furnish instances of a similar aperture on the convex side of the test and also a specimen without a hood, in which the aperture is normal.

189. **Lagena marginata**, var. **semimarginata**, Reuss. (New to Britain.)

Lagena marginata, var. *semimarginata*, Reuss, 1870, FSP. p. 468; Schlicht, 1870, FSP. p. 11, pl. iv. figs. 4–6, 10–12.
„ „ „ Brady, 1884, FC. p. 477, pl. lix. figs. 17–19.

1 *Station.*

A single specimen, rather small, which, unfortunately, has since been lost.

190. **Lagena marginato-perforata,** Seguenza.

Lagena marginato-perforata, Seguenza, 1879–80, FTR. p. 332, pl. xvii. fig. 34.
" " " Heron-Allen & Earland, 1913, CI. p. 86, pl. vii. figs. 5, 6.

1 *Station.*

Two specimens at Stn. 4, differing from one another in that one has no keel. Neither agrees with the little variety figured in our Clare Island report, the costate markings at the aperture and base lacking in the 'Runa' specimens. The species has previously been recorded as British only by us (*ut supra*) and from the North Sea (H.-A. & E. 1913, NSII. p. 135), and by Wright as a rare recent form among his Post-pliocene records from the North of Ireland (W. 1910–11, ECM. p. 12).

191. **Lagena formosa,** Schwager.

Lagena formosa, Schwager, 1866, FKN. p. 206, pl. iv. figs. 19, *a–d*, pl. vii. fig. 1.
" " Brady, 1884, FC. p. 480, pl. lx. figs. 10, 18–20, 8 ?, 17 ?.

1 *Station.*

One well-marked example of the little British variety of this handsome species. It was first recorded by us as a recent British form from Clare Island (H.-A. & E. 1913, CI. p. 88).

192. **Lagena lagenoides** (Williamson).

Entosolenia marginata, var. *lagenoides,* Williamson, RFGB. p. 11, pl. i. figs. 25, 26.
Lagena lagenoides, Brady, 1884, FC. p. 479, pl. lx. figs. 6, 7, 9, 12–14.

9 *Stations.*

Scantily distributed, and rare excepting at Stn. 20, where many specimens occurred. The best individuals were at Stn. 16. Except at Stns. 4, 12, and 20, where an occasional test of the long-necked ovate form representing Williamson's figure 25 occurs, all the shells are of the broad short-necked type of Williamson's fig. 26.

193. **Lagena lagenoides,** var. **tenuistriata,** Brady.

Lagena tubulifera, var. *tenuistriata,* Brady, 1879, etc., RRC. 1881, p. 61.
" *lagenoides,* var. *tenuistriata,* Brady, 1884, FC. p. 479, pl. lx. figs. 11, 15, 16.

3 *Stations.*

Very rare, except at Stn. 4, where it is more abundant than the type. All the specimens are of the long-necked variety, the other form not appearing to be subject to the striate variation.

194. **Lagena ornata** (Williamson).

Entosolenia marginata, var. *ornata,* Williamson, 1858, RFGB. p. 11, pl. i. fig. 24.
Lagena ornata, Heron-Allen & Earland, 1913, CI. p. 88, pl. vii. fig. 8.

7 *Stations.*

Scantily represented and very rare, except at Stn. 4.

195. **Lagena rizzæ** (Seguenza).

Fissurina rizzæ, Seguenza, 1862, FMMM. p. 72, pl. ii. fig. 50.
Lagena rizzæ, Heron-Allen & Earland, 1913, CI. p. 89, pl. vii. fig. 9.

4 *Stations.*

Several good and typical specimens at Stn. 4 and a few at Stn. 12.

196. **Lagena bicarinata** (Terquem).

Fissurina bicarinata, Terquem, 1882, FEP. p. 31, pl. i. (ix.) fig. 24.
Lagena bicarinata, Balkwill & Millett, 1884, FG. p. 82, pl. ii. fig. 4, pl. iii. fig. 9.

6 *Stations.*

Scantily represented, only an occasional specimen at each Stn. The best at Stn. 20.

197. **Lagena orbignyana** (Seguenza).

Fissurina orbignyana, Seguenza, 1862, FMMM. p. 66, pl. ii. figs. 25, 26.
Lagena orbignyana, Brady, 1884, FC. p. 484, pl. lix. figs. 1, 18, 24–26.

23 *Stations.*

Universally distributed. This is by far the most abundant *Lagena* in British dredgings, and occurs plentifully at most Stns., notably at Stns. 3, 10, and 12. There is great variety in the development of the middle keel, the tests being exceptionally broad-keeled at Stn. 3. Two forms varying in the convexity of the test are especially noticeable—a biconvex type, which is the commonest, and a flat-faced type, occurring principally at Stns. 3 and 10. This flat variety appears to be subject to more abundant keel-growth than the convex form. Many trigonal specimens at Stn. 10 and a few at Stn. 12. At Stns. 10, 14, and 19 many specimens with strongly punctate surface, suggesting a passage-form into *L. lacunata*.

198. **Lagena orbignyana,** var. **walleriana,** Wright.

Lagena orbignyana, var. *walleriana*, Wright, 1886, SWI. p. 611; and 1891, SWI. p. 481, pl. xx. fig. 8.
" " " Millett, 1898, etc., FM. 1901, p. 627, pl. xiv. fig. 19.

1 *Station.*

One typical specimen. Previously only recorded as British by Wright (*ut supra*).

199. **Lagena pulchella,** Brady.

Lagena pulchella, Brady, 1870, FTR. p. 294, pl. xii. fig. 1, *a, b*.
" " Balkwill & Wright, 1885, DIS. p. 342, pl. xii. fig. 19.

7 *Stations.*

The original diagnosis of this species is confusing. Brady described it as having "characters as in *L. marginata*, W. & J., to which it is closely allied, but differing in having a number of delicate parallel costæ springing from the base and extending into the upper half of the shell, in some specimens nearly to the aperture," but gives no figure [Brady, Brit. Assoc. 1866 (Hebrides, 1867), p. 70]. Later (*ut supra*) he repeats this description without amplification, but figures a trigonal test of the group of *L. orbignyana* (not *L. marginata*) with sinuous and branching costæ. Balkwill and Millett in 1884 (B. & M. 1884, FG. p. 32, pl. ii. fig. 13) set the matter right by figuring a specimen similar to Brady's, and describing it as "a variety of *L. orbignyana*, the surface marked with branching costæ." This was followed by Balkwill and Wright, *ut supra.*

L. pulchella occurs abundantly in some of the 'Runa' dredgings, although the records are confined to a limited number of Stns. At Stn. 20 it was excessively common. Nearly all the specimens are extremely strongly marked, contrasting markedly with the allied species *L. clathrata*, which is almost invariably a feeble type in the dredgings.

200. **Lagena pulchella,** var. **hexagona,** var. nov. (Plate 41. fig. 27.)

1 *Station.*

A single specimen from Stn. 20, which we figure. In this very distinctive variety the costæ radiating from the oral end of the shell coalesce and form a hexagonal reticulation over the basal half of the faces of the test.

201. **Lagena clathrata,** Brady.

Lagena clathrata, Brady, 1884, FC. p. 485, pl. lx. fig. 4.
,, ,,. Heron-Allen & Earland, 1913, CI. p. 90, pl. vii. fig. 10.

9 *Stations.*

This species was instituted by Brady (*ut supra*) for the varieties of *L. orbignyana* in which the faces are marked with parallel longitudinal costæ as contrasted with his earlier species, *L. pulchella*, in which the costæ are sinuous or branching. It is more widely distributed in these dredgings than *L. pulchella*, but the specimens are fewer in number and almost invariably of a weak hyaline type, with feeble costæ seldom extending over the whole face of the shell. It reaches its maximum development, like *L. pulchella*, at Stn. 20. The species has only been recorded as recent by Balkwill and Millett from Galway (B. & M. 1884, FG. p. 82, pl. ii. fig. 14), and by Wright from Dog's Bay (W. 1900, DBC. p. 54), and ourselves (*ut supra*), but it has probably been frequently included under *L. pulchella*, of which there are many British records.

202. **Lagena lacunata,** Burrows & Holland. (Plate 41. figs. 28, 29.) (New to Britain.)

Lagena lacunata, Burrows & Holland in Jones, Parker, & Brady, 1866, etc., MFC. 1895, p. 205, pl. vii. fig. 12.
,, *orbignyana,* var. *lacunata,* Sidebottom, 1912, etc., LSP. 1912, p. 416, pl. xix. figs. 16–18.

2 *Stations.*

A few individuals only. The faces of the tests, which we figure, are regularly pitted, but the markings have neither the regularity nor the uniformity of shape characteristic of normal typical specimens. They may be due to algal or fungoid perforations, and the species is therefore recorded with some reservation.

203. **Lagena reniformis,** Sidebottom. (Plate 41. figs. 30–34.)

Lagena reniformis, Sidebottom, 1912, etc., LSP. 1913, p. 204, pl. xviii. fig. 15.

2 *Stations.*

Two specimens, one of which we figure from Stn. 4 and another from Stn. 17, are, we think, attributable to Sidebottom's species, although broader in proportion to their depth than his figures. The species is probably subject to very great variation—indeed, Sidebottom refers to this in his description. We figure, for purposes of comparison, a few specimens from Noss Head, Moray Firth ('Goldseeker,' Haul 138, 70 metres), where the species occurs in some profusion, and is extremely variable in the breadth of the shell as compared with the depth.

204. **Lagena fimbriata,** Brady.

Lagena fimbriata, Brady, 1879, etc., RRC. 1881, p. 61.
" " Brady, 1884, FC. p. 486, pl. lx. figs. 26–28.

6 *Stations.*

A few individuals only, and not very strongly marked or characteristic. The majority of them have the basal processes closed, thus coming under Sidebottom's variety *occlusa* (S. 1912, etc. LSP. p. 423, pl. xx. figs. 27, 28).

205. **Lagena cymbula,** Heron-Allen & Earland.

Lagena cymbula, Heron-Allen & Earland, 1913, CI. p. 90, pl. vii. figs. 16–18.
" " Heron-Allen & Earland, 1915, NSH. p. 129, pl. x. figs. 10–12.

1 *Station.*

One typical individual.

Subfamily Nodosarinæ.

Nodosaria, Lamarck.

206. **Nodosaria rotundata** (Reuss).

Glandulina rotundata, Reuss, 1849–50, FOT. p. 366, pl. xlvi. (i.) fig. 2.
Nodosaria (*G.*) *rotundata,* Brady, 1884, FC. p. 491, pl. lxi. figs. 17–19.

2 *Stations.*

Very rare, but large and typical examples at Stn. 20.

207. **Nodosaria lævigata,** d'Orbigny.

Nodosaria (*G.*) *lævigata,* d'Orbigny, 1826, TMC. p. 252. No. 1, pl. x. figs. 1–3.
" " Brady, 1884, FC. pp. 490, 493, pl. lxi. figs. 17–22, 32.

2 *Stations.*

Very rare, but excellent and typical examples at the two Stns. At Stn. 2, where the specimens are smaller, the aboral extremity varies from blunt to spinous and bi-spinous.

208. Nodosaria calomorpha, Reuss.

Nodosaria calomorpha, Reuss, 1865–6, FABS. p. 129, pl. i. figs. 15–19.
" " Brady, 1884, FC. p. 497, pl. lxi. figs. 23–27.

1 *Station.*

Two quite typical small specimens.

209. Nodosaria pyrula, d'Orbigny.

Nodosaria pyrula, d'Orbigny, 1826, TMC. p. 253. No. 13.
" " Brady, 1884, FC. p. 497, pl. lxii. figs. 10–12.

17 *Stations.*

Widely distributed and abundant at some Stns., the best at Stns. 2, 4, 10, 14, and 18. Typical *N. pyrula* occurs nearly everywhere, but the longer-chambered form with short stolon-tubes [=*N.* (*Dentalina*) *guttifera*, d'Orbigny, 1846, FFV. p. 49, pl. ii. figs. 11–13, *not* 14] is the only representative at Stns. 11 and 17. Both forms occur together at several other Stns.

210. Nodosaria filiformis, d'Orbigny.

Nodosaria filiformis, d'Orbigny, 1826, TMC. p. 253. No. 14.
" " Brady, 1884, FC. p. 500, pl. lxiii. figs. 3–5.

8 *Stations.*

Scantily distributed, often represented only by fragments, the best at Stn. 4. Many of the specimens are distorted, a very common feature in this species.

211. Nodosaria consobrina, d'Orbigny.

Nodosaria (*D.*) *consobrina*, d'Orbigny, 1846, FFV. p. 46, pl. ii. figs. 1–3.
" " Brady, 1884, FC. p. 501, pl. lxii. figs. 23, 24.

3 *Stations.*

Very sparingly represented, good and typical at Stn. 18.

212. Nodosaria communis, d'Orbigny. (Plate 42. figs. 1, 2.)

Nodosaria (*D.*) *communis*, d'Orbigny, 1826, TMC. p. 254. No. 35.
" " Brady, 1884, FC. p. 504, pl. lxii. figs. 19–22.

17 *Stations.*

Generally distributed, but never very common, the specimens usually small, thin-shelled, and weak, but large and fairly typical specimens at Stns. 3 and 20. Two distinct forms occur, sometimes together, but often isolated—the normal round-in-section *N. communis* and a compressed or vaginuline form. The latter often develops in its later chambers into the normal round type. The best examples of the vaginuline type were at Stns. 4, 18, 20, and 21. Monstrous or double or distorted specimens, showing double or distorted primordial chambers, occur at several Stns., notably at Stn. 18, and are referable to both forms. The vaginuline or compressed form is very common in many British dredgings, and entirely supersedes the normal type in some of the North Sea ('Goldseeker') dredgings.

213. **Nodosaria pauperata,** d'Orbigny.

Dentalina pauperata, d'Orbigny, 1846, FFV. p. 46, pl. i. figs. 57, 58.
Nodosaria (*D.*) *pauperata*, Brady, 1884, FC. p. 500 (woodcuts, figs. 14, *a*, *b*, *c*).

1 *Station.*

One large and typical but damaged specimen.

214. **Nodosaria roemeri** (Neugeboren). (Plate 41. fig. 35.) (New to Britain.)

Dentalina roemeri, Neugeboren, 1856, OLS. p. 82, pl. ii. figs. 13–17.
Nodosaria (*D.*) *roemeri*, Brady, 1884, FC. p. 505, pl. lxiii. fig. 1.

3 *Stations.*

Very rare, but the few specimens which occur are large and typical, and much better developed than is usual in the 'Runa' Nodosariæ. Previously recorded with some doubt as British, only by Pearcey from the Faroe Channel (P. 1890, FC. p. 177).

215. **Nodosaria mucronata** (Neugeboren).

Dentalina mucronata, Neugeboren, 1856, OLS. p. 83, pl. iii. figs. 8–11.
Nodosaria (*D.*) *mucronata*, Brady, 1884, FC. p. 506, pl. lxii. figs. 27–31.

1 *Station.*

One rather doubtful specimen only. The species has only been recorded previously as British from South-west Ireland by Wright (W. 1891, SWI. p. 483).

216. **Nodosaria scalaris** (Batsch).

Nautilus (*Orthoceras*) *scalaris*, Batsch, 1791, CS. p. 2, pl. ii. fig. 4.
Nodosaria scalaris, Brady, 1884, FC. p. 510, pl. lxiii. figs. 28–31, pl. lxiv. figs. 16–19.

19 *Stations.*

Almost universally distributed and by far the commonest *Nodosaria* in the dredgings, but not equally abundant at all the Stns. The finest series at Stns. 4, 10, 14, and 18. The typical form of Batsch, with chambers regularly increasing in size and coarsely sulcate, is not particularly abundant, but Stn. 18 yields an exceptionally fine and large example, with no less than seven regularly increasing chambers; other good examples at (*inter alia*) Stn. 14. From this typical form practically every degree of depauperation exists down to almost smooth examples. These latter occur at Stn. 4. The weakly marked variety named by Silvestri *Lagenonodosaria pseudoscalaris* (Atti Pont. Acc. Rom. Nuovo Lincei, Anno lvii. 1904, p. 144, fig. 4), characterized by few and feeble costæ and a more or less distorted shell, occurs nearly everywhere. A variety with practically parallel sides, *i. e.*, showing no increasing diameter in the chambers, occurs at Stns. 4, 14, 20, and 23. Inæquilateral types, in which one side of the shell is developed at the expense of the other, giving an *Amphicoryne* appearance to the test, occur at Stns. 5, 12, and 21. At Stn. 14, a single example of the Batsch type was found, in which the produced neck was exceptionally thick and studded with spines, a form of growth usually found in deeper water. Bicamerate specimens are widely distributed at many Stns., and at Stns. 6, 16, and 19 were the sole representatives of the species. In many instances, these bicamerate individuals were of large proportions, indicating that they were not young shells, but a distinct local variety in which growth was normally arrested at this stage.

217. **Nodosaria scalaris, var. separans,** Brady.

Nodosaria scalaris, var. *separans*, Brady, 1884, FC. p. 511, pl. lxiv. figs. 16–19.
,, ,, ,, Millett, 1898, etc., FM. 1902, p. 520, pl. xi. figs. 11, 12.

2 *Stations.*

No perfect examples were found, but an isolated final chamber at Stn. 4, and at Stn. 20 two final chambers connected, which had evidently been attached to the earlier portion of the shell by a stolon-tube.

218. **Nodosaria proxima,** Silvestri. (New to Britain.)

Nodosaria proxima, O. Silvestri, 1872, NFVI. p. 63, pl. vi. figs. 138–147.
,, ,, Brady, 1884, FC. p. 511, pl. lxiv. fig. 15.
,, ,, Fornasini, 1888, TP. p. 149, pl. iii. figs. 10, 11.

2 *Stations.*

Bilocular Nodosariæ referable to Silvestri's species (inasmuch as the initial chamber is larger than the succeeding one) occur rarely at the two Stns. In dredgings like these, where *N. scalaris* abounds, the question of their separate identity is open to question.

219. **Nodosaria raphanistrum** (Linné).

Nautilus raphanistrum, Linné, 1788, SN. p. 3372. No. 15.
Nodosaria raphanistrum, Jones, Parker, & Brady, 1866, etc., MFC. 1866, p. 50, pl. i. figs. 6–8.

1 *Station.*

Two small specimens, one pyritised, probably derived fossils from Gault or Lias, though their occurrence in Loch Sunart is hard to explain.

220. **Nodosaria obliqua** (Linné).

Nautilus obliquus, Linné, 1767, SN. p. 1163. No. 281; 1788, SN. p. 3372. No. 14.
Nodosaria obliqua, Brady, 1884, FC. p. 513, pl. lxiv. figs. 20–22.

6 *Stations.*

Very rare; the specimens small and weakly sulcate, often distorted, the best at Stn. 20. At Stn. 23 the individual was sulcate on the initial chamber only.

LINGULINA, d'Orbigny.

221. **Lingulina biloculi,** Wright.

Lingulina carinata, var. *biloculi*, Wright, 1910–11, ECM. p. 13, pl. ii. fig. 10.
„ *biloculi*, Heron-Allen & Earland, 1913, CI. p. 94, pl. viii. figs. 5–7.

5 *Stations.*

Frequent and finely developed at Stn. 11, rare at the other Stns. All the protean forms assumed by this species occur in the dredgings.

222. **Lingulina carinata,** d'Orbigny.

Lingulina carinata, d'Orbigny, 1826, TMC. p. 257. No. 1, Modèle No. 26.
„ „ Brady, 1884, FC. p. 517, pl. lxv. figs. 16, 17.

1 *Station.*

One specimen of the same type as that figured in our Clare Island Report (H.-A. & E. 1913, CI. pl. viii. fig. 9) at Stn. 17.

223. **Lingulina carinata,** var. **bicarinata,** Sidebottom. (Plate 42. figs. 3–5.)

Lingulina carinata, var. *bicarinata*, Sidebottom, 1904, etc., RFD. 1907, p. 3, pl. i. fig. 20.
„ „ „ Heron-Allen & Earland, 1913, CI. p. 94, pl. viii. figs. 3, 4.

1 *Station.*

A few specimens at Stn. 4. They differ from our Clare Island specimens, and from the type, by the presence of a strong rib running down the middle of the face of the first chamber. One of the specimens has also three chambers, a fact not previously observed in the variety. It has only been previously recorded by us as British (*ut supra*).

224. **Lingulina carinata,** var. **seminuda,** Hantken. (Plate 42. figs. 6, 7.) (New to Britain.)

Lingulina costata, var. *seminuda*, Hantken, 1875, CSS. p. 41, pl. iv. fig. 8 *a*, *b*.
„ *carinata*, var. *seminuda*, Brady, 1884, FC. p. 518, pl. lxv. figs. 14, 15.

1 *Station.*

At Stn. 4 a few little specimens, which we figure and which we think should be attributed to this form, although, owing to their extreme minuteness and hyaline character, they differ considerably from the large deep-water specimens figured by Brady from the Atlantic. The test is bilocular, the last chamber forming quite three-fourths of the total bulk of the shell, and furnished with a long curving entosolenian tube, which runs diagonally to the lower outer edge of the chamber. The margin of the entire shell is thickened and slightly constricted on its inner edge, so as to form a fine groove running round inside the edge of the shell. These markings we consider homologous with the sulci of the deep-water form.

Frondicularia, Defrance.

225. **Frondicularia spathulata,** Brady.

Frondicularia spathulata, Brady, 1879, etc., RRC. 1879, p. 270, pl. viii. fig. 5.
„ „ Brady, 1884, FC. p. 519, pl. lxv. fig. 18.

1 *Station.*

Several specimens of this little form at Stn. 4. They resemble the individuals figured by us from Clare Island (H.-A. & E. 1913, CI. pl. viii. fig. 12). Such specimens are of fairly frequent occurrence in muddy dredgings round the British coasts, but have only been recorded and figured by us (*loc. cit.*).

226. **Frondicularia tenera** (Bornemann). (Plate 42. figs. 8–10.) (New to Britain.)

Lingulina tenera, Bornemann, 1854, LG. p. 38, pl. iii. fig. 24 *a–c*.
„ „ Tate & Blake, 1876, YL. p. 455, pl. xviii. figs. 15, 15 *a*.
Frondicularia pupa, Terquem & Berthelin, 1875, LME. p. 36, pl. iii. (xiii.) fig. 1 *a–c*.
„ *millettii*, Brady, 1884, FC. p. 524, woodcut fig. 16 *a*, *b*.

1 *Station.*

At Stn. 26 (a tube of material labelled "from various localities round Skye") we have found the specimen which we figure under the above name. As to the origin of the specimen there must be considerable doubt. Bornemann's species in one or other of its innumerable forms is apparently a common and widely-distributed Liassic fossil, but there appears to be no Lias within a great distance of Skye. The specimen, although somewhat infiltrated, cannot be distinctly recognized as fossil—it might be merely a dead recent shell. It consists of a large primordial chamber followed by six chambers, regularly increasing in breadth and but slightly arched, although we think the arching sufficient for its allocation to *Frondicularia* rather than to *Lingulina*. The surface of the shell is concave down the median line, and each edge is furnished with four strong costæ, extending the entire length of the shell. The aperture is broad and slit-like. Brady's recent species *F. millettii*, founded on specimens from coral-sand (Raine Island), appears to differ from *F. tenera* only in the greater number of chambers and the character of the terminal aperture on a produced neck, and the large number of marginal costæ. The range of varieties illustrated by Terquem's *F. pupa* (*ut supra*) more than covers these points. His figure 1 *c* appears closely to resemble both our specimen and Brady's species in all but minor details. As a fossil the form has been recorded under the name of *Lingulina tenera* from the estuarine clay of Limavady Station and from the Lias of N.E. Ireland (W. 1880, NEI. p. 150; and Wright, Irish Liassic Foraminifera, Belfast Nat. Field Club, 1871, App. ii. p. 26).

Marginulina, d'Orbigny.

227. Marginulina glabra, d'Orbigny.

Marginulina glabra, d'Orbigny, 1826, TMC. p. 259. No. 6, Modèle No. 55.
,, ,, Brady, 1884, FC. p. 527, pl. lxv. figs. 5, 6.

2 *Stations.*

Very rare. The specimens are small and weak in character.

228. Marginulina costata (Batsch).

Nautilus (*Orthoceras*) *costatus,* Batsch, 1791, CS. p. 2, pl. i. fig. 1 *a–g.*
Marginulina costata, Brady, 1884, FC. p. 528, pl. lxv. figs. 10–13.

4 *Stations.*

Very rare, but exceptionally large and fine at Stn. 19, and almost equally good at Stn. 14. At Stn. 20 the specimens are small and very complanate and regularly Cristellarian in their initial portion.

Vaginulina, d'Orbigny.

229. Vaginulina legumen (Linné).

Nautilus legumen, Linné, 1788, SN. p. 3373. No. 22.
Vaginulina legumen, Brady, 1884, FC. p. 530, pl. lxvi. figs. 13–15.

6 *Stations.*

Rare, but some extremely fine specimens were found, the best at Stn. 3. At many of the Stns. thin-shelled slender forms, vaginuline in aperture and oval in section, are of frequent occurrence. Their affinities, however, appear to lie with *Nodosaria communis* (q. v.), with which they are linked by many intermediate varieties. We have dealt with them when considering that species.

230. Vaginulina linearis (Montagu).

Nautilus linearis, Montagu, 1803–8, TB. Suppl. p. 87, pl. xxx. fig. 9.
Vaginulina linearis, Brady, 1884, FC. p. 532, pl. lxvii. figs. 10, 12.

1 *Station.*

A single specimen (damaged) from Stn. 11.

Cristellaria, Lamarck.

231. Cristellaria crepidula (Fichtel & Moll).

Nautilus crepidula, Fichtel & Moll, 1798, TM. p. 107, pl. xix. figs. *g–i.*
Cristellaria crepidula, Brady, 1884, FC. p. 542, pl. lxvii. figs. 17, 19, 20, pl. lxviii. figs. 1, 2.

13 *Stations.*

Generally distributed, sometimes fairly frequent. There is, as usual, an immense range of variation in the specimens which have to be referred to this species. At many Stns., notably Stns. 2, 4, and 20, the specimens in their regularity of growth approach *C. cymboides*, d'Orb., and *C. acutauricularis*. At Stns. 3, 12, and 20 large individuals of the compressed type of *C. arcuata*, d'Orb., occur. The majority at all Stns. are megalospheric, but microspheric specimens occur at Stns. 17 and 18. The size of the primordial chamber influences the later growth of the shell in the genus *Cristellaria* perhaps more than in any other.

232. **Cristellaria acutauricularis** (Fichtel & Moll).

Nautilus acutauricularis, Fichtel & Moll, 1798, TM. p. 102, pl. xviii. figs. *g–i*.
Cristellaria acutauricularis, Brady, 1884, FC. p. 543, pl. cxiv. figs. 17 *a, b*.

5 *Stations.*

Occurs at very few Stns. and nowhere typical. All the individuals are of a narrower type, as viewed across the face of the terminal chamber, than in Fichtel & Moll's original plates. They thus approach *C. cymboides*, d'Orbigny. At Stns. 4 and 20 some of the specimens were almost typical *C. cymboides*. This species has only been recorded as a recent British form by us from Clare Island and the North Sea (H.-A. & E. 1913, CI. p. 99, pl. viii. fig. 15), but Wright has recorded it from Post-tertiary deposits in the North of Ireland (W. 1910–11, ECM. p. 15). It has probably been included by many authors under *C. crepidula*, which, as Burrows and Holland have observed (Proc. Geol. Assoc. vol. xv. 1897, p. 40), has been made to include a very wide series of varieties.

233. **Cristellaria convergens**, Bornemann. (Plate 42. figs. 11–14.)

Cristellaria convergens, Bornemann, 1855, FSH. p. 327, pl. xiii. figs. 16, 17.
„ „ Brady, 1884, FC. p. 546, pl. lxix. figs. 6, 7.

2 *Stations.*

At Stn. 4 two minute and thin-walled specimens of a *Cristellaria* were found, which we are inclined to refer to Bornemann's species, and a single one at Stn. 20. Bornemann's figures are in themselves unsatisfactory, fig. 16 representing a rotulate form with no visible septation; whereas fig. 17 represents a form evidently allied to *C. gibba* and having marked septal lines. His fig. 18 (on same plate), *C. elliptica*, illustrates a form linking figs. 16 and 17, and *C. elliptica* is properly regarded as a synonym of *C. convergens*.

The two 'Runa' specimens represent the two types figured by Bornemann in his figs. 16 and 17, but, as might be expected in such shallow water, the specimens are small and the shell-texture thin and extremely hyaline, so that the septation is distinct in both individuals.

C. convergens is normally a deep-water type. Brady's records range between 16 and 2750 fms., the majority being in the neighbourhood of the 2000-fm. line. As a recent British species it has only been recorded by Pearcey from the Firth of Forth (Trans. Nat. Hist. Soc. Glasgow, NS. vol. v. 1900–1, p. 242).

234. **Cristellaria gibba,** d'Orbigny.

Cristellaria gibba, d'Orbigny, 1839, FC. p. 40, pl. vii. figs. 20, 21.
" " Brady, 1884, FC. p. 546, pl. lxix. figs. 8, 9.

7 *Stations.*

A few specimens, all small and somewhat starved except at Stn. 23, where a fair-sized typical individual was found.

235. **Cristellaria rotulata** (Lamarck).

Lenticulites rotulata, Lamarck, 1804, AM. vol. v. p. 188. No. 3; vol. viii. (1806) pl. lxii. fig. 11.
Cristellaria rotulata, Brady, 1884, FC. p. 547, pl. lxix. fig. 13 *a*, *b*.

19 *Stations.*

Generally distributed and often frequent, but all the specimens are small except at Stns. 2, 10, 20, and 23.

236. **Cristellaria cultrata** (Montfort).

Robulus cultratus, Montfort, 1808–10, CS. vol. i. p. 214, 54e genre.
Cristellaria cultrata, Brady, 1884, FC. p. 550, pl. lxx. figs. 4–8.

7 *Stations.*

Sparingly distributed and never very frequent, excepting at Stns. 2 and 20. At these Stns. well-grown individuals occur, but the marginal carina is everywhere very narrow.

237. **Cristellaria variabilis,** Reuss.

Cristellaria variabilis, Reuss, 1849-50, FOT. p. 369, pl. xlvi. (i.) figs. 15, 16.
" " Brady, 1884, FC. p. 541, pl. lxviii. figs. 11–16.

1 *Station.*

One small, but typical, specimen.

Subfamily Polymorphininæ.

Polymorphina, d'Orbigny.

238. **Polymorphina amygdaloides** (Reuss). (New to Britain.)

Globulina amygdaloides, Reuss, 1851, FSUB. p. 82, pl. vi. fig. 47.
Polymorphina amygdaloides, Reuss, 1855, TNMD. p. 250, pl. viii. fig. 84.
" " Brady, 1884, FC. p. 560, pl. lxxi. fig. 13.

1 *Station.*

One specimen resembling Reuss's earlier (1851) figure, which is less compressed than his later (1855) figure. The question of the advisability of separating this form from *P. lactea* is very doubtful. It has probably been often recorded under that name.

239. **Polymorphina lactea** (Walker & Jacob).

Serpula lactea, Walker & Jacob, 1798, AEM. p. 634, pl. xiv. fig. 4.
Polymorphina lactea, Brady, 1884, FC. p. 559, pl. lxxx. typical, fig. 11; var. fig. 14.

19 *Stations*.

Widely distributed, sometimes common, but the specimens as a whole run small, the only Stns. where a good series showing all stages of growth occurs being Stns. 7 and 22. No fistulose specimens.

240. **Polymorphina oblonga** (Williamson), H.-A. & E.

Polymorphina lactea, var. *oblonga*, Williamson, 1858, RFGB. p. 71, pl. vi. fig. 149.
„ *oblonga*, Heron-Allen & Earland, 1913, CI. p. 100, pl. viii. fig. 17.

7 *Stations*.

Very rare and, except at Stn. 3, nearly always very small. Many of the specimens have an entosolenian tube, which we take to be a sign of depauperation.

241. **Polymorphina concava** (Williamson), H.-A. & E.

Polymorphina lactea, var. *concava*, Williamson, 1858, RFGB. p. 72, pl. vi. figs. 151, 152.
„ *concava*, Heron-Allen & Earland, 1908, etc., SB. 1909, p. 431, pl. xvii. fig. 6.

2 *Stations*.

Very rare. A few good specimens at each Stn., all detached.

242. **Polymorphina sororia**, Reuss.

Polymorphina (*Guttulina*) *sororia*, Reuss, 1863, FCA. p. 151, pl. ii. figs. 25–29.
„ *sororia* Brady, 1884, FC. p. 562, pl. lxxi. figs. 15, 16.

16 *Stations*.

Widely distributed, but never very abundant. Taking *P. sororia* as the type of the pyriform Polymorphinæ, Reuss's species should properly be confined to the compressed forms, and d'Orbigny's earlier species, *P. gutta* (d'O. 1826, TMC. p. 267. No. 28, pl. xii. figs. 5, 6, Modèle No. 30) and *P.* (*Pyrulina*) *acuminata* (d'O. 1840, CBP. p. 43, pl. iv. figs. 18, 19) being used for the round and aborally pointed varieties respectively. The differences are, in our opinion, too trivial for consideration, and the compressed type being by far the most abundant we prefer to separate all such forms under Reuss's name *P. sororia*.

Typical *P. sororia* occurs practically at every Stn. Round (=*P. gutta*) forms at Stns. 2, 4, 12, 18, and 20, the best at Stn. 20. Pointed (=*P. acuminata*) forms are rarer, occurring only at Stns. 4, 13, and 21, the best at Stn. 21.

243. **Polymorphina rotundata** (Bornemann).

Guttulina rotundata, Bornemann, 1855, FSH. p. 346, pl. xviii. fig. 3.
Polymorphina rotundata, Brady, 1884, FC. p. 570, pl. lxxiii. figs. 5–8.

13 *Stations*.

Generally distributed and fairly common at some Stns. The short cylindrical form, the true *P. rotundata*, is the most widely distributed; the long form [=*P.* (*Guttulina*) *cylindrica*, Bornemann, 1855, FSH. p. 347, pl. xviii. figs. 4–6] occurs in company with it at several Stns. and by itself at Stn. 11. Both forms occur in the fistulose condition, but this is only recorded at four Stns.

244. **Polymorphina gibba,** d'Orbigny.

Polymorphina (*Globulina*) *gibba*, d'Orbigny, 1826, TMC. p. 266. No. 20, Modèle No. 63.
Polymorphina gibba, Brady, 1884, FC. p. 561, pl. lxxi. fig. 12 *a, b* ; fistulose, pl. lxxiii. fig. 16.

14 *Stations.*

Generally distributed, often common and attaining very large size. This species exhibits the fistulose habit at the majority of the Stns. at which it occurs, both globular and compressed forms occurring in this condition.

245. **Polymorphina communis,** d'Orbigny.

Polymorphina (*Guttulina*) *communis* and *problema,* d'Orbigny, 1826, TMC. p. 266. Nos. 14, 15, pl. xii. figs. 1–4, Modèles Nos. 61, 62.
„ *communis,* Brady, 1884, FC. p. 568, pl. lxxii. fig. 19.

3 *Stations.*

A few specimens only, all closely resembling d'Orbigny's Modèle No. 62.

246. **Polymorphina compressa,** d'Orbigny.

Polymorphina compressa, d'Orbigny, 1846, FFV. p. 233, pl. xii. figs. 32–34.
„ „ Brady, 1884, FC. p. 565, pl. lxxii. figs. 9–11; fistulose, pl. lxxiii. fig. 17.

16 *Stations.*

Generally distributed and abundant at the Stns., notably at Stns. 3, 8, 10, and 20. At the two latter Stns. excellent series of all stages and sizes, and including fistulose individuals.

247. **Polymorphina cylindroides,** Roemer. (Plate 42. figs. 15, 16.)

Polymorphina cylindroides, Roemer, 1838, NTM. p. 385, pl. iii. fig. 26.
„ *lactea,* var. *acuminata,* Williamson, 1858, RFGB. p. 71, pl. vi. fig. 148.
„ *cylindroides,* Brady, Parker, & Jones, 1870, GP. p. 221, pl. xxxix. fig. 6 *a–c.*

2 *Stations.*

Very rare. A good many specimens at Stn. 22 and a single one at Stn. 23. The only previous British record is from Mr. Barlee's material from Skye, recorded by Williamson (*ut supra*).

248. **Polymorphina myristiformis,** Williamson.

Polymorphina myristiformis, Williamson, 1858, RFGB. p. 73, pl. vi. figs. 156, 157.
„ „ Brady, 1884, FC. p. 571, pl. lxxiii. figs. 9, 10.

4 *Stations.*

Remarkably rare, the only Stn. where more than a single specimen occurs being Stn. 20, where they attained their best development.

UVIGERINA, d'Orbigny.

249. **Uvigerina pygmæa,** d'Orbigny.

Uvigerina pygmæa, d'Orbigny, 1826, TMC. p. 269, pl. xii. figs. 8, 9, Modèle No. 67.
„ „ Brady, 1884, FC. p. 575, pl. lxxiv. figs. 11–14.

8 *Stations.*

Rare, but widely distributed. Not many specimens at any Stn. except Stns. 18, 19, and 21, where several large and typical specimens occurred.

250. **Uvigerina angulosa,** Williamson.

Uvigerina angulosa, Williamson, 1858, RFGB. p. 67, pl. v. fig. 140.
„ „ Brady, 1884, FC. p. 576, pl. lxxiv. figs. 15–18.

21 *Stations.*

Almost universally distributed and often common, but very variable as regards the proportionate length and breadth of the shell. Very long and narrow forms at some Stns., but the general average gives rather a short stout type. At Stn. 2 the specimens were small, but very regular and delicately striate.

SAGRINA, Parker & Jones.

251. **Sagrina dimorpha** (Parker & Jones). (Plate 42. figs. 17, 18.)

Uvigerina (*Sagrina*) *dimorpha*, Parker & Jones, 1865, NAAF. p. 364, pl. xviii. fig. 18.
Sagrina dimorpha, Brady, 1884, FC. p. 582, pl. lxxvi. figs. 1–3.

3 *Stations.*

Very rare, but many excellent specimens at Stn. 2. We take this opportunity of figuring this species, of which the British records are confined to Brady's 'Synopsis' (B. 1887, SBRF. p. 915) and our Selsey Bill record (H.-A. & E. 1908, etc., SB. 1911, p. 326). It also occurs in several 'Goldseeker' dredgings in the North Sea. This species was by an oversight recorded in the preliminary list (Rep. Marine Biol. Stn. Port Erin, 1913, p. 31) as *Sagrina nodosa*, P. & J.

Family GLOBIGERINIDÆ.

GLOBIGERINA, d'Orbigny.

252. **Globigerina bulloides,** d'Orbigny.

Globigerina bulloides, d'Orbigny, 1826, TMC. p. 277. No. 1; Modèles Nos. 17 & 76.
„ „ Brady, 1884, FC. p. 593, pl. lxxvii., pl. lxxix. figs. 3–7.

21 *Stations.*

Almost universally distributed, but in very variable frequencies. The best and largest at Stns. 7 and 18. At many Stns. only minute and starved individuals occur, notably at Stn. 4. At this Stn. a specimen infiltrated with glauconite occurred.

253. **Globigerina dubia,** Egger. (New to Britain.)

Globigerina dubia, Egger, 1857, MSO. p. 281, pl. ix. (v.) figs. 7–9.
„ „ Brady, 1884, FC. p. 595, pl. lxxix. fig. 17 *a, b, c*.

1 *Station.*

One specimen at Stn. 18.

254. **Globigerina pachyderma** (Ehrenberg).

Aristerospira pachyderma, Ehrenberg, 1861, DSI. p. 303.
Globigerina pachyderma, Brady, 1884, FC. p. 600, pl. cxiv. figs. 19, 20.

1 *Station.*

The specimens are doubtless derived from northerly drift.

255. **Globigerina inflata,** d'Orbigny.

Globigerina inflata, d'Orbigny, 1839, FIC. p. 134, pl. ii. figs. 7–9.
„ „ Brady, 1884, FC. p. 601, pl. lxxix. figs. 8–10.

3 *Stations.*

A single specimen at each Stn.

256. **Globigerina rubra,** d'Orbigny.

Globigerina rubra, d'Orbigny, 1839, FC. p. 82, pl. iv. figs. 12–14.
„ „ Brady, 1884, FC. p. 602, pl. lxxix. figs. 11–16.
„ „ Heron-Allen & Earland, 1913, NSH. p. 131, pl. x. figs. 13–15.

12 *Stations.*

Widely distributed, but common only at Stn. 17. Good specimens also at Stns. 15 and 16. All the individuals belong to the minute type common in muddy dredgings in Northern seas, as figured by us (*ut supra*).

257. **Globigerina linnæana** (d'Orbigny).

Rosalina linneiana, d'Orbigny, 1839, FC. p. 101, pl. v. figs. 10–12.
Globigerina linnæana, Brady, 1884, FC. p. 598, pl. cxiv. fig. 21 *a–c*; Cretaceous, pl. lxxxii. figs. 12 *a–b*.

1 *Station.*

One perfectly preserved chalk-fossil. The source of origin of this specimen is entirely obscure. Unless derived from submarine denudation, it must have drifted from the North of Ireland. See also observations on *Frondicularia tenera* (No. 226).

ORBULINA, d'Orbigny.

258. **Orbulina universa,** d'Orbigny.

Orbulina universa, d'Orbigny, 1839, FC. p. 3, pl. i. fig. 1.
„ „ Brady, 1884, FC. p. 608, pl. lxxviii., pl. lxxxi. figs. 8–26, *et seq.*

2 *Stations.*

Two specimens only, one at each Stn., small and thick-shelled. The rarity of this species in the gathering is remarkable considering its abundance in the Atlantic Ocean to the immediate westward.

SPHÆROIDINA, d'Orbigny.

259. **? Sphæroidina** sp. (Plate 42. figs. 19, 20.)

1 *Station.*

We figure a single specimen from Stn. 14 of an organism which from the character of its aperture seems to present some affinity to *Sphæroidina.*

It consists of two chambers only, opposed to each other, in the manner of *Biloculina bulloides,* with a little arched aperture on either face at the line of junction. The shell in the neighbourhood of the two apertures is smooth and hyaline, but the rest of the shell, which forms a slightly compressed sphere, is coarsely aculeate. It may be an abnormal individual of *S. bulloides,* in which the early chambers have been absorbed and the outer surface is decorated with blunt spines.

We record and figure this single specimen for purposes of future reference, without naming it.

Family ROTALIIDÆ.

Subfamily SPIRILLININÆ.

SPIRILLINA, Ehrenberg.

260. **Spirillina vivipara,** Ehrenberg. (Plate 42. figs. 21–25.)

Spirillina vivipara, Ehrenberg, 1841, SNA. p. 442, pl. iii. fig. 41.
„ „ Brady, 1884, FC. p. 630, pl. lxxxv. figs. 1–5.

13 *Stations.*

Widely distributed and extremely variable. Attached specimens occur at Stns. 15, 19, and 20. At Stn. 3 the tests were all of a peculiar sub-chitinous character, very thin, and brownish in colour, and many had evidently been attached, being irregular in form. At this Stn. and in this condition associated pairs were found. Specimens exhibiting a transition-form between *S. vivipara* and *S. margaritifera*, which we figure, occur at several Stns. They agree with the Type *S. vivipara* in the section of the tube and general aspect of the shell; but the underside of the shell is distinctive, the shell-substance being deposited in thick layers on the outer edges of the convolution and coming down into cusps between the lines of perforations, thus giving a pseudo-beaded (or margaritiferous) appearance to the inferior surface. In some cases this is accompanied by a radial constriction of the upper surface of the tube corresponding to the thickening of the under surface, giving a superficial aspect similar to Sidebottom's species *S. vivipara*, var. (S. 1904, etc., RFD. 1908, pl. i. fig. 14), though in his figure this constriction marks the underside of the shell.

261. **Spirillina obconica,** var. **carinata,** Halkyard.

Spirillina vivipara, var. *carinata*, Halkyard, 1889, RFJ. p. 69, pl. ii. fig. 6.
,, *obconica*, var. *carinata*, Heron-Allen & Earland, 1913, CI. p. 108, pl. ix. figs. 6, 7.

2 *Stations.*

Two good specimens at Stn. 3, and also at Stn. 12.

Subfamily Rotaliinæ.

Patellina, Williamson.

262. **Patellina corrugata,** Williamson.

Patellina corrugata, Williamson, 1858, RFGB. p. 46, pl. iii. figs. 86–89.
,, ,, Brady, 1884, FC. p. 634, pl. lxxxvi. figs. 1–7.

21 *Stations.*

Almost universally distributed, often very abundant. There is remarkably little variation, nearly all the specimens being of the circular type. The oval form figured by us from Clare Island (H.-A. & E. 1913, CI. p. 109, pl. ix. fig. 11) occurs at several Stns. There is also a tendency to excessive carination in a few instances.

Discorbina, Parker & Jones.

263. **Discorbina nitida** (Williamson). (Plate 42. figs. 26–30.)

Rotalina nitida, Williamson, 1858, RFGB. p. 54, pl. iv. figs. 106–108.
Discorbina nitida, Sidebottom, 1904, etc., RFD. 1908, p. 13, pl. iv. fig. 6.

19 *Stations.*

Almost universally distributed and often very common. This is one of the commonest Discorbinæ of the 'Runa' gatherings, and, as such, presents endless variations. Exceptionally large individuals at Stns. 3 and 10. Specimens running into *D. praegeri* owing to the presence of a central umbilical stud, and into *D. rosacea* through the presence of small asterigine chamberlets, occur at many Stns. At Stns. 10 and 20 a few individuals of a type with somewhat inflated and enclosing chambers, which we figure (figs. 29, 30): this variety is characterized by a lobulate periphery instead of the sharp peripheral keel typical of the species. At Stn. 20 a few individuals were observed of a very curious type, which we also figure (figs. 26–28), having a comparatively high dome with a prominent megalospheric primordial chamber and a broad carinate periphery.

264. **Discorbina millettii,** Wright.

Discorbina millettii, Wright, 1910–11, ECM. p. 13, pl. ii. figs. 14–17.
" " Heron-Allen & Earland, 1913, CI. p. 121, pl. x. figs. 5–7.

4 *Stations.*

Extremely rare, the best individuals occurring at Stn. 3. The species has only been recorded by us *ut supra*, and by Wright from post-Tertiary deposits. It has probably been included in some of the British records of *D. nitida*, the characteristic beading of the under surface requiring careful diagnosis to separate it from that form.

265. **Discorbina praegeri,** Heron-Allen & Earland.

Discorbina praegeri, Heron-Allen & Earland, 1913, CI. p. 122, pl. x. figs. 8–10.
" " Heron-Allen & Earland, 1914, etc., FKA. 1915, p. 692.

19 *Stations.*

Almost universally distributed. The usual variations occur, connecting the species on the one side with *D. rosacea* and on the other with *D. nitida.*

266. **Discorbina peruviana** (d'Orbigny).

Rosalina peruviana, d'Orbigny, 1839, FAM. p. 41, pl. i. figs. 12–14.
Discorbina peruviana, Heron-Allen & Earland, 1913, CI. p. 122, pl. xi. figs. 1–3.

3 *Stations.*

Very sparingly distributed compared with *D. rosacea,* but often running into that form. This is one of the d'Orbignyan species revived by us for taxonomic purposes, having probably been frequently included under *D. rosacea.*

267. **Discorbina rosacea** (d'Orbigny).

Rotalia rosacea, d'Orbigny, 1826, TMC. p. 273. No. 15, Modèle No. 39.
Discorbina rosacea, Brady, 1884, FC. p. 644, pl. lxxxvii. figs. 1, 4.
" " Heron-Allen & Earland, 1913, CI. p. 124, pl. xi. figs. 7–9.

21 *Stations.*

Almost universally distributed and generally extremely common. The best individuals at Stns. 10, 18, and 20. There is an immense range of variation, specimens linking the type with *D. praegeri, D. peruviana,* and *D. turbo* occurring at many Stns.

268. **Discorbina planorbis** (d'Orbigny).

Asterigerina planorbis, d'Orbigny, 1846, FFV. p. 205, pl. xi. figs. 1–3.
Discorbina planorbis, Heron-Allen & Earland, 1913, CI. p. 124, pl. xi. figs. 10–12.

8 *Stations.*

Very unevenly distributed. Very common at some of the Stns. at which it occurs. Intermediate forms linking the species with *D. mamilla* are abundant. This species, revived by us *ut supra,* has probably been recorded by British authors under *D. turbo.*

269. **Discorbina baccata,** Heron-Allen & Earland.

Discorbina baccata, Heron-Allen & Earland, 1913, CI. p. 124, pl. xii. figs. 1–3.

4 *Stations.*

Very rare. An occasional specimen only, the most typical being at Stn. 7. Since the description of our species was published, we have come across a figure of Terquem (T. 1875, etc., APD. 1881, p. 125, pl. xvi. fig. 1 *a–c*) of *Rotalina tuberculata* which suggests our species, but both figure and description differ in essential points from our type. Terquem describes his form as smooth, and the figures show no markings except a rosette of beads at the umbilicus and lines radiating from them. *D. baccata*, on the other hand, has, in perfect specimens, a characteristic rough or "shagreened" (or beaded) surface all over. Of course, Terquem's figure and description may have been based on dead and water-worn shells, and, as his specific name has been appropriated and used for thirty years for a very distinctive type of Balkwill and Wright (B. & W. 1885, DIS. p. 350, pl. xiii. figs. 28–30), it would seem very inadvisable to disturb the nomenclature of the species at this date. Terquem's name (if, indeed, it refers to the same form as our *D. baccata*) should lapse because of incorrect and insufficient diagnosis.

270. **Discorbina turbo** (d'Orbigny).

Rotalia (*Trochulina*) *turbo*, d'Orbigny, 1826, TMC. p. 274. No. 39, Modèle No. 73.
Discorbina turbo, Brady, 1884, FC. p. 642, pl. lxxxvii. fig. 8 *a, b, c*.

14 *Stations.*

Generally distributed, but never very abundant.

271. **Discorbina orbicularis** (Terquem).

Rosalina orbicularis, Terquem, 1875, etc., APD. 1876, p. 75, pl. ix. fig. 4.
Discorbina orbicularis, Brady, 1884, FC. p. 647, pl. lxxxviii. figs. 4–8.

1 *Station.*

Confined to Stn. 15, where it occurred in the free and sessile conditions.

272. **Discorbina mamilla** (Williamson).

Rotalina mamilla, Williamson, 1858, RFGB. p. 54, pl. iv. figs. 109–111.
Discorbina mamilla, Heron-Allen & Earland, 1913, CI. p. 123, pl. xi. figs. 4–6.

20 *Stations.*

Almost universally distributed, often very abundant, the best at Stns. 11 and 17. There is hardly any variation in this well-marked form, except in the height of the spire. This is one of the species revived by us for taxonomical purposes (*ut supra*); it has, no doubt, been included by other authors since Williamson's time under the heading of *D. rosacea*, as it is of frequent occurrence all round the coasts of Britain.

273. **Discorbina mediterranensis** (d'Orbigny).

Rosalina mediterranensis, d'Orbigny, 1826, TMC. p. 271. No. 2.
Discorbina mediterranensis, Fornasini, 1898, RFI. p. 264 (fig.).
" " Heron-Allen & Earland, 1913, CI. p. 118, pl. ix. figs. 12–14, and pl. x. fig. 1.

6 *Stations*.

Very sparingly distributed, but good and typical specimens at Stns. 6 and 15. This species is also one of those revived for taxonomical purposes (*ut supra*). It has probably been included by other authors under *D. globularis* and *D. rosacea.*

274. **Discorbina globularis** (d'Orbigny).

Rosalina globularis, d'Orbigny, 1826, TMC. p. 271. No. 1, pl. xiii. figs. 1–4, Modèle No. 69.
Discorbina globularis, Brady, 1884, FC. p. 643, pl. lxxxvi. figs. 8, 13.

25 *Stations*.

Universally distributed, often very abundant. There is, as usual, a great variation in the height of the shell and the character of the inferior surface. Free-growing specimens are, as a rule, smaller and more inflated than those of sessile origin, many of which are very flat and regular, and have the base almost plane. The sessile specimens are also, as a rule, more coarsely perforate than the small free type.

275. **Discorbina obtusa** (d'Orbigny).

Rosalina obtusa, d'Orbigny, 1846, FFV. p. 179, pl. xi. figs. 4–6.
Discorbina obtusa, Brady, 1884, FC. p. 644, pl. xci. fig. 9 *a, b, c* (?).

10 *Stations*.

Fairly widely distributed and moderately frequent. The specimens are usually very small, but large and typical examples occurred at Stns. 7, 22, and 23.

276. **Discorbina polyrraphes** (Reuss).

Rotalina polyrraphes, Reuss, 1845–6, VBK. pt. i. p. 35, pl. xii. fig. 18.
Discorbina polyrraphes, Heron-Allen & Earland, 1913, CI. p. 128, pl. xii. figs. 10–13 (not 14).

5 *Stations*.

Occasional specimens at a few Stns. only. The best at Stns. 4 and 18. Its minute size has probably caused it to be overlooked in many British gatherings.

277. **Discorbina chasteri,** Heron-Allen & Earland.

Discorbina minutissima, Chaster, 1892, FS. p. 65, pl. i. fig. 15.
" *chasteri*, Heron-Allen & Earland, 1913, CI. p. 128, pl. xiii. figs. 1–3.

11 *Stations*

Widely distributed, but never more than an occasional specimen, except at Stns. 4 and 13, where it was fairly frequent. All the specimens are of the original circular type. Prior to our records from Clare Island (*ut supra*) and from the North Sea (H.-A. & E. 1913, NSH. p. 136) this species had only been recorded by Gough from

Larne Lough [Fisheries, Ireland, Sci. Invest. 1905, iii. (1906) p. 7] since it was originally recorded from Southport.

278. **Discorbina chasteri, var. bispinosa,** Heron-Allen & Earland.

Discorbina chasteri, var. *bispinosa*, Heron-Allen & Earland, 1913, CI. p. 129, pl. xiii. fig. 4.

1 *Station.*

A single well-marked individual at Stn. 13.

279. **Discorbina bertheloti** (d'Orbigny).

Rosalina bertheloti, d'Orbigny, 1839, FIC. p. 135, pl. i. figs. 28–30.
Discorbina bertheloti, Brady, 1884, FC. p. 650, pl. lxxxix. figs. 10–12.

2 *Stations.*

A few good specimens at Stns. 6 and 16.

280. **Discorbina pustulata,** Heron-Allen & Earland.

Discorbina pustulata, Heron-Allen & Earland, 1913, CI. p. 129, pl. xii. figs. 5–7; 1914, etc., FKA. 1915, p. 701, pl. lii. figs. 24–26.

1 *Station.*

A single typical example at Stn. 16.

281. **Discorbina parisiensis** (d'Orbigny).

Rosalina parisiensis, d'Orbigny, 1826, TMC. p. 271. No. 1, Modèle No. 38.
Discorbina parisiensis, Brady, 1884, FC. p. 648, pl. xc. figs. 5, 6, 9–12.

1 *Station.*

Two good and typical examples.

282. **Discorbina vesicularis** (Lamarck).

Discorbites vesicularis, Lamarck, 1804, AM. vol. v. p. 183; vol. viii. (1806) pl. lxii. fig. 7.
Discorbina vesicularis, Brady, 1884, FC. p. 651, pl. lxxxvii. fig. 2 *a*, *b*, *c*.
„ „ Earland, 1905, FBS. p. 224, pl. xii. figs. 9, 10, pl. xiv. fig. 6.

3 *Stations.*

Extremely rare. The specimens are all of the thin-walled type such as are usually found in British shore-gatherings.

Planorbulina, d'Orbigny.

283. **Planorbulina mediterranensis,** d'Orbigny.

Planorbulina mediterranensis, d'Orbigny, 1826, TMC. p. 280, No. 2. pl. xiv. figs. 4–6, Modèle No. 79.
„ „ Brady, 1884, FC. p. 656, pl. xcii. figs. 1–3.

22 *Stations.*

Almost universally distributed in all stages of growth, and often attaining a very large size.

TRUNCATULINA, d'Orbigny.

284. **Truncatulina refulgens** (Montfort).

Cibicides refulgens, Montfort, 1808–10, CS. vol. i. p. 122, 31me genre.
Truncatulina refulgens, Brady, 1884, FC. p. 659, pl. xcii. figs. 7–9.

20 *Stations.*

Widely distributed, often common and of immense size, especially at Stns. 10 and 12.

285. **Truncatulina lobatula** (Walker & Jacob).

Nautilus lobatulus, Walker & Jacob, 1798, AEM. p. 642, pl. xiv. fig. 36.
Truncatulina lobatula, Brady, 1884, FC. p. 660, pl. xcii. fig. 10, pl. xciii. figs. 1, 4, 5, pl. cxv. figs. 4, 5.

25 *Stations.*

Universally distributed, and exhibiting every diversity of form.

286. **Truncatulina tenuimargo,** Brady.

Truncatulina tenuimargo, Brady, 1884, FC. p. 662, pl. xciii. figs. 2, 3.
,, ,, Heron-Allen & Earland, 1908, etc., SB. 1909, p. 680, pl. xx. fig. 2.

1 *Station.*

Many specimens of *T. lobatula* showed a marked tendency to the carinate edge which characterizes this species. The nearest approach to the type (which we regard as having no zoological importance) was found at Stn. 8. It has been recorded by us from Selsey Bill (*ut supra*) and from Clare Island (H.-A. & E. 1913, CI. p. 133).

287. **Truncatulina variabilis,** d'Orbigny.

Truncatulina variabilis, d'Orbigny, 1826, TMC. p. 279. No. 8.
,, ,, Brady, 1884, FC. p. 661, pl. xciii. figs. 6, 7.

9 *Stations.*

Very generally occurring in company with the type, and exhibiting all the diversities of this protean form. Excellent specimens of the long rectilinear form figured by Brady occur at more than one Stn.

288. **Truncatulina haidingerii** (d'Orbigny).

Rotalina haidingerii, d'Orbigny, 1846, FFV. p. 154, pl. viii. figs. 7–9.
Truncatulina haidingerii, Brady, 1884, FC. p. 663, pl. xcv. fig. 7.

2 *Stations.*

Very rare, but large and excellent specimens occurred at Stn. 13.

289. **Truncatulina ungeriana** (d'Orbigny).

Rotalina ungeriana, d'Orbigny, 1846, FFV. p. 157, pl. viii. figs. 16–18.
Truncatulina ungeriana, Brady, 1884, FC. p. 664, pl. xciv. fig. 9 *a–d*.

4 *Stations.*

Rare, but several good specimens at the Stns.

290. **Truncatulina akneriana** (d'Orbigny). (New to Britain.)

Rotalina akneriana, d'Orbigny, 1846, FFV. p. 156, pl. viii. figs. 13–15.
Truncatulina akneriana, Brady, 1884, FC. p. 663, pl. xciv. fig. 8 *a, b, c.*

1 *Station.*

A single typical specimen at Stn. 16.

291. **Truncatulina tenera,** Brady. (Plate 42. figs. 31–33.) (New to Britain.)

Truncatulina tenera, Brady, 1884, FC. p. 665, pl. xcv. fig. 11 *a–c.*

1 *Station.*

This rather noteworthy addition to the British Fauna is represented by one well-developed example from Stn. 20. It is quite characteristic, but slightly more compressed than Brady's figure. It is apparently a rather deep-water species, the few records lying between 166 and 1375 fms.

PULVINULINA, Parker & Jones.

292. **Pulvinulina repanda** (Fichtel & Moll).

Nautilus repandus, Fichtel & Moll, 1798, TM. p. 35, pl. iii. figs. *a–d.*
Pulvinulina repanda, Brady, 1884, FC. p. 684, pl. civ. fig. 18 *a, b, c.*

8 *Stations.*

Rare, never attaining such large dimensions as its variety *concamerata.*

293. **Pulvinulina repanda,** var. **concamerata** (Montagu).

Serpula concamerata, Montagu, 1803–8, TB. Suppl. p. 160 (*fide* Williamson).
Pulvinulina repanda, var. *concamerata*, Brady, 1884, FC. p. 685, pl. civ. fig. 19 *a, b, c.*

10 *Stations.*

This variety of *P. repanda*, characterized by a less convex (to flat or even concave) inferior side, is more widely distributed than the type, and often attains very fine proportions. The finest and most numerous specimens were at Stn. 3.

294. **Pulvinulina punctulata** (d'Orbigny).

Rotalia punctulata, d'Orbigny, 1826, TMC. p. 273. No. 25, Modèle No. 12.
Pulvinulina punctulata, Brady, 1884, FC. p. 685, pl. civ. fig. 17 *a, b, c.*

4 *Stations.*

Very rare, and only a few specimens at the Stns.—very small, but quite typical. It is a widely distributed form, but appears to have been recorded only by us as a recent British form from Clare Island (H.-A. & E. 1913, CI. p. 136, pl. xii. figs. 8, 9).

295. **Pulvinulina auricula** (Fichtel & Moll).

Nautilus auricula, var. α, Fichtel & Moll, 1798, TM. p. 108, pl. xx. figs. *a*, *b*, *c*.
Pulvinulina auricula, Brady, 1884, FC. p. 688, pl. cvi. fig. 5 *a*, *b*, *c*.

12 *Stations.*

Fairly widely distributed and sometimes common; the only noticeable feature is the fact that at Stn. 11 all the specimens were extremely small, those at the other Stns. showing normal to large.

296. **Pulvinulina oblonga** (Williamson).

Nautilus auricula, var. β, Fichtel & Moll, 1798, TM. p. 108, pl. xx. figs. *d*, *e*, *f*.
Rotalina oblonga, Williamson, 1858, RFGB. p. 51, pl. iv. figs. 98–100.
Pulvinulina oblonga, Brady, 1884, FC. p. 688, pl. cvi. fig. 4 *a*, *b*, *c*.

10 *Stations.*

The distribution is practically the same as that of its close ally *P. auricula*, from which, in our opinion, it ought not to be separated. The same curious feature occurs in this species at Stn. 11 as in the case of *P. auricula*, all the specimens being exceedingly minute.

297. **Pulvinulina brongniartii** (d'Orbigny).

Rotalia brongniartii, d'Orbigny, 1826, TMC. p. 273. No. 27.
Pulvinulina brongniartii, Heron-Allen & Earland, 1913, CI. p. 136, pl. xii. figs. 8, 9.

1 *Station.*

A few very compressed and rather doubtful specimens. First recorded as British by us from Clare Island, *ut supra*.

298. **Pulvinulina haliotidea,** Heron-Allen & Earland.

Pulvinulina haliotidea, Heron-Allen & Earland, 1908, etc., SB. 1911, p. 338, pl. xi. figs. 6–11; 1913, CI. p. 136.

14 *Stations.*

Widely distributed and often frequent, but, as a rule, very small, the best at Stns. 3 and 23.

299. **Pulvinulina karsteni** (Reuss). (Plate 42. figs. 34–37.)

Rotalia karsteni, Reuss, 1855, KKM. p. 273, pl. ix. fig. 6.
Pulvinulina karsteni, Brady, 1884, FC. p. 698, pl. cv. figs. 8, 9.

13 *Stations.*

Generally distributed, often abundant. All the individuals are of the small pauperate hyaline type widely distributed in shallow waters round the British coast. We now figure this variety for the first time, for, although there are many British records, no attempt to reproduce this pauperate form has been made.

The earliest British record of the species is in Brady's 'Fauna of the Shetlands'—

"three or four small starved specimens" (B. 1864, RFS. p. 470, pl. xlviii. fig. 15). Instead of figuring these specimens as should have been done, Brady reproduced Reuss's original figure (*ut supra*) from the chalk of Mecklenberg. These fossils are of the robust type, with strong marginal edge and deep sutural lines on the base, such as are commonly found in deep water. Brady's original Shetland specimens appear to have been lost; we cannot find any trace of them at Cambridge, Newcastle, or the British Museum, but there can be little doubt that they were similar to the little form which we figure, and which is quite common in the Shetland area. A slide in the Cambridge collection among the N. Polar 1875 Expedition slides contains small specimens, which, but for the rather strong sutural lines, are identical with the familiar British type.

300. **Pulvinulina elegans** (d'Orbigny).

Rotalia (*Turbinulina*) *elegans*, d'Orbigny, 1826, TMC. p. 276. No. 54.
Pulvinulina elegans, Brady, 1884, FC. p. 699, pl. cv. figs. 4–6.

1 *Station.*

One small and hyaline specimen.

ROTALIA, Lamarck.

301. **Rotalia beccarii** (Linné).

Nautilus beccarii, Linné, 1767, SN. p. 1162. No. 276; 1788, p. 3370. No. 4.
Rotalia beccarii, Brady, 1884, FC. p. 704, pl. cvii. figs. 2, 3.

16 *Stations.*

Almost universally distributed, reaching its maximum in size and numbers at Stn. 1, where it forms 95 per cent. of the coarse siftings. At this Stn. the specimens are very strongly marked with secondary growths.

302. **Rotalia orbicularis** (d'Orbigny).

Gyroidina orbicularis, d'Orbigny, 1826, TMC. p. 278. No. 1, Modèle No. 13.
Rotalia orbicularis, Brady, 1884, FC. p. 706, pl. cvii. fig. 5, pl. cxv. fig. 6

16 *Stations.*

Widely distributed and of the typical neatly rounded form.

303. **Rotalia perlucida,** Heron-Allen & Earland.

Rotalia beccarii (pars), Balkwill & Wright, 1885, DIS. p. 351.
,, *perlucida*, Heron-Allen & Earland, 1913, CI. p. 139, pl. xiii. figs. 7–9; 1914, etc., FKA. 1915, p. 718.

4 *Stations.*

Rare, but excellent and typical specimens at Stns. 4 and 5.

304. **Rotalia schroeteriana,** Parker & Jones. (Plate 43. figs. 1–3.) (New to Britain.)

Faujasina sp., Williamson, 1853, Trans. R. Micr. Soc. (Lond.), ser. 2, vol. i. p. 87, pl. x.
Rotalia schroeteriana, Carpenter, Parker, & Jones, 1862, IF. p. 213, pl. iv. fig. 3, pl. xiii. figs. 7–9.
,, ,, Brady, 1884, FC. p. 707, pl. cxv. fig. 7 *a–c*.

1 *Station.*

A single specimen which we figure from Stn. 6 presents the essential characteristics of this species in its flat superior face, conical inferior face, and strongly limbate sutural lines, but it has only seven chambers in the final whorl, each chamber being considerably longer than is the case in the large tropical specimens on which the species was founded. The occurrence of a specimen in a British gathering is very startling, the records of the species being confined to tropical shallow water, where it attains a very large size. It may, of course, be nothing more than a local "sport" from *R. beccarii*; but, if so, its assimilation of the characteristics of another typical species is equally remarkable.

Parker and Jones's species appears to be merely a compressed and broadened form of the *Gyroidina conoides* of d'Orbigny (d'O. 1826, TMC. p. 278. No. 9), of which we have examined the type-specimens both at Paris and at La Rochelle.

Subfamily TINOPORINÆ.

GYPSINA, Carter.

305. **Gypsina inhærens** (Schultze).

Acervulina inhærens, Schultze, 1854, OP. p. 68, pl. vi. fig. 12.
Gypsina inhærens, Brady, 1884, FC. p. 718, pl. cii. figs. 1–6.

20 *Stations.*

Almost universally distributed and varying greatly in abundance. Commonest at Stns. 8, 12, and 16. At Stns. 17 and 23 a very thin scale-like form, with fine perforations; both free and attached. At Stn. 4 one large double specimen, resulting from the fusion of two individuals at a comparatively advanced stage of growth.

306. **Gypsina vesicularis** (Parker & Jones).

Orbitolina vesicularis, Parker & Jones, 1859, etc., NF. 1860, p. 31. No. 5.
Gypsina vesicularis, Brady, 1884, FC. p. 718, pl. ci. figs. 9–12.

5 *Stations.*

Only an occasional specimen, except at Stn. 3, where many of all sizes were found, including a number of hollow specimens such as we figured from Clare Island (H.-A. & E. 1913, CI. pl. xiii. fig. 11).

307. **Gypsina globulus** (Reuss).

Ceriopora globulus, Reuss, 1847, Haidinger's Naturw. Abh. Wien, vol. ii. p. 33, pl. v. fig. 7.
Gypsina globulus, Brady, 1884, FC. p. 717, pl. ci. fig. 8.

3 *Stations.*

Very rare. The specimens are quite typical, both large and small.

Family NUMMULINIDÆ.

Subfamily Polystomellinæ.

Nonionina, d'Orbigny.

308. **Nonionina depressula** (Walker & Jacob). (Plate 43. figs. 4–7.)

Nautilus depressulus, Walker & Jacob, 1798, AEM. p. 641, pl. xiv. fig. 33.

Nonionina depressula, Brady, 1884, FC. p. 725, pl. cix. figs. 6, 7.

23 *Stations.*

Almost universally distributed, abundant at many Stns., and, as usual, subject to excessive variation, due primarily to the character of the sutural lines, which are sometimes depressed and sometimes limbate. The best examples of typical *N. depressula* occur at Stns. 5 and 22.

Among the most noticeable and constant varieties is one which we figure, and which forms the principal feature of Stn. 17, characterized by deeply excised sutural lines; in some cases the marginal edge is scolloped as a result of this feature. The umbilical portion of the shell is filled in, sometimes a stud of solid shell-matter appearing in the centre. This appears to be the *Nautilus spiralis* of Walker and Boys (W. & B. 1784, TM. p. 19, pl. iii. fig. 68). It occurs in smaller numbers at many other Stns. Another widely distributed variety is characterized by a biconvex hyaline and strongly punctate shell with limbate sutures. This is the form to which we have referred in our Kerimba Mongraph (H.-A. & E. 1914, etc., FKA. 1915, p. 730). Monstrous specimens due to fusion of two and sometimes more individuals occur at Stns. 5 and 17.

309. **Nonionina umbilicatula** (Montagu).

Nautilus umbilicatulus, Montagu, 1803–8, TB. p. 191, Suppl. p. 78, pl. xviii. fig. 1.

Nonionina umbilicatula, Brady, 1884, FC. p. 726, pl. cix. figs. 8, 9.

20 *Stations.*

Almost universally distributed and often very common. There is a certain amount of variation due (i.) to the degree of turgidity in the growth of shell, and (ii.) to the degree of envelopment of the chambers of the final whorl. In young specimens there is no depression at the umbilicus. With increase in size, if the shell continues of the non-turgid type, the whorls are almost entirely embracing, so that the umbilical region remains either almost flush or very slightly depressed. If the chambers are of the turgid type approaching *N. pompilioides* (F. & M.) each successive convolution becomes less enveloping, so that the umbilicus becomes deep; and at some Stns. the successive later whorls are undercut, exhibiting two entire convolutions in the centre of the shell. Distorted specimens occur at Stn. 18.

310. **Nonionina orbicularis**, Brady.

Nonionina orbicularis, Brady, 1881, HNPE. p. 105, pl. ii. fig. 5 *a*, *b*.
„ „ Brady, 1884, FC. p. 727, pl. cix. figs. 20, 21.

1 *Station.*

One specimen, characterized by a deposit of granular shell-matter over the earlier chambers of the last convolution in the neighbourhood of the aperture.

311. **Nonionina asterizans** (Fichtel & Moll).

Nautilus asterizans, Fichtel & Moll, 1798, TM. p. 37, pl. iii. figs. *e–h*.
Nonionina asterizans, Heron-Allen & Earland, 1913, CI. p. 143, pl. xiii. figs. 12, 13.

8 *Stations.*

Scantily distributed, frequent at some Stns., notably at Stn. 4, where the best examples occur. Very little variation except in the depth of the sutural lines.

312. **Nonionina stelligera**, d'Orbigny. (Plate 43. figs. 8–10.)

Nonionina stelligera, d'Orbigny, 1839, FIC. p. 128, pl. iii. figs. 1, 2.
„ „ Brady, 1884, FC. p. 728, pl. cix. figs. 3–5.

3 *Stations.*

Very rare, the best and most typical specimens at Stn. 10.

N. stelligera is a very distinctive form of the *N. depressula* group, characterized by inflated chambers due to the depressed sutural lines. The umbilical portion is clearly marked out by a stellate process radiating down each sutural depression, sometimes almost to the marginal edge. This stellate process is in its highest development almost a secondary series of chambers, due to the partial overlapping of its predecessor by each successive chamber in the convolution. Occasionally this overlapping "star," instead of being a hollow chamberlet, is a solid mass of shell-substance, in which case we get a solid radiating stud or a stellate limbation.

Far commoner than the true *N. stelligera* is a form which closely resembles it in superficial appearance, *i. e.* with swollen chambers and sunken sutural lines, with radiating stellate ornament, but the ornament in this case is merely superficial and masks rudimentary retral processes. We have separated this form under *Polystomella faba* (F. & M.).

313. **Nonionina boueana**, d'Orbigny.

Nonionina boueana, d'Orbigny, 1846, FFV. p. 108, pl. v. figs. 11, 12.
„ „ Brady, 1884, FC. p. 729, pl. cix. figs. 12, 13.

7 *Stations.*

Very rare and far from typical; the only really good examples at Stn. 6.

314. **Nonionina scapha** (Fichtel & Moll).

Nautilus scapha, Fichtel & Moll, 1798, TM. p. 105, pl. xix. figs. *d–f*.
Nonionina scapha, Brady, 1884, FC. p. 730, pl. cix. figs. 14, 15, 16 (?).

6 *Stations.*

Extremely rare, only an occasional small specimen at the Stns. where it occurs—all of them of the compressed elongated type represented by *N. sloanii*, d'Orbigny (d'O. 1839, FC. p. 46, pl. vi. figs. 18 & 18 *bis*).

315. **Nonionina turgida** (Williamson).

Rotalina turgida, Williamson, 1858, RFGB. p. 50, pl. iv. figs. 95–97.
Nonionina turgida, Brady, 1884, FC. p. 731, pl. cix. figs. 17–19.

20 *Stations.*

Almost universally distributed with practically no variation, except in the degree of turgidity of the overlapping chambers.

316. **Nonionina pauperata,** Balkwill & Wright.

Nonionina pauperata, Balkwill & Wright, 1885, DIS. p. 353, pl. xiii. figs. 25, 26.
„ „ Heron-Allen & Earland, 1908, etc., SB. 1911, p. 342, pl. xi. figs. 16, 17.

12 *Stations.*

Widely distributed, but always rare. All the specimens are rather small, the best being found at Stns. 4 and 25.

POLYSTOMELLA, Lamarck.

317. **Polystomella faba** (Fichtel & Moll). (Plate 43. figs. 11–19.) (New to Britain.)

Nautilus faba, Fichtel & Moll, 1798, TM. p. 103, pl. xix. figs. *a–c*.
Polystomella faba, Parker & Jones, 1859, etc., NF. 1860, vol. v. pp. 102, 103, & vol. vi. p. 139.
„ „ Jones, Parker, & Brady, 1866, etc., MFC. p. 349 (woodcut).
„ „ Fornasini, 1899, PFI. p. 647.

9 *Stations.*

Fichtel and Moll's description indicates a pauperate form intermediate between *Nonionina* and *Polystomella*, but referable to the latter genus on account of its retral processes. Their figure, however (of which we possess Moll's original water-colour drawing), gives no indication of the Polystomelline affinities, such as are plainly referred to in their text, and are shown in Parker and Jones's woodcut (*ut supra*), which is reproduced from their previous work (P. & J. 1865, NAAF. p. 402, pl. xiv. fig. 36). Two distinctive types occur in these dredgings, both of which, we think, should be placed under Fichtel and Moll's species, although differing in certain respects. The first or compressed type, which is nearest to *P. faba*, has somewhat inflated chambers of an involute type, six or seven visible in the final convolutions; sutural lines curving and strongly depressed, filled with fine granular matter radiating from the umbilicus down the sutures, and giving a stellate appearance to the test, owing to the whitish granulations contrasting strongly with the hyaline surface of the chambers. It closely resembles *Nonionina stelligera* superficially, and is probably responsible for many British records of that species, as it is widely distributed round the British coast, whereas true *N. stelligera* is rare. The retral processes, which are few in number, are masked by the secondary shell-matter, but become visible when wetted. The second or turgid type, which occurs abundantly at Stn. 22 and elsewhere, is much larger, the chambers being less inflated and more numerous, ranging up to eight or nine in the final embracing convolution; sutural lines depressed, but less so than in the compressed type, and filled with the same granular matter radiating from the depressed umbilicus, but to a lesser degree. The retral processes are much more numerous than in the compressed type, and, although rarely visible in the dry shell, come out strongly when wetted.

The compressed type is evidently to some extent isomorphous with *N. scapha* (as observed by Fornasini) and the turgid with *N. depressula*. Both forms represent connecting-links between the two species and *P. striato-punctata*, as also does *P. decipiens*, though on a different line of development.

318. **Polystomella decipiens,** Costa. (Plate 43. figs. 20–22.) (New to Britain.)

Polystomella decipiens, Costa, 1853, etc., PRN. 1856, p. 220, pl. xix. fig. 13 *a*, *b*.
" " Fornasini, 1897, FIC. p. 17, pl. ii. fig. 12.
" " Fornasini, 1899, PFI. p. 646.

5 *Stations.*

This specific name of Costa's, though of no zoological value, has a taxonomical use for recording those extremely pauperate specimens of *P. striato-punctata* in which the septation and fossettes are so obscure that specimens are with difficulty separated from *Nonionina depressula*. It occurs at a few Stns., the best at Stns. 5 and 17. It has, no doubt, been included in many lists under *P. striato-punctata*.

319. **Polystomella striato-punctata** (Fichtel & Moll).

Nautilus striato-punctatus, Fichtel & Moll, 1798, TM. p. 61, pl. ix. figs. *a*, *b*, *c*.
Polystomella striato-punctata, Brady, 1884, FC. p. 733, pl. cix. figs. 22, 23.

25 *Stations.*

Universally distributed, generally very abundant and constant in type, practically the only variation being in the thickness of the shell. The very thick typical form is most general, occurring practically everywhere; the thinner form (cf. *P. poeyana*, d'O. 1839, FC. p. 55, pl. vi. figs. 25, 26) occurs in lesser numbers at nearly all the Stns. At Stn. 17 a good many distorted and abnormal individuals were found, including one in which the initial spiral was followed by five chambers arranged in a straight line, forming a long crozier-shaped shell.

320. **Polystomella striato-punctata, var. selseyensis,** Heron-Allen & Earland.

Polystomella striato-punctata, var. *selseyensis*, Heron-Allen & Earland, 1908, etc., SB. 1909, p. 695, pl. xxi. fig. 2, 1911, p. 448 (table); 1914, etc., FKA. 1915, p. 733.

7 *Stations.*

Widely distributed in company with the type, never very abundant, the best at Stns. 4 and 5.

321. **Polystomella arctica,** Parker & Jones.

Polystomella arctica, Parker & Jones, MS.; Brady, 1864, RFS. p. 471, pl. xlviii. fig. 18.
„ „ Brady, 1884, FC. p. 735, pl. cx. figs. 2–5.

8 *Stations.*

Rare, and the specimens few in number, rather small, and generally worn. The best specimens were at Stn. 22.

322. **Polystomella macella** (Fichtel & Moll).

Nautilus macellus, Fichtel & Moll, 1798, TM. p. 66, pl. x. figs. *e–g*.
Polystomella macella, Brady, 1884, FC. p. 737, pl. cx. figs. 8, 9, 11, & ? 10.

18 *Stations.*

Widely distributed, but never very abundant, the best at Stns. 3, 4, and 17. The chief variation lies in the relative depression of the septal lines, which in some cases are so depressed as to give a turgid character to the chambers. These turgid specimens are, as a rule, characterized by a granular deposit over the shell-substance. At Stns. 6 and 8 the specimens were intermediate between *P. macella* and *P. crispa*.

323. **Polystomella crispa** (Linné).

Nautilus crispus, Linné, 1767, SN. p. 1162. No. 275.
Polystomella crispa, Brady, 1884, FC. p. 736, pl. cx. figs. 6, 7.

21 *Stations.*

Almost universally distributed, but never common. The specimens are, as a rule, large and handsome and of the compressed type. At several Stns., notably at Stns. 4 and 17, the marginal spines persist to an advanced or even mature stage (see H.-A. & E. 1913, CI. p. 146, pl. xiii. fig. 14). Distorted specimens occur at Stns. 5, 11, and notably Stn. 15, usually due to fission of the protoplasm separating into two distinct shells at about half the growth, the subsequent growth being continued on two distinct planes.

Subfamily Nummulitinæ.

Operculina, d'Orbigny.

324. **Operculina ammonoides** (Gronovius).

Nautilus ammonoides, Gronovius, 1781, ZG. p. 282. No. 1220, pl. xix. (fasc. iii. tab. 2) figs. 5, 6.
Operculina ammonoides, Brady, 1884, FC. p. 745, pl. cxii. figs. 1, 2.

20 *Stations.*

Almost universally distributed, often very common, the best specimens at Stns. 4, 11, and 14. Variation is almost entirely dependent on the degree of limbation of the sutures, which at some Stns. is very marked and striking. Distorted or wild-growing forms occur at Stns. 19, 20, and 21. At Stn. 19 there is a tendency to an inflation of the later chambers.

No.	Page	SPECIES.	Lowlandman's Bay, Jura. Stn. 1.	Sound of Mull. Stn. 2.	Off Ardnamurchan. Stn. 3.	Loch Sunart. Stn. 4.	Soriby Bay, Ulva. Stn. 5.	Atlantic Shore, Iona. Stn. 6.	Gott Bay, Tiree. Stn. 7.	Sandy Island, Canna. Stn. 8.	Laga Bay, Loch Sunart. Stn. 9.	Shiant East Bank. Stn. 10.	Loch Shell, Lewis. Stn. 11.	Loch Dunvegan, Skye. Stn. 12.	Off Neist Point, Skye. Stn. 13.	Loch Ainneart, Skye. Stn. 14.	Tobermory Bay, S. Stn. 15.	Between Rhum and Eigg. Stn. 16.	Scresort Bay, Rhum. Stn. 17.	Off S. of Eigg. Stn. 18.	Cronlin Beg. Stn. 19.	Between Ru Ruag and Carr Point. Stn. 20.	Loch Hourn. Stn. 21.	Oronsay. Stn. 22.	Off Bradda Head, Port Erin. Stn. 23.	Eilean Gartmael, Oronsay. Stn. 25.	Skye (var. loc.). Stn. 26.
1.	205	*Nubecularia lucifuga*, Def.	...			...	1	...	...	...	...	...	...	...	...	...	...	...	...	...		...	...	...	...	...	...
2.	205	*Biloculina ringens* (Lam.)		1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	VR	F	...		...		
3.	205	,, *bulloides*, d'O.	1	1	1	...	...	...	...	...	...	VR	...	VC	...	C	...	R	...	F	C	...	...	VR	VR		...
4.	205	,, *elongata*, d'O.	...	C	R	R	...	...	...	...	VR	C	R	VR	...	F	...	1	...	C	C	C	VR	...	F	...	...
5.	205	,, *depressa*, d'O.	...	F	VR	R	...	...	...	...	VR	F	VR	VR	1	F	...	...	...	F	C	C	VR	...	C	...	VR
6.	206	,, *inflata*, Wright	...	...	...			...	...	...	...	...	...	...	...	...	...	...	...	R	VR	...	...	...	...	...	...
7.	206	,, *irregularis*, d'O.	...	...		VR	...	...	...	...	F	VC	VR	...	VR	...	...	F	...	C	C	VC	VR	...	...	...	F
8.	206	,, *sphæra*, d'O.	...	F	...		...	...	...	...	...	...		...	...	...	...	...	...	...	R	VVC	...	...	...	...	...
9.	207	*Spiroloculina nitida*, d'O.	...	...	...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	VR	...	...	1	...	1
10.	207	,, *grata*, Terq.	...	...			...	...	...		...	...	...	...	...	1	...	...	...	...	...	VR		...	...		
11.	207	,, *excavata*, d'O.	1	VR	F	VR	VR	VR	1	R	...	F	F	R	VR	F	R	...	...	C	C	C	VR	...	F	VR	VR
12.	207	,, *planulata* (Lam.)	1	VR	VR	VR	...	...	1	...	...	F	VR	...	...	F	VR	...	...	C	F	1	...	...	R	...	1
13.	207	,, *dorsata*, Rss.	...	...	...	VR	...	...	...	...	...	VR	...	...	...	F	...	...		F	...	VR					
14.	208	,, *acutimargo*, Br.	...		VR	...	...	...	...	...	...	1	VR	VR	...	1	...	...	...	...	...	...			...		
15.	208	,, ,, var. *concava*, Wiesner.	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
16.	208	,, *tenuis* (Cz.)	...	...		C	...	...	...	...	...	...	...	...	...	VR	...		...	...	...	...	...	...	...	...	...
17.	208	*Miliolina bucculenta*, Br.	...	...		...	...	...			...	...	...		...	...		...	...			1	...		...		
18.	209	,, *circularis* (Born.)	VR	...	F	R	...	C	VC	C	F	F	...	C	F	F	F	1		F	R	...	...	VR	F	VR	F
19.	209	,, *labiosa* (d'O.)	...			...		...	...	...	...	...	...	R	...	...	...	...		...	...	...			...		...
20.	209	,, *subrotunda* (Mont.)	VR	VR	VR	R	...	R	C	F	VR	F	VR	F	VR	...	C	R	...	R	R	R	...	R	VR	VR	C
21.	209	,, *seminuda* (Rss.)	...	...	1	...	...	...	VR	1	...	VR	...	...	...	...	...	...	...		...	...	...		VR		
22.	210	,, *suborbicularis* (d'O.)	...	...		...	...	...	...			1	...			...	...				...	...			...		...
23.	210	,, *trigonula* (Lam.)	...		VR	VC	...	...	...	...	VR	F	...	VR	...	F	VR	VR	1	C	C	F	VR	VR	C		
24.	210	,, *tricarinata* (d'O.)	1	VR	...	VR	...	R	...	...	VR	VR	...	1	...	R	...	...		F	VR	F		...	VR	VR	
25.	210	,, *bosciana* (d'O.)	...		...	F	1	...	...	...	...	...	VR	VR	...	VR	...		VR	R	...	...	...	...	VR	...	...
26.	210	,, *oblonga* (Mont.)	...	F	F	VR	...	VR	VR	VR	1	R	...	VR	R	VR		...		C	...	R	...	...	VR	...	VR
27.	211	,, *pygmæa* (Rss.)	...	F	1	C	R	...	...	...	VC	F	C	F	...	VC	...	...	...	F	VC	C	C	1	VR	...	VR
28.	211	,, *rotunda* (d'O.)	...	...	1		...	...	...	...	...	...	...	...		...	...		...	...	...	...		...	1		
29.	211	,, *anconensis* (Schultze)	...	...		R	VR	...	...	...	...	...	R	...	...	...	R	...	F				...			...	...
30.	212	,, *vulgaris* (d'O.)	...	R	...	F		...	...	VR	...	...	...	...		...	C	...			...			...	...		
31.	212	,, *seminulum* (Linné)	C	F	R	F	VR	VR	F	VVC	F	F	F	VR	1	C	VC	F	VC	F	C	F	VR	F	F	VR	VR
32.	212	,, *candeiana* (d'O.)	...	...		...	...	...	1	1	...	F	...	F	VR	R	...	1	...	F	VR	...			VR		
33.	213	,, *auberiana* (d'O.)	R	...	VR	VR	...	VR	VR	VR	1	...	VR	...	...	VR	...	...	VR	F	1	...	VR	...	...	VR	R
34.	213	,, *undosa* (Karr.)	...		...	...	...	...	...	VR	...	...	...	1	...	...	...	...		...	...	...	...		...	...	...
35.	213	,, *agglutinans* (d'O.)	...	R	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	VR	...	...	F	...	...	...
36.	213	,, *fusca* (Br.)	...	...	...	...	VR	...	...	VR	...	...	...	...	...	...	...	...	VR	1	VR	...	VR	F	1		
37.	213	,, *contorta* (d'O.)	...	...		...	...	...	1	...	...	...	...	...	...	...	R	...	F	R	...	...	...	R	...	VR	...
38.	213	,, *sclerotica* (Karr.)	C	...	...	...	...	...	VR	...	1	VR	VR	...	...	R	...	...	VR	F	...	...	...	R	R	...	...
39.	214	,, *ferussacii* (d'O.)	...	...	F	...	...	...	...	...	...	F	...	VR	...	...	...	1	...	...	...	F	...	...	...	...	...
40.	214	,, *pulchella* (d'O.)	R	...		VR	...	...	...	...	1	...	...	...	...	...	...	...		VR	...	...	...	...		...	...
41.	214	,, *brongniartii* (d'O.)	R	...	F	VR	VR	VR	R	F	VR	F	R	VR	VR	C	C	VR	VR	C	F	F	...	...	VR	VR	...
42.	214	,, *bicornis* (W. & J.)	F	VR	...	R	...	...	...	1	VR	VR	...	...	...	...	R	...	...	R	F	VR	...	...	VR	...	1
43.	214	,, *lævigata* (d'O.)	1	VR	...	1	...	...	...	...	...	...	...	...	...	VR	VR	...	...	F	R	...	...	...	R	...	...
44.	215	,, *stelligera* (Schl.)	...	...	...	VR	...	...	...	...	...	VR	...	...	...	R	...	...	...	R	...	R	VR	...	...	...	...

45.	215	*Massilina secans* (d'O.)	1			VR			VVC	VVC	1								1					VR		VR	
46.	215	*Opthalmidium carinatum*, B. & W.			VR	F					VR	F		F	VR	F	VR	VR		VR	VR	VR			VR	VR	1
47.	216	*Planispirina celata* (Costa)		F		1					VR	VR		1		1				C	1				1		VR
48.	216	" *sigmoidea*, Br.										VR															
49.	216	*Cornuspira foliacea* (Phil.)				VR								1		R					F	C					
50.	217	" *diffusa*, H.-A. & E.																		VR							
51.	217	" *carinata* (Costa)		VR						R						VR				VR	1	VR					
52.	217	" *selseyensis*, H.-A. & E.			1	VR		1			VR	VR		F	1					VR	VR	C			VR		VR
53.	217	" *involvens* (Rss.)		VR	VR				1		VR	VR		VR	VR	F	F	VR	VR	VR	1	VR			VR		
54.	217	" *angigyra* (Rss.)		1													VR	1			F			VR			
55.	218	*Iridia diaphana*, H.-A. & E.										VR															
56.	218	*Pelosina variabilis*, Br.										VR															
57.	218	*Storthosphæra albida*, Schulze																		VR							
58.	218	*Bathysiphon argenteus*, H.-A. & E.				VR							VR			VR							R		VR		
59.	219	*Psammosphæra fusca*, Schulze				1						R									VR						R
60.	219	" *bowmanni*, H.-A. & E.														1						1					
61.	219	*Crithionina mamilla*, Goës			VR	VC														1	1	VR					R
62.	219	*Jaculella acuta*, Br.				VR								VR								VC					
63.	220	" *obtusa*, Br.		1							VR	1	VR								1	F					
64.	220	*Hyperammina friabilis*, Br.		1								1								R	1	VR					
65.	220	" *elongata*, Br.														VR						F					
66.	220	" *ramosa*, Br.	1																								
67.	220	" *arborescens* (Norm.)				VR					1			R		C				1							VR
68.	221	" *vagans*, Br.										F															R
69.	221	*Rhabdammina abyssorum*, M. Sars																						1			
70.	221	*Rhizammina algæformis*, Br.														VR											C
71.	221	*Botellina labyrinthica*, Br.										1										C	1				
72.	222	*Haliphysema tumanowiczii*, Bow.												1													
73.	222	*Reophax difflugiformis*, Br.				1						1				1											
74.	222	" *fusiformis* (Will.)				VR						VR		1		C				F			F				
75.	222	" *scorpiurus*, Montf.			VR	VR							1							VR	R	R	1				
76.	222	" *scottii*, Chaster				1	VR						VR							VR		1					
77.	223	" *moniliforme*, Sidd.			1									1						1							
78.	223	*Haplophragmium pseudospirale* (Will.)	1	F	VR	VC	VR				F	F	VR			R			1	R	F		VR		VR		VR
79.	223	" *canariense* (d'O.)		1	C	F	R	1		VR	F	C	VR	C	F	C	VR	C	VR	R	VC	F	VR	1	R	VR	F
80.	224	" " var. *pauperata*, Chap.				VR																	VR				
81.	224	" *runianum*, sp. nov.																	F								
82.	224	" *globigeriniforme* (P. & J.)		VC	C	F					F	C	F	F	VR	C		F		C	R	F	F				VR
83.	225	" *glomeratum*, Br.		C	VR	R	1				F	F	VR	F		VC	1	1		C	F	F	VR	1			VR
84.	225	*Placopsilina vesicularis*, Br.																									R
85.	225	*Thurammina papillata*, Br.				1									1						VR						VR
86.	225	*Ammodiscus incertus* (d'O.)			C	VR					VR	C		C	1	C		VR		VC	F	VC	R				VR
87.	226	" *gordialis* (J. & P.)		VR	F	VR					1	C	VR	VC	VR			VR		VR	C	C	VR		VR		F
88.	226	" *charoides* (J. & P.)		VC	VR							VR				VR					R	VR					1
89.	227	" *shoneanus* (Sidd.)															1										
90.	227	*Trochammina inflata* (Mont.)												VR													
91.	227	" " var. *macrescens*, Br.				VR													1				VR				
92.	227	" *ochracea* (Will.)			F	R	VR					VR	VR	F	F	VR	F	F		VR	VR	VR	VR			VR	1
93.	227	" *plicata* (Terq.)			F	VR						VR			R			R				F					
94.	228	" *squamata*, J. & P.	1		VR	F	F	VR				F	C	F	F		F	F	VR	VR	VR	R			1	VR	
95.	228	" *rotaliformis*, Wr.		1	R	1					VR	F		VR		VR		F		VR		VR					
96.	228	" *nitida*, Br.												1													
97.	228	" *robertsoni*, Br.		VC	VR	VR					F	F	F	F	VR	VC	VR			C	C	F	R				F
98.	229	*Textularia fusiformis*, Chast.														1											
99.	229	" *concava*, var. *heterostoma*, Forn.														VR											
100.	229	" *sagittula*, Def.				1				VR	C	F		VR				VR		C	R						
101.	229	" " var. *jugosa*, Br.																1									
102.	230	" *agglutinans*, d'O.			C							F				C		R			R		VR			VR	

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103.	230	*Textularia candeiana*, d'O.									1	C								VC	C	C					
104.	230	" *gramen*, d'O.	F	VC	VC	F	1	VR	1	F	C	F	R	C	C	VC	VR	C		VC	C	C	F		VR		VR
105.	230	" *conica*, d'O.		R	C	C	VR	R	F	C	VR	VC	F	C	C	VC		C	VR	VC	C	VC	C	VR	R	VR	F
106.	230	" *trochus*, d'O.												VR						VC							
107.	231	" *turris*, d'O.		1	1																VR						
108.	231	*Verneuilina polystropha* (Rss.)	C	F		F	F	VR			F	F	F	R	VR	C	VR	1	VVC	C	C	F	F		VR	VR	R
109.	231	*Bigenerina digitata*, d'O.									1		VR			R				VR	F		VR				
110.	231	*Spiroplecta biformis* (P. & J.)									VR	VR								F					VR		
111.	231	" *wrightii*, Silv.			R	C			1	VR	VC	C	VR	F	VR	VC	VR	1		VC	C	C	VR		VR		F
112.	232	" *fusca*, Earland			1																						
113.	232	*Gaudryina filiformis*, Berth.				F	1						R			VR			F	VR	1						VR
114.	232	" *rudis*, Wr.			VC	F		1	1	VR	VR	C		VR	1	VR		F		F	C						VR
115.	232	*Valvulina fusca* (Will.)										C		C	VR	C		1		F	VC	C	VR			VR	C
116.	233	" *conica*, P. & J.				1																					
117.	233	*Clavulina obscura*, Chast.	1			1						VR								1							
118.	233	*Bulimina pupoides*, d'O.	F	VR	R	C	C		VR		C	R	C					F	VVC	C	R	F	VVC	VR	C	VR	VR
119.	233	" *elegans*, d'O.	C	VR		VC	VC	C		VR	C	R	C	R		VC	VR	VR	VC	VC	VC	C	VVC	F	C		
120.	234	" " var. *exilis*, Br.				R					VR		R						1	R			VR				
121.	234	" *elongata*, d'O.				VC										VC				VC	F		R				
122.	235	" *fusiformis*, Will.	VR	F	VR	C	VC	VR			C	VC	C	C	VR	VC	R	R	VVC	VC	VC	VC	VVC	VR	VR	VR	F
123.	235	" *ovata*, d'O.																	1		VR	VR					
124.	235	" *elegantissima*, d'O.	VR			C	VC	C			VR		VR	1		1		VR	C			1			VR		
125.	235	" *marginata*, d'O.	C	VVC	C	VVC	C	C		VR	F	VVC	VC	F	1	VVC	VR	R	VVC	VC	VVC	VC	VVC	C	C	VR	C
126.	235	" *echinata*, d'O.	1			R																					
127.	236	" *aculeata*, d'O.	VR	VVC	F	VC					C	VC	C			F					C	C	VC				VR
128.	236	" *subteres*, Br.	VR			F					1	VR		F		VR			1	R		VR					
129.	237	" *minutissima*, Wr.										1			1												
130.	237	" *squammigera*, d'O.	VR			C	R				VR		F						F	F		R			VR		
131.	237	*Virgulina schreibersiana*, Cz.	VR	VR		C	VR	VR			VR		VC	VR		C		1	R	VR	F		1				
132.	237	*Bolivina punctata*, d'O.	VR	F	F	C	F	1			VR		C	R	VR	...		VR	R	C	F	VR			VR		
133.	238	" *nobilis*, Hantk.				F	VR						F	1		R				F	F	VR	F				VR
134.	238	" *textilarioides*, Rss.				F	F	C	VR	1	R	F	C	R	VR	R		VR	C	VC	F		F		VR		
135.	238	" *lævigata* (Will.)		1		VR						1	1						VR	VR		R					
136.	238	" *dilatata*, Rss.	VR	F	VR	F	R	VR			C	VR	C	R	1			VR	VR	F	F	VR	F		R		1
137.	239	" *difformis* (Will.)	VR		F	VR	VR					F	VR	R	VR	VR		R	1	F	VR						VR
138.	239	" *gramen* (d'O.)				R	VR				1		VR								VR						
139.	239	" *beyrichi*, Rss.				F						VR															
140.	239	" *ænariensis* (Costa)		C		F						VR	F	1		R		VR	VR	VC	1	C	R				
141.	240	" *tortuosa*, Br.				1		1																			
142.	240	" *plicata*, d'O.	F	VR	F	C	F	VR	R		F	F	C	R	VR	R	F	VR	VC	VR	C	F	R	VR	F	VR	
143.	240	" *variabilis* (Will.)	F			C	F		VR		R	VR	C	F	VR	R	F	F	F	F	F	F	VR	R	R		VR
144.	240	" *inflata*, H.-A. & E.	VR			F						VR	F	1						VR		VR	VR		...	VR	
145.	240	*Cassidulina lævigata*, d'O.		VR	VR	R		VR	1	1	F	F	VR	VR	VR	R	VR	VR	VR	F	VR	VR	VR	VR	VR		
146.	241	" *crassa*, d'O.	VR	F	F	C	R	1			VR	C	R	F	R	VR		F	VR	F	VR	F	F	VR	VR	VR	1
147.	241	" *subglobosa*, Br.	F	C	C	F	VR	VR			VR	R		F	F	VR		VR		VR	VR	C	F		F		

148.	241	,, *bradyi*, Norm.				F							1			1			1			1					
149.	241	,, *nitidula* (Chast.)			1										1	1	1	1									
150.	242	*Lagena globosa* (Mont.)	R	R	F	C	VR	R	F	1	1	F	R	VR	1	VR			R	F	R	VR		VR	VR		
151.	242	,, *ovum* (Ehr.)				1																1					
152.	242	,, *apiculata* (Rss.)	VC									F	VR					1				VC					
153.	242	,, *botelliformis*, Br.				VR										1											
154.	243	,, *aspera*, Rss.				1													1								
155.	243	,, *hispida*, Rss.		F	1	1						VR				VR			1	VR	VR	VR					
156.	243	,, *lineata* (Will.)	R			VR			VR		1	VR	VR	R		VR	VR		VR	VR	R	VR			VR	VR	VR
157.	243	,, *costata* (Will.)	1	VR	C	VR	VR	R	VC	R		F			1		F			VR	VR	C	1	R	F	VR	
158.	244	,, *hexagona* (Will.)	C	1		F	F	VR	1		VR	C	F	F	1	F			1	F	F	VC	VR	VR	F	VR	VR
159.	244	,, *reticulata* (Macg.)	R			VR					1	VR															
160.	244	,, *squamosa* (Mont.)	C	VR		F	F	R	R	F	VR	C		F		F	F	VR	R	R	F	R	VR	F	F		VR
161.	244	,, ,, var. *montagui* (Alcock)							1			VR								VR		VR		VR			
162.	245	,, *spumosa*, Mill.		VR																							
163.	245	,, *lævis* (Mont.)	R	VR		C	R	R	1		VR	VR	F	R			VR	VR	C	VR	R	VR	VR	VR			VR
164.	245	,, ,, var. *distoma*, Silv.		1		VR										1											
165.	245	,, *semistriata*, Will.				C	R	VR			VR	F	F	R					VC	1		VR	R	VR	VR		1
166.	246	,, *semilineata*, Wr.									1									1							
167.	246	,, *perlucida* (Mont.)	F			F											VR		C								
168.	246	,, *striata* (d'O.)		C	VR	C	F					F	F			F			C	VC	VR	C	F		VR		
169.	246	,, *sulcata* (W. & J.)	F	VR	1	R	VR		R	V	VR	C	VR	R		F	R		F	VC	R	R	VR	VR	VR		
170.	247	,, *lyellii* (Seg.)		C	1	F		1								VR				F			VR				
171.	247	,, *williamsoni* (Alcock)	C			F	F	R	VVC	C	R	VC	VC	C	VR	F	F	VR	VR	C	VC	VC	VR	VC	C		VR
172.	247	,, *acuticosta*, Rss.		1		VR						F			VR	R				F	C	C					
173.	247	,, *striatopunctata*, P. & J.				VR																					
174.	248	,, *clavata* (d'O.)	R	F		F	R			1		F	C	1		R				F		F	VR	R	F		VR
175.	248	,, *gracillima* (Seg.)	R	F	VR	VR	VC				1	VR	R	1		R					F	R					
176.	248	,, *gracilis*, Will.		VR		F						VR	F	1		R			F	VR	VR		VR				
177.	248	,, *distoma*, P. & J.		VR								1	R			1			R		VR	VR					
178.	249	,, *lævigata* (Rss.)	R	F	R	VC	R	F			F	VC	C	C	F	F	F	F	VVC	F	C	VR	VC	F	R	VR	F
179.	249	,, *acuta* (Rss.)	VC	F	VR	C					F	VR	VR	R		VR				F	F	VR	R	VR	C		VR
180.	249	,, *falcata*, Chast.				VR																					
181.	249	,, *lucida* (Will.)	F	R	V	C	VR	1		VR	1	R	R	F	1	R			VVC	VR	C			F	F		
182.	250	,, *fasciata* (Eg.)	VC		VC	C					1	R		C				VR				R	VR				R
183.	250	,, ,, var. *faba*, B. & M.						VR	F	VR		C		F	F	R	R	VR	VR	R	VR	VR	...			VR	VR
184.	250	,, *annectens*, B. & H.		VR	1	F	VC				1	C	VR	F	R				C	F		C	VR				VR
185.	251	,, *quadrata* (Will.)			VR						1	VR	1	R			1	VR	VR	VR							
186.	251	,, *malcomsonii*, Wr.				VR					1	1	1	1				1	VR								
187.	251	,, *marginata* (W. & B.)	F	VR	VC	F	VR			1	VR	F	VR	F	R	R	VR	VR	R	R	C	F			VR		1
188.	251	,, ,, var. *inæquilateralis*, Wr.			1	V						1									VR						
189.	251	,, ,, var. *semimarginata*, Rss.			1																						
190.	252	,, *marginato-perforata*, Seg.				VR																					
191.	252	,, *formosa*, Schw.																		1							
192.	252	,, *lagenoides* (Will.)	1			VR								VR	VR	1		VR	R	VR		F					
193.	252	,, ,, var. *tenuistriata*, Br.				F															1	VR					
194.	252	,, *ornata* (Will.)			1	R								1				1	VR	1					1		
195.	253	,, *rizzæ* (Seg.)				VR						VR		VR					R								
196.	253	,, *bicarinata* (Terq.)			VR	VR						VR							VR			VR			VR		
197.	253	,, *orbignyana* (Seg.)	C	F	C	C	R	VR	R	R	1	VVC	VR	F	VR	F		R	C	C	VR	VC	VR	C	VR		VR
198.	253	,, ,, var. *walleriana*, Wr.															1										
199.	253	,, *pulchella*, Br.								1		C		R		1				VR	C	VC					
200.	254	,, ,, var. *hexagona*, var. nov.																				1					
201.	254	,, *clathrata*, Br.										VC		VR		VR	1			F	R	VC	VR				VR
202.	254	,, *lacunata*, B. & H.												R								R					
203.	255	,, *reniformis*, Sideb.				1													1								
204.	255	,, *fimbriata*, Br.				VR	1				1	1							VR								1
205.	255	,, *cymbula*, H.-A. & E.														1											
206.	255	*Nodosaria rotundata* (Rss.)												1								F					

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207.	255	*Nodosaria laevigata*, d'O.		VR																		F					
208.	256	,, *calomorpha*, Rss.				VR																					
209.	256	,, *pyrula*, d'O.	VR	F	1	F	VR				VR	R	1	VR		F			VR	R	1	F	VR	VR	VR		
210.	256	,, *filiformis*, d'O.		R	1	F	VR					VR			F					1			R				
211.	256	,, *consobrina*, d'O.																		1	F	1					
212.	256	,, *communis*, d'O.	VR	C	1	F	VR				1	VR		1	F	F			1	VR	VR	C	F		VR		1
213.	257	,, *pauperata*, d'O.												VR													
214.	257	,, *roemeri* (Neugeb.)		VR											VR							VR					
215.	257	,, *mucronata* (Neugeb.)				1																					
216.	257	,, *scalaris* (Batsch)	VR	C		VC	VR	1			1	C	VR	1		F		1	F	VC	F	C	F	VR	VR		1
217.	258	,, ,, var. *separans*, Br.				1																VR					
218.	258	,, *proxima*, Silv.				F							1														
219.	258	,, *raphanistrum* (Linn.)				VR																					
220.	258	,, *obliqua* (Linn.)		VR		VR						VR				VR						VR			1		
221.	259	*Lingulina biloculi*, Wr.				VR						VR	F	VR					VR								
222.	259	,, *carinata*, d'O.																	1								
223.	259	,, ,, var. *bicarinata*, Sideb.				VR																					
224.	259	,, ,, var. *seminuda*, Hantk.				VR																					
225.	260	*Frondicularia spathulata*, Br.				VR																					
226.	260	,, *tenera* (Born.)																									1
227.	261	*Marginulina glabra*, d'O.				VR																1					
228.	261	,, *costata* (Batsch)		1												R					VR	VR					
229.	261	*Vaginulina legumen* (Linn.)			R	VR	1		VR					1								VR					
230.	261	,, *linearis* (Mont.)											1														
231.	261	*Cristellaria crepidula* (F. & M.)		VR	VR	VR			1			R	1	R				1	VR	1	1	R			1		
232.	262	,, *acutauricularis* (F. & M.)				VR										VR			1	1		R					
233.	262	,, *convergens*, Born.				VR																1					
234.	263	,, *gibba*, d'O.			1	VR							1								1	VR	1		VR		
235.	263	,, *rotulata* (Lam.)	1	F	1	R	VR	VR	1	VR	1	1	R	1		VR				VR	VR	VR		VR	VR	VR	
236.	263	,, *cultrata* (Montf.)	1	R		VR		1				VR								VR		R					
237.	263	,, *variabilis*, Rss.																	VR								
238.	263	*Polymorphina amygdaloides* (Rss.)																							VR		
239.	264	,, *lactea* (W. & J.)			1	R	VR	C	C	F	1	VR	VR	F	VR	R	VR	VR	VR	F		VR		R	F		
240.	264	,, *oblonga*, Will.			VR	1				1		1			VR			F	1								
241.	264	,, *concava*, Will.			VR													VR									
242.	264	,, *sororia*, Rss.		VR	C	VR		1				C	1	R	VR			VR	VR	VR		VR	1	VR	F		1
243.	264	,, *rotundata* (Born.)			F	VR			VR	1		R	VR	R	VR			VR	VR		R	VR			C		
244.	265	,, *gibba*, d'O.	1		C				F	VR		R		F	1	VR	1	C			R	C		VR	VR		
245.	265	,, *communis*, d'O.				VR			1													R					
246.	265	,, *compressa*, d'O.		1	F	VR			VR	F		C	VR	R	1	R				VR	R	VC		R	R		VR
247.	265	,, *cylindroides*, Roemer																						R	1		
248.	265	,, *myristiformis*, Will.							1	1										1		VR					
249.	266	*Uvigerina pygmaea*, d'O.										VR	VR	1		VR		1		F	R		F				
250.	266	,, *angulosa*, Will.	R	VR	VR	C	R	VR			VR	F	VR	R	VR	F	VR		VR	R	R	R	VR	R	VR		1
251.	266	*Sagrina dimorpha*, P. & J.		F								1										1					

252.	266	*Globigerina bulloides*, d'O.	R	...	VR	F	...	R	R	VR	...	VC	R	F	...	C	VR	VR	F	F	F	F	R	C	VR	VR	VR
253.	267	„ *dubia*, Eg.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		...	VR	...	...	...		...	...	...
254.	267	„ *pachyderma* (Ehr.)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	VR	...	...	...
255.	267	„ *inflata*, d'O.	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...
256.	267	„ *rubra*, d'O.	...	VR	VR	R	VR	...	...	...	VR	VR	VR	...	...	VR	VR	VR	VC	R	...	...	...	...	...	...	...
257.	267	„ *linnæana* (d'O.)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
258.	268	*Orbulina universa*, d'O.	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
259.	268	? *Sphæroidina* sp.	...	...	...	...	...	...	...	...	...	...		...	...	1	...	...	...	...	...	...	...	...		...	...
260.	268	*Spirillina vivipara*, Ehr.	...	...	F	VR	...	...	...	1	VR	F	...	F	R	...	F	VR	...	...	VR	VR	...		VR	...	VR
261.	269	„ *obconica*, var. *carinata*, Halk.	...	...	VR		...	...	...	...	...	...	...	VR	...	...	...	...	...	...	...	...		...	...	...	
262.	269	*Patellina corrugata*, Will.	...	VR	F	F	VR	VR	...	...	VR	VR	F	F	VR	C	F	VR	VR	VR	F	F	VR	VR	F	...	VR
263.	269	*Discorbina nitida* (Will.)	VR	...	F	VR	1	...	1	1	1	F		F	F	F	F	F	1	F	F	R	...		R		VR
264.	270	„ *millettii*, Wr.	1		VR	...	...	...	...	...	...	VR	...	...	VR	...	...	...	...	...	...	...	...	...	...		
265.	270	„ *praegeri*, H.-A. & E.	VR	VR	F	F	...	...	...	...	F	F	R	F	F	C	R	F	...	F	F	R	...	C	C	VR	F
266.	270	„ *peruviana* (d'O.)		...	R	F	...	...	...	...	...		...	...	...	...	...	...	...	...	F	...	...	...	...	...	...
267.	270	„ *rosacea* (d'O.)	F	...	R	C	R	1	...	...	1	C	VC	R	R	C	R	F	R	C	F	VC	VR	VR	C		R
268.	270	„ *planorbis* (d'O.)	C	...	VR	C	1	...	VR	...	...	1	1	...	...	...	...	...	...	...	...	...	...	VR			...
269.	271	„ *baccata*, H.-A. & E.	...	...	...	VR	...	...	1		1	...	VR	...	...	...	...	...	...	...	...	...	...	...	...	...	
270.	271	„ *turbo*, d'O.	F	...	...	VR	F	...	...	1	F	VR	VVC	VR	...	...	...	1	VC	VR	...	...	...	VR	F		1
271.	271	„ *orbicularis* (Terq.)		...	...	...	...	...	...	...	...	...		...	...	...	R	...	...	...	...	...	...				
272.	271	„ *mamilla* (Will.)	F		VR	C	VR	VR	F	F	F	C	VC	VR	...	...	...	VR	C	VR	F	VR	VR	VR	C		F
273.	272	„ *mediterranensis* (d'O.)	VR	...		VR	...	VR	...	...	...	...	...	...	...	...	VC	...	...	VR	...	...	...	VR		...	
274.	272	„ *globularis* (d'O.)	R	F	VC	F	VR	VC	C	VVC	F	VC	R	VC	F	C	C	R	VR	VC	C	F	R	VR	F	VR	F
275.	272	„ *obtusa* (d'O.)	1		VR	VR	F	R	R	...	...	...	...	...	...	...	...	VR	...	VR	...	...	...	1	C	...	...
276.	272	„ *polygraphes* (Rss.)	1	...	...	VR	...	...	...	...	...	...		...	1	...	...	...	1	VR	...	...	...	...	...	...	...
277.	272	„ *chasteri*, H.-A. & E.	...	1	1	R	...	...	1	...	1	...	1	...	R	VR	VR	VR	VR	...	...	...	...	...	...	...	...
278.	273	„ „ var. *bispinosa*, H.-A. & E.	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...		...	...
279.	273	„ *bertheloti* (d'O.)		...	...	...	...	VR	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...		...	...
280.	273	„ *pustulata*, H.-A. & E.	...	...	...		...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...			...	
281.	273	„ *parisiensis* (d'O.)	...	...	...	...	...	...	...	VR	...	...	...	...	...	...	...	...	...	...	...	...	...	...		...	...
282.	273	„ *vesicularis* (Lam.)		VR	...	...	...	...	...		...	...		1	...	...	...	...	...	...	...	...		VR		...	...
283.	273	*Planorbulina mediterranensis* (d'O.)	R		C	R	VR	R	R	VR	VR	VC	F	R	VR	VR	1	F	...	C	F	F	VR	VR	C	...	C
284.	274	*Truncatulina refulgens* (Montf.)	1		R	VR		F	VR	C	F	C	VR	C	R	VR	...	R	R	VR	VC	R	VR	VC		...	R
285.	274	„ *lobatula* (W. & J.)	C	R	VC	C	C	VVC	VVC	VVC	C	VVC	C	VC	F	VC	VC	C	C	VC	VVC	VC	VR	C	R	VR	C
286.	274	„ *tenuimargo*, Br.	...	...	...	...	...	...	...	VR	...	...	...	...	...	...	...		...	...	...	...	...			...	...
287.	274	„ *variabilis*, d'O.	R	...	R	...	VR	VR	VR	F	...	F	VR	F	R	C	C	VR	...	R	...	C	...	VR	VR	VR	VR
288.	274	„ *haidingerii* (d'O.)		1	...	...		...		...	...	...	...	...	VR	...	...	...	...	...	...	...	...	...		...	...
289.	274	„ *ungeriana* (d'O.)	...	...	1	...	...	...	...	...	...	VR	...	1	...	...	...	...	...	...	...	...	...	...	VR	...	...
290.	275	„ *akneriana* (d'O.)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	VR	...	...	...	...	...	...		...	
291.	275	„ *tenera*, Br.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	VR	...			...	...
292.	275	*Pulvinulina repanda* (F. & M.)	...	...	C	1	...	...	...	...	...	C	...	VR	...	...	...	...	...	1	VR	...	...	...	VR		VR
293.	275	„ „ var. *concamerata* (Mont.)	...	...	F	...	...	VR	...	...	1	F	...	VR	1	...	...	1	...	...	VR	R	...	...			1
294.	275	„ *punctulata* (d'O.)	...	...	VR	...	1	...	...	...	...	...	...	...	VR	...	...	VR	...	...	...	...	...	...	...	...	
295.	276	„ *auricula* (F. & M.)			VR	VR	...	...	...	1	...	F	VR	VR	VR	VR	...	...	...	VR	C	R	F	...	...	...	
296.	276	„ *oblonga* (Will.)	...	...	...	...	...	...	R	...	...	VR	VR	...	...	...	...	...	VR	VR	C	C	...	R	1	...	VR
297.	276	„ *brongniartii* (d'O.)	...	...	...		...	...	...	...	...	...	...	...	...	...	...	VR	...	...	...	...	...	...		...	...
298.	276	„ *haliotidea*, H.-A. & E.	1		R	F	...	...	...	...	...	VR	...	F	VR	VR	...	VR	VR	VR	C	VR	VR	...	VR		
299.	276	„ *karsteni* (Rss.)	...	...	...	C	...	...	...	...	VR	F	VC	F	...	VC	R	...	VVC	VC	C	C	C	...	...	...	F
300.	277	„ *elegans* (d'O.)	...	...	F	...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		...	...
301.	277	*Rotalia beccarii* (Linn.)	VVC	...	...	F	R	VR	C	VR	C	...	C	VR	...	...	R	VR	VVC	VC	...	R	...	C	VR		
302.	277	„ *orbicularis* (d'O.)	...	C	VR	C	VR		...	...	C	C	C	VR	...	C	...	VR	...	VC	VC	VC	VC	...	C	...	VR
303.	277	„ *perlucida*, H.-A. & E.	...	...	...	F	F	...	...	...	R	...	...	...	...	...	...	...	...	...	...	...	...	...	VR	...	...
304.	278	„ *schroeteriana*, P. & J.	...	...		...		1	...	...	...	...	...	...	...	...	...	...		...		...	...				...
305.	278	*Gypsina inhærens* (Schultze)	...	...	F	VR	VR	R	F	VC	VR	R	VR	C	R	...	R	C	VR	R	...	VR	...	VR	VR	VR	C
306.	278	„ *vesicularis* (P. & J.)	...	...	R	...	...	...	1	1	...	...	1	...	...	...	...	...	...	VR	...	...	...	...	...	...	...
307.	278	„ *globulus* (Rss.)	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	VR	...	...	...	...	...		...
308.	279	*Nonionina depressula* (W. & J.)	C	C	R	VC	VC	F	...	VR	C	F	F	...	VR	VC	C	F	VVC	VC	VC	VC	C	VVC	C	VR	R
309.	279	„ *umbilicatula* (Mont.)	...	F	F	VC	VR	...	...	VR	C	C	F	F	VR	VVC	...	VR	...	VC	VVC	VVC	VVC	R	VR	VR	F
310.	280	„ *orbicularis*, Br.	...	...						...						1	...										

No.	Page	SPECIES.	Lowlandman's Bay, Jura. Stn. 1	Sound of Mull. Stn. 2.	Off Ardnamurchan. Stn. 3.	Loch Sunart. Stn. 4.	Soriby Bay, Ulva. Stn 5.	Atlantic Shore, Iona. Stn. 6.	Gott Bay, Tiree. Stn. 7.	Sandy Island, Canna. Stn. 8.	Laga Bay, Loch Sunart. Stn. 9.	Shiant East Bank. Stn. 10.	Loch Shell, Lewis. Stn. 11.	Loch Dunvegan, Skye. Stn. 12.	Off Neist Point, Skye. Stn. 13.	Loch Aimeart, Skye. Stn. 14.	Tobermory Bay, S. Stn 15.	Between Rhum and Eigg. Stn. 16.	Scresort Bay, Rhum. Stn. 17.	Off S. of Eigg. Stn. 18.	Croulin Beg. Stn. 19.	Between Ru Ruag and Carr Point. Stn. 20.	Loch Hourn. Stn. 21.	Oronsay. Stn. 22.	Off Bradda Head, Port Erin. Stn. 23.	Eilean Gartmael, Oronsay. Stn. 25.	Skye (var. loc.). St. 26.
311.	280	*Nonionina asterizans* (F. & M.)	...	...	...	C	C	R	VR	...	...	...	VR	...	...	...	C	...	VVC	...	...	...	...	...	1	..	
312.	230	„ *stelligera*, d'O.	...	...	...	VR	...	...	...	...	...	VR	...	VR	...	...	...	...	...	...		.	.	.			.
313.	230	„ *boueana*, d'O.	.	.		VR	.	VR	.	.	.	.	.	.	.	VR	...	.	1	R	VR	R			.		
314.	280	„ *scapha* (F. & M.)	...	1	...	VR	...	...	...	...	1	...	...	1	...	...	...	VR	VR	...	...	...	...	...	...	...	...
315.	281	„ *turgida* (Will.)	VR	C	...	VC	F	VR	...	...	C	VC	VC	F	1	VC	VR	VR	VVC	VC	C	VC	C	VR	...	...	R
316.	281	„ *pauperata*, B. & W.	...	...	...	R	...	1	...	...	1	VR	...	R	...	...	VR	VR	...	VR	...	R	F	...	F	VR	
317.	281	*Polystomella faba* (F. & M.)	...	VR	...	R	F	...	...	...	...	VR	...	VR	...	...	...	VR	...	C	...	...	...	VC	VR		.
318.	282	„ *decipiens*, Costa	...	F	VR	...	C	...	...	...	...	...	F	...	...	...	...	...	C	...	...	...	...			.	
319.	282	„ *striato-punctata* (F. & M.)	VC	R	R	VC	VC	C	C	R	VR	R	C	F	R	C	R	R	C	C	VC	R	R	C	F	VR	VR
320.	282	„ „ var. *selseyensis*, H.-A. & E.	...	...	...	VC	1	F	...	...	...	R	F	...	...	...	...	F	VC	.	.						
321.	283	„ *arctica*, P. & J.	...	...	VR	VR	...	...	...	...	...	VR	...	F	...	VR	...	1	...	...	...	VR	...	C	...	...	
322.	283	„ *macella* (F. & M.)	VR	...	VR	F	VR	F	F	F	...	VR	VR	...	...	...	F	...	C	VR	VR	VR	VR	VC	F	VR	
323.	283	„ *crispa* (Linn.)	F	VR	VR	F	R	F	F	F	VR		VVC				VVC	VR	VC	VR	VR	VC	VR	VC	VR	VR	VR
324.	283	*Operculina ammonoides* (Gron.)	1	F	...	VC	...	1	...	VR	C	VC	C	F	VR	VC	...	VR	...	C	C	VC	VVC	C	VR	VR	F
		TOTALS	90.	102.	123.	203.	88.	72.	66.	66.	113.	170.	122.	142.	87.	136.	71.	107.	109.	169.	141.	164.	94.	77.	112.	42.	94.

BIBLIOGRAPHY.

An effort has been made to reduce the synonymies prefixed to the three hundred and twenty-four species and varieties described in this Report to a minimum of space. The principle first adopted by us in the Clare Island Monograph (H.-A. & E. 1913, CI.) has therefore been followed here, and with very few exceptions the original reference to the author of a species has been given with one later and well-illustrated record. In all cases where the species is illustrated in Brady's 'Challenger' Report (B. 1884, FC.) that reference has *alone* been given in addition to the original. Where the species has not been included in, or has been diagnosed subsequently to, Brady, 1884, FC., one later reference—if possible, British—has been given.

Names of authors, titles of articles, and full bibliographical references to the Transactions and Proceedings in which they are to be found are given once and for all in this Bibliography, some lengthy titles being shortened as follows :—

QJGS. = Quarterly Journal of the Geological Society, London.
JRMS. = Journal of the Royal Microscopical Society, London.
JQMC. = Journal of the Quekett Microscopical Club, London.
MASIB. = Memorie della Reale Accademia delle Scienze dell' Instituto di Bologna.
SAWW. = Sitzungsberichte der Kaiserliche Akademie der Wissenschaften Wien. (D = Denkschrift.)
AMNH. = Annals and Magazine of Natural History.

The titles of all papers and books are indicated by initials only, after the date of publication, and the first letter of the author's name :—thus, C. 1892, PCT. = F. Chapman, 'Microzoa from the Phosphatic Chalk of Taplow,' the page, etc., only being given, and all further details being found under that initial and date in the Bibliography. In the case of long or short series of papers, the date of the first is given and the initials are followed by the year in which the paper referred to appeared : thus, M. 1898, etc., FM. 1900 = the papers of Millett's series, beginning in 1898, which were published in JRMS. in 1900.

A. 1865, NHC. T. Alcock.—Notes on Natural History Specimens lately received from Connemara. Proc. Lit. & Phil. Soc. Manchester, vol. iv. no. 45, pp. 192–208.

B. 1791, CS. A. J. G. K. Batsch.—Sechs Kupfertafeln mit Conchylien des Seesandes. Jena, 1791.

B. 1854, LG. J. G. Bornemann.—Ueber die Lias Formation in der Umgegend von Göttingen, etc. 8vo. Berlin, 1854.

B. 1855, FSH. J. G. Bornemann.—Die mikroskopische Fauna des Septarienthones von Hermsdorf bei Berlin. Zeitschr. Deutschen geol. Ges. vol. vii. pp. 307–371, pls. xii.–xxi.

B. 1864, RFS. H. B. Brady.—Contributions to our Knowledge of the Foraminifera. On the Rhizopodal Fauna of the Shetlands. Trans. Linn. Soc. (Lond.), vol. xxiv. pp. 463–475, pl. xlviii.

B. 1870, FTR. G. S. Brady, D. Robertson, & H. B. Brady.—The Ostracoda and Foraminifera of Tidal Rivers. AMNH. ser. 4, vol. vi. pp. 273–306, pls. xi., xii.

B. P. & J. 1870, GP. H. B. Brady, W. K. Parker, & T. Rupert Jones.—A Monograph of the Genus *Polymorphina*. Trans. Linn. Soc. (Lond.), vol. xxvii. pp. 197–253, pls. xxxix.–xlii.

B. 1878, RRNP. H. B. Brady.—On the Reticularian and Radiolarian Rhizopoda (Foraminifera and Polycistina) of the North-Polar Expedition of 1875–76. AMNH. ser. 5, vol. i. pp. 425–440, pls. xx., xxi.

B. 1879, etc., RRC. H. B. BRADY.—Notes on some of the Reticularian Rhizopoda of the 'Challenger' Expedition. Quart. Journ. Micr. Sci. (London), n. s., vol. xix. pp. 20–63, pls. iii.–iv.; pp. 261–299, pl. viii. Continued in vol. xxi. 1881, pp. 37–71.

B. 1880, EAM. G. BERTHELIN.—Mémoire sur les Foraminifères Fossiles de l'Étage Albien de Montcley (Doubs). Mém. Soc. Géol. France, ser. 3, vol. i. no. 5.

B. 1881, HNPE. H. B. BRADY.—Ueber einige Arktische Tiefsee-Foraminiferen, gesammelt während der österreichisch-ungarischen Nordpol-Expedition in den Jahren 1872–74. DAWW. vol. xliii. (1881), pp. 91–110, pls. i., ii.

B. 1882, BKE. H. B. BRADY.—Report on the Foraminifera, in Comm. Tizard and John Murray: Exploration of the Faroe Channel during the Summer of 1880 in H.M. Hired Ship, 'Knight Errant.' Proc. Roy. Soc. Edinb. vol. xi. pp. 708–717, pl. vi.

B. & M. 1884, FG. F. P. BALKWILL & F. W. MILLETT.—The Foraminifera of Galway. Journ. Micr. & Nat. Sci. (London), vol. iii. pp. 19–28 & 78–90, pls. i.–iv. Revision—The Recent Foraminifera of Galway, etc., by F. W. Millett (Notes and Corrections, plates re-engraved). Plymouth, 1908.

B. 1884, FC. H. B. BRADY.—Report on the Scientific Results of the Voyage of H.M.S. 'Challenger' (Zoology), vol. ix. Report on the Foraminifera, 2 vols., 4to, text and plates. London, 1884.

B. & W. 1885, DIS. F. P. BALKWILL & J. WRIGHT.—Report on some Recent Foraminifera found off the Coast of Dublin and in the Irish Sea. Trans. R. Irish Acad. vol. xxviii. (Science), pp. 317–368, pls. xii.–xiv.

B. 1887, SBRF. H. B. BRADY.—Synopsis of the British Recent Foraminifera. JRMS. (London), 1887, pp. 872–927.

B. P. & J. 1888, AB. H. B. BRADY, W. K. PARKER, & T. R. JONES.—On some Foraminifera from the Abrolhos Bank. Trans. Zool. Soc. (London), vol. xii. pp. 211–239, pls. xl.–xlvi.

C. 1848, FWB. J. CZJZEK.—Beitrag zur Kenntniss der fossilen Foraminiferen des Wiener Beckens. Haidinger's Naturw. Abh. (Vienna), vol. ii. pp. 137–150, pls. xii., xiii.

C. 1853, etc., PRN. O. G. COSTA.—Paleontologia del Regno di Napoli, pt. ii. (25 Aug., 1850). Atti Acc. Pontaniana (Naples), vol. vii. pt. i. (pub. 1856), fasc. i. 1853, pp. 105–112; fasc. ii. 1856, pp. 113–378, pls. ix.–xxvii.

C. 1855, FFMV. O. G. COSTA.—(i.) Foraminiferi Fossili della Marna Blú del Vaticano. (ii.) Foraminiferi Fossili delle Marne Terziarie di Messina. Mem. Acc. Sci. (Naples), vol. ii. 1857, pp. 113–147, pls i., ii., and pp. 367–373, pl. iii.

C. P. & J. 1862, IF. W. B. CARPENTER, W. K. PARKER, & T. R. JONES.—Introduction to the Study of the Foraminifera. London (Ray Society), 1862.

C. 1892, FS. G. W. CHASTER.—Report upon the Foraminifera of the Southport Society of Natural Science District. First Report Southport Soc. Nat. Sci. 1890–91 (Southport, 1892), pp. 54–72, pl. i.

C. 1910, etc., FNP. J. A. CUSHMAN.—A Monograph of the Foraminifera of the North Pacific Ocean. U.S. Nat. Museum Bull. 71, pt. i. 1910 ; pt. ii. 1911 ; pt. iii. 1913 ; pt. iv. 1914 ; pt. v. 1915. (*In progress.*)

C. 1913, FHH. F. CHAPMAN.—On some Foraminifera from the Eocene Beds of Hengistbury Head, Hampshire. Geol. Mag. dec. 5, vol. x. 1913, pp. 555–9 (figs.).

E. 1841, SNA. C. G. EHRENBERG.—Verbreitung und Einfluss des mikroscopischen Lebens in Süd- und Nord-Amerika. Abh. d. kgl. Akad. Wiss. (Berlin), 1843 (for 1841), pp. 291–446, pls. i.–iv., and Bericht, pp. 139–142, with Appendix, pp. 202–209.

E. 1843, MMO. C. G. EHRENBERG.—Neue Beobachtungen über den sichtlichen Einfluss de Mikroscopischen Meeres Organismen, auf Boden des Elb-bettes bis oberhalb Hamburg (Berlin), 1843, pp. 161–167.

E. 1854, M. C. G. Ehrenberg.—Mikrogeologie. Das Wirken des unsichtbaren kleinen Lebens auf der Erde. Leipzig, 1854.

E. 1857, MSO. J. G. Egger.—Die Foraminiferen der Miocän-Schichten bei Ortenburg in Nieder-Bayern. Neues Jahrb. für Min. etc. (Stuttgart), 1857, pp. 266–311, pls. v.–xv.

E. 1861, DSI. C. G. Ehrenberg.—Ueber Tiefgrund Verhältnisse des Oceans am Eingange der Davisstrasse und bei Island. Monatsb. K. preuss. Ak. Wiss. Berlin, 1861 (1862), pp. 275–315.

E. 1893, FG. J. G. Egger.—Foraminiferen aus Meeresgrundproben gelothet von 1874 bis 1876 von S.M.Sch. 'Gazelle.' Abhandl. k. bayerisch Ak. d. Wiss. (Munich), ii. Cl. vol. xviii. pt. 2, pp. 195–458, pls. i.–xxi.

E. 1905, FBS. A. Earland.—The Foraminifera of the Shore Sand at Bognor, Sussex. JQMC. (London), ser. 2, vol. ix. no. 57, pp. 187–232.

F. & M. 1798, TM. L. von Fichtel & J. P. C. von Moll.—Testacea Microscopica aliaque minuta ex generibus Argonauta et Nautilus ad naturam picta et descripta . . . . cum 24 tabulis aeri incisis coloratis. Vienna, 1798 ; Second issue, 1803.

F. 1883, FPS. C. Fornasini.—Nota preliminare sui Foraminiferi della marna pliocenica del Ponticello di Savena nel Bolognese. Boll. Soc. Geol. Ital. vol. ii. fasc. 2, 1883, pp. 176–190, pl. ii.

F. 1888, TP. C. Fornasini.—Tavola Paleo-Protistographica. Boll. Soc. Geol. Ital. vol. vii. fasc. i. 1888, pp. 145–149, pl. iii.

F. 1896, TC. C. Fornasini.—Di alcune forme Plioceniche della *Textilaria candeiana* e della *T. concava*. MASIB. ser. 5, vol. vi. pp. 3–8.

F. 1897, FIC. C. Fornasini.—Intorno ad alcuni Foraminiferi illustrati da O. G. Costa. Rend. Sess. R. Ist. Bologna, 14 Nov., 1897, vol. ii. pp. 15–19, pl. ii.

F. 1898, RFI. C. Fornasini.—Indice Ragionato de le Rotaline Fossili d'Italia. MASIB. ser. 5, vol. vii. pp. 239–290.

F. 1899, PFI. C. Fornasini.—Le Polistomelline Fossili d'Italia. MASIB. ser. 5, vol. vii. pp. 639–660.

F. 1901, BCI. C. Fornasini.—Le Bulimine e le Cassiduline Fossili d'Italia. Boll. Soc. Geol. Ital. vol. xx. (1901), pp. 159–214 (figs.).

G. 1781, ZG. L. T. Gronovius.—Zoophylacium Gronovianum exhibens Animalia Quadrupeda, etc. Leyden, 1781.

G. 1894, ASF. A. Goës.—A Synopsis of the Arctic and Scandinavian recent Marine Foraminifera hitherto discovered. Kongl. Svenska Vetensk.-Ak. Handl. Stockholm, vol. xxv. no. 9.

H. 1875, CSS. M. von Hantken.—Die Fauna der Clavulina Szaboi Schichten.—I. Foraminiferen. Mitth. Jahrb. ungarisch geolog. Anst. (Buda Pesth), vol. iv. 1875 (1881), pp. 1–93, pls. i.–xvi.

H. 1889, RFJ. E. Halkyard.—Recent Foraminifera of Jersey. Trans. Manchester Micr. Soc. pp. 55–72, pls. i., ii.

H.-A. & E. 1908, etc., SB. E. Heron-Allen & A. Earland.—The Recent and Fossil Foraminifera of the Shore Sands at Selsey Bill, Sussex. JRMS. 1908, pp. 529–543 ; 1909, pp. 306–336 ; 1909, pp. 422–446 ; 1909, pp. 677–698 ; 1910, pp. 401–426 ; 1910, pp. 693–695 ; 1911, pp. 298–343 ; 1911, pp. 436–448.

H.-A. & E. 1912, etc., NSG. E. Heron-Allen & A. Earland.—On some Foraminifera from the North Sea, dredged by the Fisheries Cruiser 'Goldseeker' (International North Sea Investigations—Scotland). JRMS. No. 1, 1912, pp. 382–389, pls. v.–vii. ; No. 2, 1913, pp. 1–26, pls. i.–iv. ; No. 3, 1913, pp. 272–276, pl. xii.

H.-A. & E. 1913, CI. E. HERON-ALLEN & A. EARLAND.—Clare Island Survey: Pt. 64. Foraminifera. Proc. R. Irish Acad. vol. xxxi. pt. 64.

H.-A. & E. 1913, NSH. E. HERON-ALLEN & A. EARLAND.—On some Foraminifera from the North Sea dredged by the F.C. 'Huxley,' etc. JQMC. ser. 2, vol. xii. pp. 121–138, pls. x., xi.

H.-A. & E. 1914, etc., FKA. E. HERON-ALLEN & A. EARLAND.—On the Foraminifera of the Kerimba Archipelago, etc. Trans. Zool. Soc. London, Part I., vol. xx. 1914, pp. 363–390, pls. xxxv.–xxxvii.; Part II., vol. xx. 1915, pp. 543–794, pls. xl.–liii.

J. & P. 1860, RFM. T. RUPERT JONES & W. K. PARKER.—On the Rhizopodal Fauna of the Mediterranean compared with that of the Italian and some other Tertiary Deposits. QJGS. vol. xvi. pp. 292–307, & table.

J. P. & B. 1866, etc., MFC. T. R. JONES, W. K. PARKER, H. B. BRADY, and others.—A Monograph of the Foraminifera, of the Crag. London, 1866–1897 (Palæontographical Soc.). Pt. I. 1866, pp. 1–72; Pt. II. 1895, pp. 73–210; Pt. III. 1896, pp. 211–314; Pt. IV. 1897, pp. 315–402.

K. 1867, FO. F. KARRER.—Zur Foraminiferenfauna in Oesterreich. Sitzb. k. Ak. Wiss. Wien, vol. lv. Abth. i. pp. 331–368, pls. i.–iii.

K. 1868, MFKB. F. KARRER.—Die Miocene Foraminiferenfauna von Kostej im Banat. SAWW. vol. lviii. Abth. i. pp. 111–193, pls. i.–v.

L. 1767, etc., SN. C. VON LINNÉ.—Systema naturae sive regna tria naturae, etc. Edn. xii. Leipzig, 1767. Edn. xiii., by J. F. Gmelin, 10 vols., Leipzig, 1788–93.

L. 1804, AM. J. B. P. A. DE M. DE LAMARCK.—Suite des Mémoires sur les Fossiles des Environs de Paris. (Explication des Planches rélatives aux Coquilles Fossiles des Environs de Paris.) Annales du Muséum (Paris), vol. v. pp. 179–180, 237–245, 349–357. Continued in vol. viii. 1806, pp. 383–387, pl. lxii., and vol. ix. 1807, pp. 236–240, pl. xvii.

M. 1803–8, TB. G. MONTAGU.—Testacea Britannica, or Natural History of British Shells. In 3 vols., 4to. London, 1803. Supplement (Plates), 1808.

M. 1808–10, CS. D. DE MONTFORT.—Conchyliologie Systématique et Classification Méthodique des Coquilles, etc. 2 vols. Paris, 1808–10.

M. 1843, HMAA. W. MACGILLIVRAY.—A History of the Molluscous Animals of the Counties of Aberdeen, etc. London, 1843.

M. 1898, etc., FM. F. W. MILLETT.—Report on the recent Foraminifera of the Malay Archipelago contained in anchor-mud, collected by Mr. A. Durrand, F.R.M.S. JRMS. 1898, pp. 258–269, 499–513, 607–614; 1899, pp. 249–255, 357–365, 557–564; 1900, pp. 6–13, 273–281, 539–549; 1901, pp. 1–11, 485–497, 619–628; 1902, pp. 509–528; 1903, pp. 253–275, 685–704; 1904, pp. 489–506, 597–609.

N. 1856, OLS. J. L. NEUGEBOREN.—Die Foraminiferen aus der Ordnung der Stichosteger von Ober-Lapugy in Siebenburgen. DAWW. vol. xii. 1856, pp. 65–100, pls. i.–v.

d'O. 1826, TMC. A. D. D'ORBIGNY.—Tableau Méthodique de la Classe de Céphalopodes. Ann. Sci. Nat. (Paris), vol. vii. pp. 245–314, pls. x.–xvii.

d'O. 1826 (Modèles). A. D. D'ORBIGNY.—Modèles de Céphalopodes Microscopiques vivants et fossiles, représentant un individu de chacun des genres et des sous-genres de ces Coquilles. Paris, 1826. (2nd edn., 1843.)

d'O. 1839, FAM. A. D. D'ORBIGNY.—Voyage dans l'Amérique Méridionale. Vol. v. pt. 5. Foraminifères. Paris, 1839.

d'O, 1839, FC. A. D. D'ORBIGNY.—Foraminifères. In Ramon de la Sagra: Histoire Physique, Politique et Naturelle de l'Ile de Cuba. Text 8vo and Plates fol. Paris, 1839.

d'O, 1839, FIC. A. D. d'Orbigny.—Foraminifères. In Barker-Webb & Berthelot: Histoire Naturelle des Iles Canaries, vol. ii. pt. 2, pp. 119–146, 3 pls. Paris, 1839.

d'O. 1840, CBP. A. D. d'Orbigny.—Mémoire sur les Foraminifères de la Craie Blanche du Bassin de Paris. Mém. Soc. Géol. France, vol. iv. pp. 1–51, pls. i.–iv.

d'O. 1846, FFV. A. D. d'Orbigny.—Foraminifères Fossiles du Bassin Tertiaire de Vienne. 4to, 21 plates. Paris, 1846.

O. 1867, SFMO. S. J. R. Owen.—On the Surface-Fauna of Mid-Ocean. No. 2. Foraminifera. Journ. Linn. Soc. (Lond.), Zoology, vol. ix. pp. 147–157, pl. v.

P. 1844, EMS. R. A. Philippi.—Enumeratio Molluscorum Siciliae cum viventium tum in tellure tertiaria fossilium. Vol. ii. Halle (Halis Saxorum), 1844.

P. & J., etc., 1859, etc., NF.—W. K. Parker, T. R. Jones, H. B. Brady, & J. W. Kirkby.—On the Nomenclature of the Foraminifera. AMNH. 1860, no. 4, ser. 3, vol. v. pp. 285, 466 ; vol. vi. p. 29.

P. & J. 1865, NAAF. W. K. Parker & T. R. Jones.—On some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin's Bay. Phil. Trans. Roy. Soc. (London), vol. clv. pp. 325–441, pls. xii.–xix.

P. 1890, FC. F. G. Pearcey.—Notes on the Foraminifera of the Faroe Channel and Wyville Thomson Ridge. Trans. Nat. Hist. Soc. Glasgow, vol. ii. N.S. (Pt. 2, 1887–88) p. 163.

R. 1838, NTM. F. A. Roemer.—Die Cephalopoden des norddeutschen tertiären Meeressandes. Neues Jahrb. für Min. etc. (Stuttgart), 1838, pp. 381–394, pl. iii.

R. 1845–6, VBK. A. R. Reuss.—Die Versteinerungen der böhmischen Kreideformation. Stuttgart, 4to, 1845–46.

R. 1849–50, FOT. A. E. Reuss.—Neue Foraminiferen aus den Schichten des oesterreichischen Tertiärbeckens. DAWW. vol. i. 1850, pp. 365–390, pls. xlvi.–li.

R. 1851, FKL. A. E. Reuss.—Die Foraminiferen und Entomostraceen des Kreidemergels von Lemberg. Haidinger's Naturw. Abhandl. vol. iv. pp. 17–52, pls. viii., ix.

R. 1851, FSUB. A. E. Reuss.—Ueber die Fossilen Foraminiferen etc. der Septarienthone der Umgegend von Berlin. Zeitschr. Deutschen geol. Ges. (Berlin), vol. iii. pp. 49–92, pls. iii.–vii.

R. 1855, KKM. A. E. Reuss.—Ein Beitrag zur genaueren Kenntniss der Kreidegebilde Meklenburgs. Zeitschr. Deutschen geol. Ges. (Berlin), vol. vii. pp. 261–292, pls. viii.–xi.

R. 1855, TNMD. A. E. Reuss.—Beiträge zur Charakteristik der Tertiärschichten des nördlichen und mittleren Deutschlands. SAWW. vol. xviii. pp. 197–273, pls. i.–xii.

R. 1858, FP. A. E. Reuss.—Ueber die Foraminiferen von Pietzpuhl. Zeitschr. Deutschen geol. Ges. vol. x. pp. 433–438.

R. 1862, NHG. A. E. Reuss.—Die Foraminiferen des norddeutschen Hils und Gault. SAWW. Math.-nat. Kl. vol. xlvi. Abth. i. (1863), pp. 5–100, pls. i.–xiii.

R. 1862, FFL. A. E. Reuss.—Die Foraminiferen-Familie der Lagenideen. SAWW. vol. xlvi. Abth. i. 1862 (1863), pp. 305–342, pls. i.–vii.

R. 1863, KTF. A. E. Reuss.—Beiträge zur Kenntniss der tertiären Foraminiferen-fauna. (Zweite Folge.) III. Die Foraminiferen des Septarienthones von Offenbach. IV. Die Foraminiferen des Septarienthones von Kreuznach. SAWW. vol. xlviii. (1864), pp. 36–71, pls. i–viii.

R. 1863, FCA. A. E. Reuss.—Les Foraminifères du Crag d'Anvers. Bull. Ac. Roy. Belge (Brussels), ser. 2, vol. xv. pp. 137–162, pls. i.–iii.

R. 1865–6, FABS. A. E. Reuss.—Die Foraminiferen, Anthozoen und Bryozoen des Deutschen Septarienthones. DAWW. vol. xxv. pp. 117–204, pls. i.–xi.

R. 1870, FSP. A. E. Reuss.—Die Foraminiferen des Septarienthones von Pietzpuhl. SAWW. vol. lxii. Abth. i. pp. 455–493. Plates, see S. 1870, FSP.

S. 1854, OP. M. S. Schultze.—Ueber den Organismus der Polythalamien (Foraminiferen) nebst Bemerkungen über die Rhizopoden in Allgemeinen. Leipzig, 1854.

S. 1862, FMMM. G. Seguenza.—Descrizione dei Foraminiferi Monotalamici delle Marne Mioceniche del Distretto di Messina. Messina, 1862.

S. 1862, RPC. G. Seguenza.—Prime Ricerche intorno ai Rhizopodi fossili delle Argille Pleistoceniche dei dintorni di Catania. Att. Accad. Gioenia Sci. Nat. ser. 2, vol. xviii. 1862, pp. 85–126, pls. i.–iii. (Catania).

S. 1866, FKN. C. Schwager.—Fossile Foraminiferen von Kar Nicobar. Novara-Expedition. Geologisches Theil, vol. ii. pp. 187–268, pls. iv.–vii. Vienna, 1866.

S. 1868, LUHD. M. Sars.—Fortsatte Bemaerkninger over det dyriske Livs Udbredning i Havets Dybder. Vorh. Vidensk. Selsk. Christiania (1869), pp. 246–275; AMNH. (London), ser. 4, vol. iii. pp. 423–444.

S. 1870, FSP. E. von Schlicht.—Die Foraminiferen des Septarienthones von Pietzpuhl. Berlin, 1870.

S. 1872, NFVI. O. Silvestri.—Le Nodosarie fossili nel Terreno subappenino Italiano, e viventi nei mari d'Italia. Monografia delle Nodosarie. Atti Acc. Gioenia di Sci. Nat. (Catania), ser. 3, vol. vii. pp. 1–108, pls. i.–xi.

S. 1874, R. F. E. Schulze.—Zoologische Ergebnisse der Nordseefahrt vom 21. Juli bis 9. September, 1872. I. Rhizopoden. II. Jahresb. Komm. Untersuch. der deutschen Meere in Kiel (Berlin), pp. 99–114, pl. ii.

S. 1878, FRD. J. D. Siddall.—The Foraminifera of the River Dee. Proc. Chester Soc. Nat. Sci. pt. ii. pp. 42–56.

S. 1879–80, FTR. G. Seguenza.—Le Formazioni Terziarie nella Provincia di Reggio (Calabria). Atti Acc. Lincei (Rome), ser. 3, vol. vi. pp. 1–446, pls. i.–xvii.

S. 1886, LMBC. J. D. Siddall.—Report on the Foraminifera of the L(iverpool) M(arine) B(iology) C(ommittee) District. LMBC. Report No. 1. Proc. Lit. Phil. Soc. Liverpool, No. xl. Appendix, pp. 42–71, pl. i.

S. 1891, BGF. C. Schlumberger.—Revision des Biloculines des Grands Fonds. Mém. Soc. Géol. France, vol. iv. pp. 542–579 (pp. 155–198 in the Reprints), pls. ix.–xii.

S. 1893. MGM. C. Schlumberger.—Monographie des Miliolidées du Golfe de Marseilles. Mém. Soc. Zool. France, vol. vi. pp. 57–80 (pp. 199–228 in reprints), pls. ii.–iv.

S. 1900, FPNT. A. Silvestri.—Fauna Protistologica Neogenica dell' alta valle Tiberina. Mem. Acc. Nuovi Lincei, vol. xvii. pp. 233–306, pl. vi.

S. 1902, LMT. A. Silvestri.—Lagenine del Mar Tirreno. Memorie della Pont. Accademia dei Nuovi Lincei (Rome), vol. xix. pp. 133–172.

S. 1903, S. A. Silvestri.—Dimorfismo e nomenclatura d'una Spiroplecta. Atti Acc. Romana dei Nuovi Lincei, Ann. lvi. sess. iii., Feb. 1903, pp. 8.

S. 1904, etc., RFD. H. Sidebottom.—Report on the Recent Foraminifera from the Coast of the Island of Delos (Grecian Archipelago). Mem. Manchester Lit. Phil. Soc. (Manchester), pt. i., vol. xlviii. 1904, no. 5; pt. ii., vol. xlix. 1905, no. 5; pt. iii., vol. l. 1906, no. 5; pt. iv., vol. li. 1907, no. 9; pt. v., vol. lii. 1908, no. 13; pt. vi., vol. liii. 1909, no. 21.

S. 1904, TB. A. Silvestri.—Richerche strutturali su alcune forme dei Trubi di Bonfornello (Palermo). Mem. Pont. Acc. Nuovi Lincei, vol. xxii. pp. 235–276, figs.

S. 1912, etc., LSP. H. Sidebottom.—Lagenæ of the South-West Pacific Ocean, from Soundings taken by H.M.S. 'Waterwitch,' 1895. JQMC. ser. 2, vol. xi. no. 70, pp. 375–434, pls. xiv.–xxi. Supplementary Paper: JQMC. ser. 2, vol. xii. 1913, no. 73, pp. 161–210, pls. xv.–xviii.

T. 1875, etc., APD. O. Terquem.—Essai sur le Classement des Animaux qui vivent sur la Plage et dans les Environs de Dunkerque. Paris, pt. 1, 1875, pp. 1–54, pls. i.–vi.; pt. 2, 1876, pp. 55–100, pls. vii.–xii.; pt. 3, 1881, pp. 101–152, pls. xiii.–xvii.

T. & B. 1875, LME. O. Terquem & G. Berthelin.—Etudes Microscopiques des Marnes du Lias Moyen d'Essey-les Nancy. Mém. Soc. Géol. France, sér. 2, vol. x. Mém. 3.

T. & B. 1876, YL. R. Tate & J. F. Blake.—The Yorkshire Lias. London, 8vo, 1876.

T. 1878, FIR. O. Terquem.—Les Foraminifères, etc. du Pliocène Supérieur de l'Ile de Rhodes. Mém. Soc. Géol. France, sér. 3, vol. i. Mém. 3.

T. 1882, FEP. O. Terquem.—Les Foraminifères de l'Eocène des Environs de Paris. Mém. Soc. Géol. France, sér. 3, vol. ii. Mém. 3.

W. & B. 1784, TMR. G. Walker & W. Boys.—Testacea Minuta Rariora, etc. London, n. d. [1784].

W. & J. 1798, AEM. G. Walker & E. Jacob.—In G. Adams: Essays on the Microscope. F. Kanmacher's (2nd) Edition. (Plates copied from W. & B. 1784, and named by E. Jacob.) London, 1798.

W. 1848, BSGL. W. C. Williamson.—On the Recent British Species of the Genus *Lagena*. AMNH. ser. 2, vol. i. pp. 1–20, pls. i., ii.

W. 1858, RFGB. W. C. Williamson.—On the Recent Foraminifera of Great Britain. London, 1858 (Ray Society).

W. 1880, NEI. J. Wright.—The Post-Tertiary Foraminifera of the North-east of Ireland. Proc. Belfast Nat. Field Club, 1879–1880. Appendix, pp. 149–163.

W. 1880–81, SD. J. Wright.—Foraminifera found during the Belfast Nat. Field Club's Excursion to S. Donegal, 1880. Proc. Belfast Nat. Field Cl., Appendix vi., 1880–81, pp. 179–187, pl. viii.

W. 1885–86, BLP. J. Wright.—Foraminifera of the Belfast Naturalists' Field Club's Cruise off Belfast Lough in the Steam Tug 'Protector,' June, 1885; also, Foraminifera found by Dr. Malcomson at Rockport, Belfast Lough. Rep. Belfast Nat. Field Club, 1885–86, Appendix, pp. 317–325, pl. xxvi.

W. 1886, SWI. J. Wright.—Report on the Marine Fauna of the South-west of Ireland—Foraminifera. Proc. Roy. Irish Acad. ser. 2, vol. iv. (1887) (Science), pp. 607–614.

W. 1889, SWI. J. Wright.—Report of a Deep-Sea Trawling Cruise off the S.W. Coast of Ireland. AMNH. ser. 6, vol. iv. p. 447.

W. 1891, SWI. J. Wright.—Report on the Foraminifera obtained off the South-west of Ireland during the Cruise of the 'Flying Falcon,' 1888. Proc. Roy. Irish Acad. ser. 3, vol. i. no. 4, pp. 460–502, pl. xx.

W. 1900, DBC. J. Wright.—The Foraminifera of Dog's Bay, Connemara. Irish Naturalist, vol. ix. 1900, pp. 51–55, pl. ii.

W. 1902, FRI. J. Wright.—Some Foraminifera from Rathlin Island. Irish Naturalist, vol. xi. pp. 211–213, pl. iii.

W. 1902, GFL. J. Wright.—Foraminifera. In T. M. Reade: Glacial and Post-Glacial Features of the Lower Valley of the River Lune and its Estuary, with List of Foraminifera. Proc. Liverpool Geol. Soc. vol. ix. pp. 163–196, pls. xi.–xiii.

W. 1910–11, BCNI. J. Wright.—Boulder Clays from the North of Ireland, with Lists of Foraminifera. Proc. Belfast Nat. Field Club, ser. 2, vol. iii. Appendix no. 1, pl. i.

W. 1910–11, ECM. J. Wright.—Foraminifera from the Estuarine Clays of Magheramorne, Co. Antrim, and Limavady Station (Junction), Co. Derry, Rep. Belfast Nat. Field Club, ser. 2, vol. iii. no. 6, Appendix no. 6, pp. 11–20, pl. ii.

W. 1913, FAR. H. Wiesner.—Notizen über die Fauna der Adria bei Rovigno. Zool. Anz. vol. xli. no. 11, pp. 521–528.

EXPLANATION OF THE PLATES.

Plate 39.

Figs. 1–3. *Spiroloculina acutimargo*, Brady, var. *concava*, Wiesner. Fig. 1. Superior or convex surface. Fig. 2. Inferior or concave surface. Fig. 3. Edge view. × 113.

Figs. 4–6. *Miliolina bucculenta*, Brady. Fig. 4. Front view. Fig. 5. Dorsal view. Fig. 6. Oral view. × 48.

Figs. 7–9. *Miliolina suborbicularis* (d'Orbigny). Fig. 7. Front view. Fig. 8. Dorsal view. Fig. 9. Edge or oral view. × 64.

Figs. 10–18. *Miliolina pygmæa* (Reuss). (i.) Milioline type. Fig. 10. Young specimen. Figs. 11–15. Various stages, side views. Fig. 16. Oral view. (ii.) Spiroloculine type. Fig. 17. Side view. Fig. 18. Oral view. × 113.

Figs. 19–27. *Miliolina candeiana* (d'Orbigny). Figs. 19, 20. Young or Spiroloculine form. Fig. 21. Transition from Spiroloculine to Milioline form. Fig. 22. Oral view of young Milioline form. Fig. 23. Ditto. Edge view. Fig. 24. Adult Milioline form. Front view. Fig. 25. Ditto. Dorsal view. Fig. 26. Ditto. Edge view. Fig. 27. Ditto. Oral view. × 113.

Figs. 28–31. *Miliolina stelligera* (Schlumberger). Fig. 28. Dorsal view. Fig. 29. Edge view. Fig. 30. Front view. Fig. 30. Oral (or apical) view. × 113.

Figs. 32–34. *Planispirina sigmoidea*, Brady. Figs. 32, 33. Side views. Fig. 34. Oral (or apical) view. × 113.

Plate 40.

Figs. 1–9. *Miliolina ferussacii* (d'Orbigny). Figs. 1–3. Front views, various stages of growth. Figs. 4–6. Dorsal view, ditto. Figs. 7–8. Edge views. Fig. 9. Oral view. Figs. 1, 2, 6, 9, × 48. Figs. 4, 7, × 64. Figs. 3, 5, 8, × 30.

Figs. 10, 11. *Cornuspira angigyra* (Reuss). Fig. 10. Side view. Fig. 11. Edge view. × 113.

Figs. 12, 13. *Haplophragmium canariense* (d'Orbigny). Abnormal specimen. × 64.

Fig. 14. *Haplophragmium pseudospirale* (Williamson). × 113.

Figs. 15–18. *Haplophragmium runianum*, sp. nov. Fig. 15. Side view. Fig. 16. Ditto, showing traces of septation. Fig. 17. Edge view. Fig. 18. Optical section; Balsam mount, showing septa of varying thicknesses. Figs. 15, 16, 17, × 113. Fig. 18, × 150.

Figs. 19–21. *Trochammina nitida*, Brady. Fig. 19. Superior view. Fig. 20. Inferior view. Fig. 21. Edge (oral) view. × 113.

Figs. 22, 23. *Textularia concava*, var. *heterostoma*, Fornasini. Fig. 22. Side view. Fig. 23. Edge (oral) view. × 64.

Plate 41.

Figs. 1, 2. *Textularia candeiana*, d'Orbigny. Fig. 1. Side view. Fig. 2. Edge (oral) view. × 64.

Fig. 3. *Bulimina echinata*, d'Orbigny. × 113.

Figs. 4–9. *Bulimina elegans*, var. *exilis*, Brady. Figs. 4, 5, 9, showing aperture. × 113.

Figs. 10–14. *Bolivina textilarioides*, Reuss. Figs. 10–12. Side views. Fig. 13. Side view of strongly limbate specimen. Fig. 14. Edge view. × 113.

Fig. 15. *Bolivina beyrichi*, Reuss. × 150.

Fig. 16. *Lagena hispida*, Reuss. × 170.

Figs. 17, 18. *Lagena costata* (Williamson). Fig. 17. Side view. Fig. 18. Oral view. × 150.

Figs. 19, 20. *Lagena spumosa,* Millett. Fig. 20. External shell broken away, showing internal structure. × 150.

Figs. 21, 22. *Lagena semilineata,* Wright. × 113.

Figs. 23, 24. *Lagena lævigata* (Reuss). × 150.

Fig. 25. *Lagena falcata,* Chaster. Short form. × 160.

Fig. 26. *Lagena marginata* (Walker & Boys). × 113.

Fig. 27. *Lagena pulchella,* var. *hexagona,* var. nov. × 113.

Figs. 28, 29. *Lagena lacunata,* Burrows & Holland. × 113.

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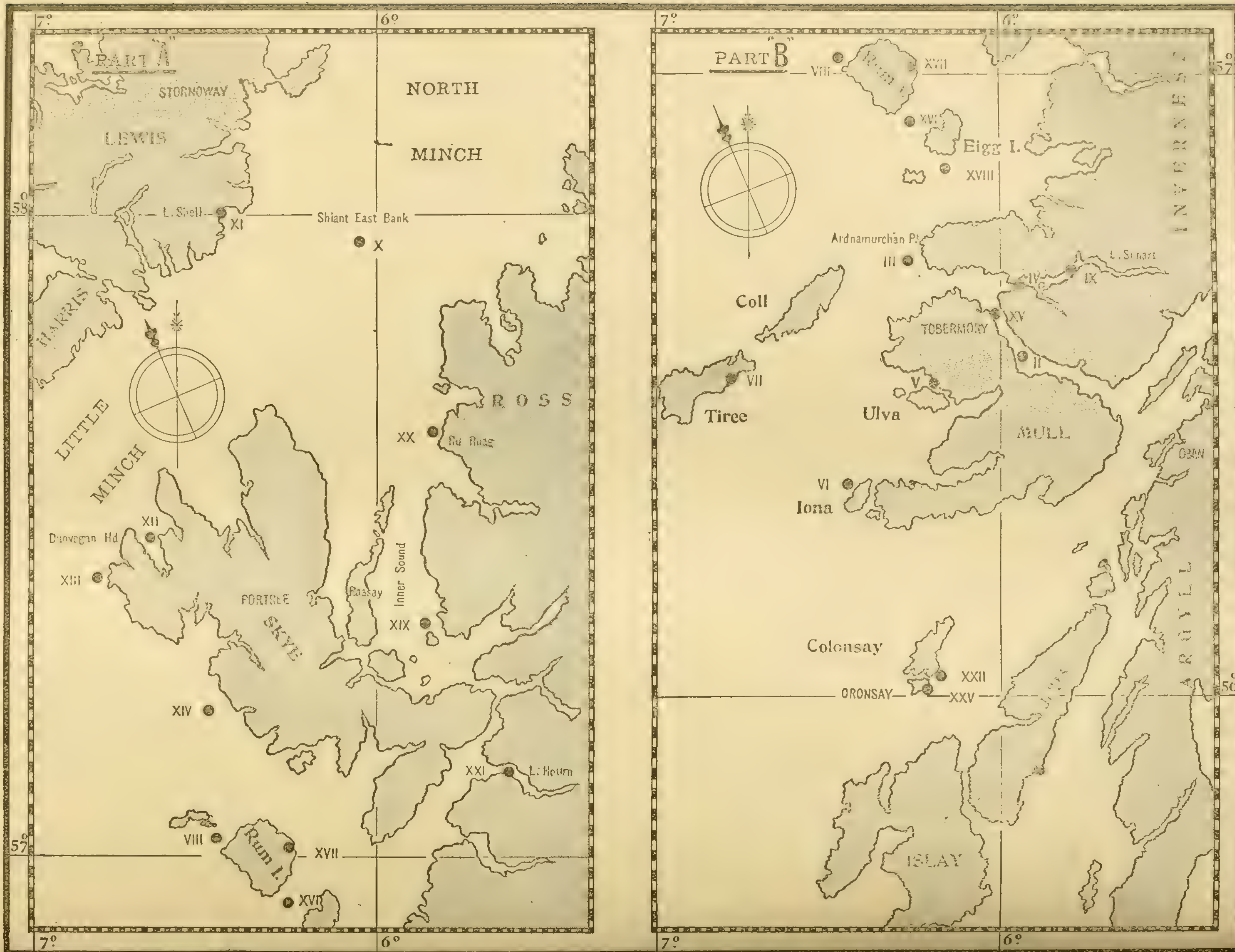
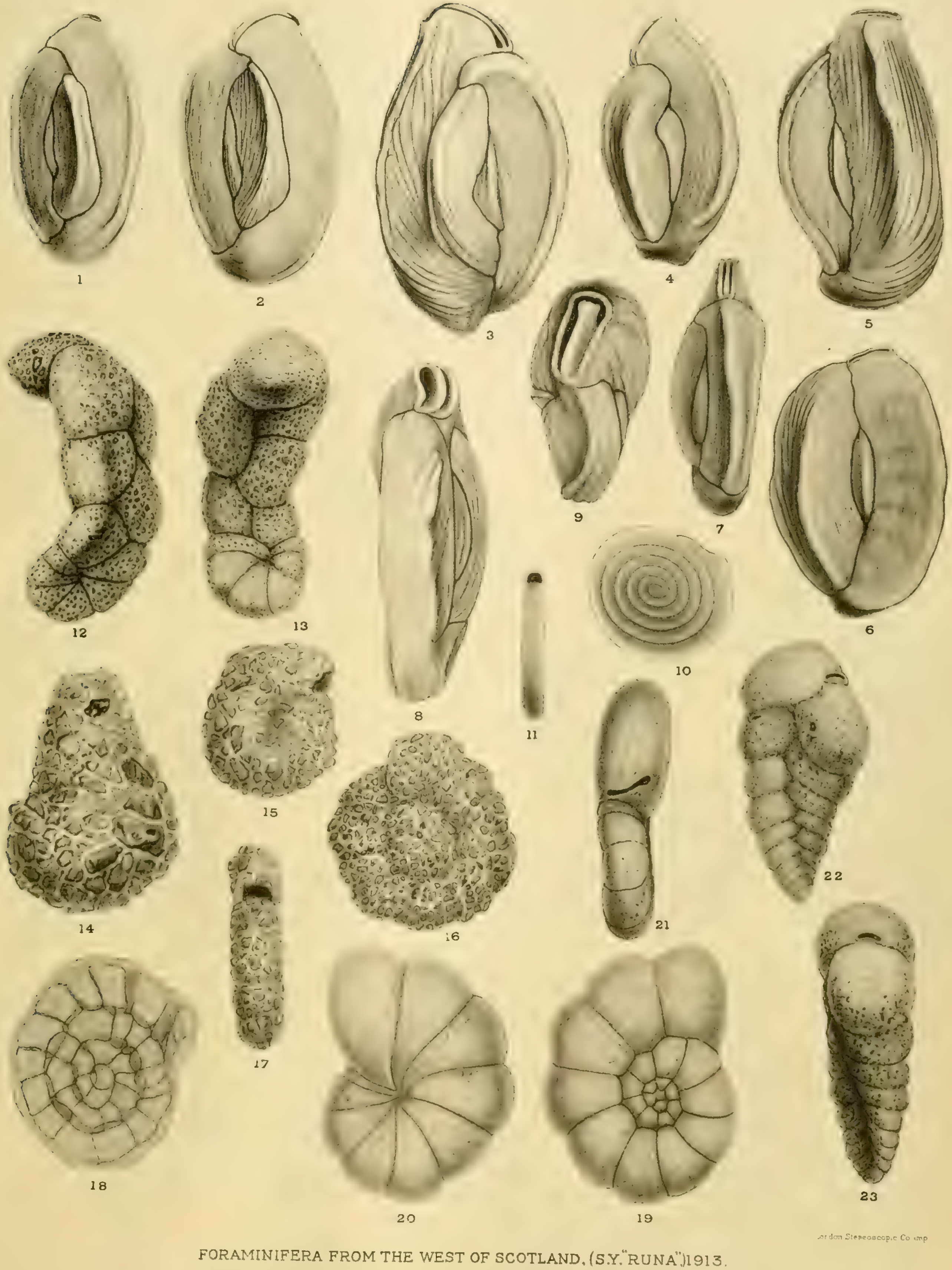


MAP SHOWING COLLECTING-STATIONS OF S.Y. 'RUNA,' 1913.

FORAMINIFERA FROM THE WEST OF SCOTLAND, (S.Y. "RUNA") 1913



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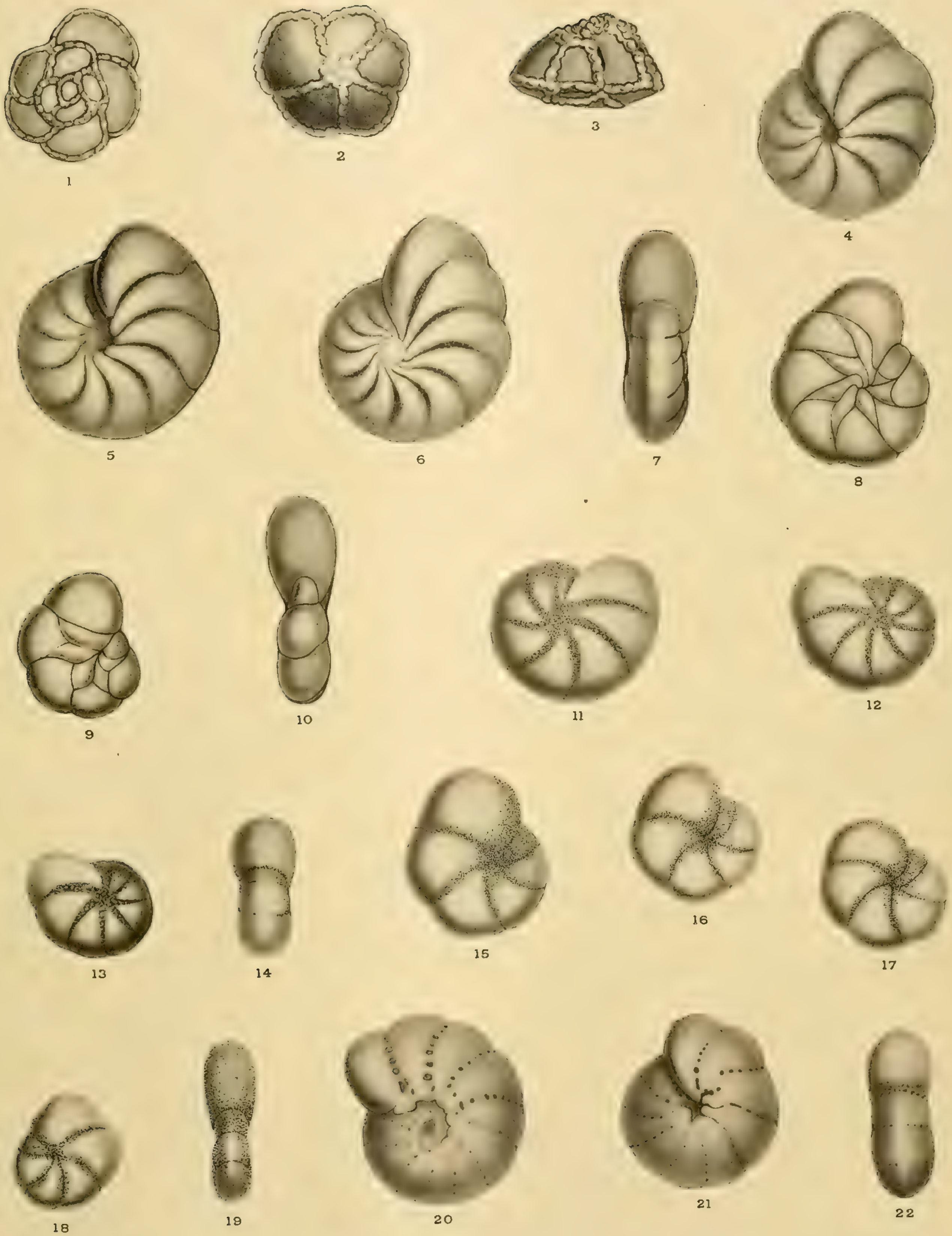

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INDEX.

[NOTE.—Synonyms and Native Names are printed in *italics*. A star * is added to names which appear to be used for the first time.]

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2nd Ser. ZOOLOGY.] [VOL. XI. PART 1.

THE TRANSACTIONS OF THE LINNEAN SOCIETY OF LONDON.

ON KOONUNGA CURSOR, A REMARKABLE NEW TYPE OF MALACOSTRACOUS CRUSTACEANS.

BY

O. A. SAYCE, Melbourne University.

(*Communicated, with a Supplementary Note, by* W. T. Calman, D.Sc., F.L.S.)

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	Part V.	1887.	0	8	0	0	6	0
	Part VI.	1888.	0	6	0	0	4	6
IV.	Part I.	1886.	1	4	0	0	18	0
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	Part III.	1888.	0	16	0	0	12	0
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	Part II.	1888.	0	5	0	0	3	9
	Part III.	1889.	1	7	0	1	0	0
	Part IV.	1890.	0	12	0	0	9	0
	Part V.	1890.	0	6	0	0	4	6
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	Part III.	1894.	0	10	0	0	7	6
	Part IV.	1896.	1	4	0	0	18	0
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VII.	Part I.	1896.	0	10	0	0	7	6
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	Part XIII.	Index.	0	2	9	0	2	3
IX.	Part I.	1903.	0	9	0	0	6	9
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	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905.	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Index (in preparation).							
XI.	Part I.	1908.	0	4	0	0	3	0
	(In Progress).							
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0

2nd Ser. ZOOLOGY.] [VOL. XI. PART 2.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

ON SOME NEW ALCYONARIA FROM THE INDIAN AND PACIFIC OCEANS, WITH A DISCUSSION OF THE GENERA *SPONGODES, SIPHONOGORGIA, CHIRONEPHTHYA*, AND *SOLENOCAULON*.

BY

RUTH M. HARRISON, Lady Margaret Hall, Oxford.

(*Communicated, with a Prefatory Note, by* Prof. G. C. BOURNE, M.A., D.Sc., F.L.S.)

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	Part VI.	1888.	0	6	0	0	4	6
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V.	Part I.	1888.	0	12	0	0	9	0
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VI.	Part I.	1894.	2	0	0	1	10	0
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	Part XIII.	1907.	0	6	0	0	4	6
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X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
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XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
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THE

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NOTES ON SOME PARASITIC COPEPODA;

WITH A DESCRIPTION OF A NEW SPECIES OF *CHONDRACANTHUS*.

BY

MAY E. BAINBRIDGE, B.Sc., F.L.S.

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	Part IV.	1890.	0	12	0	0	9	0
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VI.	Part I.	1894.	2	0	0	1	10	0
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	Part II.	1900.	0	10	0	0	7	6
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	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3
IX.	Part I.	1903.	0	9	0	0	6	9
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	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905.	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII. (In progress.)	1907.	0	4	0	0	3	0
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909	0	8	0	0	6	0
	Part III. (In progress.)	1909.	0	6	0	0	4	6
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9

2nd Ser. ZOOLOGY.] [VOL. XI. PART 4.

THE TRANSACTIONS OF THE LINNEAN SOCIETY OF LONDON.

THE FRESHWATER CRUSTACEA OF TASMANIA,

WITH REMARKS ON THEIR GEOGRAPHICAL DISTRIBUTION.

BY

GEOFFREY WATKIN SMITH, M.A., F.L.S.,

FELLOW OF NEW COLLEGE, OXFORD.

NATURÆ DISCERE MORES

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

SOLD AT THE SOCIETY'S APARTMENTS, BURLINGTON-HOUSE, PICCADILLY, W.,

AND BY LONGMANS, GREEN, AND CO., PATERNOSTER-ROW.

June 1909.

LINNEAN SOCIETY OF LONDON.

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Second Series.—Zoology.

Volume.		When Published.	Price to the Public.			Price to Fellows.		
			£	*s.*	*d.*	£	*s.*	*d.*
I.	Parts I.–VIII.	1875–79.	8	10	0	6	7	6
II.	Parts I.–XVIII.	1879–88.	7	17	0	5	18	5
III.	Parts I.–VI.	1884–88.	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88.	3	8	0	2	11	0
V.	Part I.	1888.	0	12	0	0	9	0
	Part II.	1888.	0	5	0	0	3	9
	Part III.	1889.	1	7	0	1	0	0
	Part IV.	1890.	0	12	0	0	9	0
	Part V.	1890.	0	6	0	0	4	6
	Part VI.	1891.	0	12	0	0	9	0
	Part VII.	1891.	0	6	0	0	4	6
	Part VIII.	1892.	0	8	0	0	6	0
	Part IX.	1892.	0	12	0	0	9	0
	Part X.	1893.	1	8	0	1	1	0
	Part XI.	1894.	0	2	6	0	2	0
VI.	Part I.	1894.	2	0	0	1	10	0
	Part II.	1894.	1	11	0	1	3	3
	Part III.	1894.	0	10	0	0	7	6
	Part IV.	1896.	1	4	0	0	18	0
	Part V.	1896.	0	10	0	0	7	6
	Part VI.	1896.	0	8	0	0	6	0
	Part VII.	1896.	0	12	0	0	9	0
	Part VIII.	1897.	0	2	6	0	2	0
VII.	Part I.	1896.	0	10	0	0	7	6
	Part II.	1897.	0	12	0	0	9	0
	Part III.	1897.	0	6	0	0	4	6
	Part IV.	1898.	0	10	0	0	7	6
	Part V.	1898.	0	18	0	0	13	6
	Part VI.	1898.	0	13	0	0	9	9
	Part VII.	1899.	0	18	0	0	13	6
	Part VIII.	1899.	0	12	0	0	9	0
	Part IX.	1899.	1	0	0	0	15	0
	Part X.	1900.	0	6	0	0	4	6
	Part XI.	1900.	0	2	9	0	2	0
VIII.	Part I.	1900.	0	10	0	0	7	6
	Part II.	1900.	0	10	0	0	7	6
	Part III.	1900.	0	10	0	0	7	6
	Part IV.	1901.	0	14	0	0	10	6
	Part V.	1901.	0	5	0	0	3	9

Second Series.—Zoology (*continued*).

Volume.		When Published.	Price to the Public.			Price to Fellows.		
			£	*s.*	*d.*	£	*s.*	*d.*
VIII.	Part VI.	1901.	0	10	0	0	7	6
	Part VII.	1901.	1	8	0	1	1	0
	Part VIII.	1902.	0	4	0	0	3	0
	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903.	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905.	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII. (In progress.)	1907.	0	4	0	0	3	0
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV. (In progress.)	1909.	0	12	0	0	9	0
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9

2nd Ser. ZOOLOGY.] [VOL. XI. PART 5.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

ON A BLIND PRAWN FROM THE SEA OF GALILEE (*TYPHLOCARIS GALILEA*, g. et sp. n.).

BY

W. T. CALMAN, D.Sc., F.L.S.

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

SOLD AT THE SOCIETY'S APARTMENTS, BURLINGTON-HOUSE, PICCADILLY, W.,

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July 1909.

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			£	*s.*	*d.*	£	*s.*	*d.*
I.	Parts I.–VIII.	1875–79.	8	10	0	6	7	6
II.	Parts I.–XVIII.	1879–88.	7	17	0	5	18	5
III.	Parts I.–VI.	1884–88.	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88.	3	8	0	2	11	0
V.	Part I.	1888.	0	12	0	0	9	0
	Part II.	1888.	0	5	0	0	3	9
	Part III.	1889.	1	7	0	1	0	0
	Part IV.	1890.	0	12	0	0	9	0
	Part V.	1890.	0	6	0	0	4	6
	Part VI.	1891.	0	12	0	0	9	0
	Part VII.	1891.	0	6	0	0	4	6
	Part VIII.	1892.	0	8	0	0	6	0
	Part IX.	1892.	0	12	0	0	9	0
	Part X.	1893.	1	8	0	1	1	0
	Part XI.	1894.	0	2	6	0	2	0
VI.	Part I.	1894.	2	0	0	1	10	0
	Part II.	1894.	1	11	0	1	3	3
	Part III.	1894.	0	10	0	0	7	6
	Part IV.	1896.	1	4	0	0	18	0
	Part V.	1896.	0	10	0	0	7	6
	Part VI.	1896.	0	8	0	0	6	0
	Part VII.	1896.	0	12	0	0	9	0
	Part VIII.	1897.	0	2	6	0	2	0
VII.	Part I.	1896.	0	10	0	0	7	6
	Part II.	1897.	0	12	0	0	9	0
	Part III.	1897.	0	6	0	0	4	6
	Part IV.	1898.	0	10	0	0	7	6
	Part V.	1898.	0	18	0	0	13	6
	Part VI.	1898.	0	13	0	0	9	9
	Part VII.	1899.	0	18	0	0	13	6
	Part VIII.	1899.	0	12	0	0	9	0
	Part IX.	1899.	1	0	0	0	15	0
	Part X.	1900.	0	6	0	0	4	6
	Part XI.	1900.	0	2	9	0	2	0
VIII.	Part I.	1900.	0	10	0	0	7	6
	Part II.	1900.	0	10	0	0	7	6
	Part III.	1900.	0	10	0	0	7	6
	Part IV.	1901.	0	14	0	0	10	6
	Part V.	1901.	0	5	0	0	3	9

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.		When Published.	Price to the Public.			Price to Fellows.		
			£	*s.*	*d.*	£	*s.*	*d.*
VIII.	Part VI.	1901.	0	10	0	0	7	6
	Part VII.	1901.	1	8	0	1	1	0
	Part VIII.	1902.	0	4	0	0	3	0
	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903.	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905.	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII. (In progress.)	1907.	0	4	0	0	3	0
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V. (In progress.)	1909.	0	2	0	0	1	6
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9

2nd Ser. ZOOLOGY.] [VOL. XI. PART 6.

THE TRANSACTIONS OF THE LINNEAN SOCIETY OF LONDON.

ON THE LIFE-HISTORY OF CHERMES HIMALAYENSIS, Steb., ON THE SPRUCE (*PICEA MORINDA*) AND SILVER FIR (*ABIES WEBBIANA*).

BY

E. P. STEBBING, F.L.S., F.Z.S., F.R.G.S.

LONDON:

PRINTED FOR THE LINNEAN SOCIETY
BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,
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III.	Parts I. VI.	1884–88.	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88.	3	8	0	2	11	0
V.	Parts I.–XI.	1888–94.	6	10	6	4	17	9
VI.	Part I.	1894.	2	0	0	1	10	0
	Part II.	1894.	1	11	0	1	3	3
	Part III.	1894.	0	10	0	0	7	6
	Part IV.	1896.	1	4	0	0	18	0
	Part V.	1896.	0	10	0	0	7	6
	Part VI.	1896.	0	8	0	0	6	0
	Part VII.	1896.	0	12	0	0	9	0
	Part VIII.	1897.	0	2	6	0	2	0
VII.	Part I.	1896.	0	10	0	0	7	6
	Part II.	1897.	0	12	0	0	9	0
	Part III.	1897.	0	6	0	0	4	6
	Part IV.	1898.	0	10	0	0	7	6
	Part V.	1898.	0	18	0	0	13	6
	Part VI.	1898.	0	13	0	0	9	9
	Part VII.	1899.	0	18	0	0	13	6
	Part VIII.	1899.	0	12	0	0	9	0
	Part IX.	1899.	1	0	0	0	15	0
	Part X.	1900.	0	6	0	0	4	6
	Part XI.	1900.	0	2	9	0	2	0
VIII.	Part I.	1900.	0	10	0	0	7	6
	Part II.	1900	0	10	0	0	7	6
	Part III.	1900.	0	10	0	0	7	6
	Part IV.	1901.	0	14	0	0	10	6
	Part V.	1901.	0	5	0	0	3	9
	Part VI.	1901.	0	10	0	0	7	6
	Part VII.	1901.	1	8	0	1	1	0
	Part VIII.	1902.	0	4	0	0	3	0
	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3

Second Series.—Zoology (*continued*).

Volume.		When Published.	Price to the Public. £	*s.*	*d.*	Price to Fellows. £	*s.*	*d.*
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903.	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905.	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Part IX.	1909. (In progress.)	1	1	0	0	15	9
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V.	1909.	0	2	0	0	1	6
	Part VI.	1910.	0	11	0	0	8	3
	Part VII.	1910. (In progress.)	0	5	0	0	3	9
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9
XIII.	Part I.	1909.	1	4	0	0	18	0
	Part II.	1910.	2	3	0	1	12	3
	Part III.	1910.	0	16	0	0	12	0
	Part IV.	1910. Index.	0	5	0	0	3	9

2nd Ser. ZOOLOGY.] [VOL. XI. PART 7.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

SOME POINTS IN THE ANATOMY OF THE LARVA OF TIPULA MAXIMA.

A CONTRIBUTION TO OUR KNOWLEDGE OF THE RESPIRATION AND CIRCULATION IN INSECTS.

BY

JAMES MEIKLE BROWN, B.Sc., F.L.S.

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,

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II.	Parts I. XVIII.	1879–88.	7	17	0	5	18	5
III.	Parts I. VI.	1884–88..	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88..	3	8	0	2	11	0
V.	Parts I.–XI.	1888–94..	6	10	6	4	17	9
VI.	Part I.	1894.	2	0	0	1	10	0
	Part II.	1894.	1	11	0	1	3	3
	Part III.	1894.	0	10	0	0	7	6
	Part IV.	1896.	1	4	0	0	18	0
	Part V.	1896.	0	10	0	0	7	6
	Part VI.	1896.	0	8	0	0	6	0
	Part VII.	1896.	0	12	0	0	9	0
	Part VIII.	1897.	0	2	6	0	2	0
VII.	Part I.	1896.	0	10	0	0	7	6
	Part II.	1897.	0	12	0	0	9	0
	Part III.	1897.	0	6	0	0	4	6
	Part IV.	1898.	0	10	0	0	7	6
	Part V.	1898.	0	18	0	0	13	6
	Part VI.	1898.	0	13	0	0	9	9
	Part VII.	1899.	0	18	0	0	13	6
	Part VIII.	1899.	0	12	0	0	9	0
	Part IX.	1899.	1	0	0	0	15	0
	Part X.	1900.	0	6	0	0	4	6
	Part XI.	1900.	0	2	9	0	2	0
VIII.	Part I.	1900.	0	10	0	0	7	6
	Part II.	1900	0	10	0	0	7	6
	Part III.	1900.	0	10	0	0	7	6
	Part IV.	1901.	0	14	0	0	10	6
	Part V.	1901.	0	5	0	0	3	9
	Part VI.	1901.	0	10	0	0	7	6
	Part VII.	1901.	1	8	0	1	1	0
	Part VIII.	1902.	0	4	0	0	3	0
	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.		When Published.	Price to the Public. £	*s.*	*d.*	Price to Fellows. £	*s.*	*d.*
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903.	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905.	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Part IX. (In progress.)	1909.	1	1	0	0	15	9
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V.	1909.	0	2	0	0	1	6
	Part VI.	1910.	0	11	0	0	8	3
	Part VII. (In progress.)	1910.	0	5	0	0	3	9
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9
XIII.	Part I.	1969.	1	4	0	0	18	0
	Part II.	1910.	2	3	0	1	12	3
	Part III.	1910.	0	16	0	0	12	0
	Part IV.	1910. Index.	0	5	0	0	3	9

2nd Ser. ZOOLOGY.] [VOL. XI. PART 8.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

THREE SPECIES OF HARPACTID COPEPODA.

BY

CANON A. M. NORMAN, M.A., D.C.L., LL.D., F.R.S., F.L.S.

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,

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October 1911.

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The Second Series of the Transactions is divided into Zoological and Botanical sections. The prices of the Zoological parts of those which have been published are as undermentioned :—

Second Series.—Zoology.

Volume.		When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
I.	Parts I.–VIII.	1875–79.	8	10	0	6	7	6
II.	Parts I. XVIII.	1879–88.	7	17	0	5	18	5
III.	Parts I.–VI.	1884–88.	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88.	3	8	0	2	11	0
V.	Parts I.–XI.	1888–94.	6	10	6	4	17	9
VI.	Parts I.–VIII.	1894–97.	6	17	6	5	3	3
VII.	Part I.	1896.	0	10	0	0	7	6
	Part II.	1897.	0	12	0	0	9	0
	Part III.	1897.	0	6	0	0	4	6
	Part IV.	1898.	0	10	0	0	7	6
	Part V.	1898.	0	18	0	0	13	6
	Part VI.	1898.	0	13	0	0	9	9
	Part VII.	1899.	0	18	0	0	13	6
	Part VIII.	1899.	0	12	0	0	9	0
	Part IX.	1899.	1	0	0	0	15	0
	Part X.	1900.	0	6	0	0	4	6
	Part XI.	1900.	0	2	9	0	2	0
VIII.	Part I.	1900.	0	10	0	0	7	6
	Part II.	1900.	0	10	0	0	7	6
	Part III.	1900.	0	10	0	0	7	6
	Part IV.	1901.	0	14	0	0	10	6
	Part V.	1901.	0	5	0	0	3	9
	Part VI.	1901.	0	10	0	0	7	6
	Part VII.	1901.	1	8	0	1	1	0
	Part VIII.	1902.	0	4	0	0	3	0
	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903.	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6

Second Series.—Zoology (*continued*).

Volume.		When Published.	Price to the Public. £	s.	d.	Price to Fellows. £	s.	d.
IX.	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Part IX.	1909.	1	1	0	0	15	9
	Part X.	1911. (In progress.)	0	4	0	0	3	0
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V.	1909.	0	2	0	0	1	6
	Part VI.	1910.	0	11	0	0	8	3
	Part VII.	1910.	0	5	0	0	3	9
	Part VIII.	1911. (In progress.)	0	4	0	0	3	0
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9
XIII.	Part I.	1909.	1	4	0	0	18	0
	Part II.	1910.	2	3	0	1	12	3
	Part III.	1910.	0	16	0	0	12	0
	Part IV.	1910. Index.	0	5	0	0	3	9
XIV.	Part I.	1910.	1	18	0	1	8	6
	Part II.	1911.	1	0	0	0	15	0
	Part III.	1911.	1	8	0	1	1	0
	Part IV.	Index (in preparation).						

2nd Ser. ZOOLOGY.] [VOL. XI. PART 9.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

DERMAPTERA (EARWIGS) PRESERVED IN AMBER, FROM PRUSSIA.

BY

MALCOLM BURR, M.A., D.Sc., F.L.S.

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,

SOLD AT THE SOCIETY'S APARTMENTS, BURLINGTON-HOUSE, PICCADILLY, W.,

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October 1911.

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Second Series.—Zoology.

Volume.		When Published.	Price to the Public.			Price to Fellows.		
			£	*s.*	*d.*	£	*s.*	*d.*
I.	Parts I.–VIII.	1875–79.	8	10	0	6	7	6
II.	Parts I.–XVIII.	1879–88.	7	17	0	5	18	5
III.	Parts I.–VI.	1884–88.	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88.	3	8	0	2	11	0
V.	Parts I.–XI.	1888–94.	6	10	6	4	17	9
VI.	Parts I.–VIII.	1894–97.	6	17	6	5	3	3
VII.	Parts I.–XI.	1896–1900.	6	7	9	4	15	9
VIII.	Part I.	1900.	0	10	0	0	7	6
	Part II.	1900	0	10	0	0	7	6
	Part III.	1900.	0	10	0	0	7	6
	Part IV.	1901.	0	14	0	0	10	6
	Part V.	1901.	0	5	0	0	3	9
	Part VI.	1901.	0	10	0	0	7	6
	Part VII.	1901.	1	8	0	1	1	0
	Part VIII.	1902.	0	4	0	0	3	0
	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903.	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3

Second Series.—Zoology (*continued*).

Volume.		When Published.	Price to the Public.			Price to Fellows.		
			£	*s.*	*d.*	£	*s.*	*d.*
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Part IX.	1909.	1	1	0	0	15	9
	Part X.	1911.	0	4	0	0	3	0
	(In progress.)							
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V.	1909.	0	2	0	0	1	6
	Part VI.	1910.	0	11	0	0	8	3
	Part VII.	1910.	0	5	0	0	3	9
	Part VIII.	1911.	0	4	0	0	3	0
	Part IX.	1911.	0	2	6	0	2	0
	(In progress.)							
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9
XIII.	Part I.	1909.	1	4	0	0	18	0
	Part II.	1910.	2	3	0	1	12	3
	Part III.	1910.	0	16	0	0	12	0
	Part IV.	1910. Index.	0	5	0	0	3	9
XIV.	Part I.	1910.	1	18	0	1	8	6
	Part II.	1911.	1	0	0	0	15	0
	Part III.	1911.	1	8	0	1	1	0
	Part IV. Index (in preparation).							

2nd Ser. ZOOLOGY.] [VOL. XI. PART 10.

THE TRANSACTIONS OF THE LINNEAN SOCIETY OF LONDON.

ON THE LIFE-HISTORY OF CROCE FILIPENNIS, Westw.

BY

Prof. A. D. IMMS, B.A., D.Sc.

(*Communicated by the* Rev. Canon Fowler, M.A., D.Sc., F.L.S.)

NATURÆ DISCERE MORES

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,

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October 1911.

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III.	Parts I. VI.	1884–88.	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88.	3	8	0	2	11	0
V.	Parts I.–XI.	1888–94.	6	10	6	4	17	9
VI.	Parts I.–VIII.	1894–97.	6	17	6	5	3	3
VII.	Parts I.–XI.	1896–1900.	6	7	9	4	15	9
VIII.	Part I.	1900.	0	10	0	0	7	6
	Part II.	1900	0	10	0	0	7	6
	Part III.	1900.	0	10	0	0	7	6
	Part IV.	1901.	0	14	0	0	10	6
	Part V.	1901.	0	5	0	0	3	9
	Part VI.	1901.	0	10	0	0	7	6
	Part VII.	1901.	1	8	0	1	1	0
	Part VIII.	1902.	0	4	0	0	3	0
	Part IX.	1902.	0	5	0	0	3	9
	Part X.	1903.	1	0	0	0	15	0
	Part XI.	1903.	0	6	0	0	4	6
	Part XII.	1903.	0	10	0	0	7	6
	Part XIII.	Index.	0	2	9	0	2	3
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903.	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.	Parts	When Published.	Price to the Public. £	*s.*	*d.*	Price to Fellows. £	*s.*	*d.*
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Part IX.	1909.	1	1	0	0	15	9
	Part X.	1911. (In progress.)	0	4	0	0	3	0
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V.	1909.	0	2	0	0	1	6
	Part VI.	1910.	0	11	0	0	8	3
	Part VII.	1910.	0	5	0	0	3	9
	Part VIII.	1911.	0	4	0	0	3	0
	Part IX.	1911.	0	2	6	0	2	0
	Part X.	1911. (In progress.)	0	2	6	0	2	0
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9
XIII.	Part I.	1909.	1	4	0	0	18	0
	Part II.	1910.	2	3	0	1	12	3
	Part III.	1910.	0	16	0	0	12	0
	Part IV.	1910. Index.	0	5	0	0	3	9
XIV.	Part I.	1910.	1	18	0	1	8	6
	Part II.	1911.	1	0	0	0	15	0
	Part III.	1911.	1	8	0	1	1	0
	Part IV.	Index (in preparation).						

2nd Ser. ZOOLOGY.] [VOL. XI. PART 11.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

SYNAGOGA MIRA, A CRUSTACEAN OF THE ORDER ASCOTHORACICA.

BY

Canon A. M. NORMAN, M.A., D.C.L., LL.D., F.R.S., F.L.S.

NATURÆ DISCERE MORES

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,

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February 1913.

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Volume.		When Published.	Price to the Public. £	*s.*	*d.*	Price to Fellows. £	*s.*	*d.*
I.	Parts I.–VIII.	1875–79.	8	10	0	6	7	6
II.	Parts I.–XVIII.	1879–88.	7	17	0	5	18	5
III.	Parts I.–VI.	1884–88	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88	3	8	0	2	11	0
V.	Parts I.–XI.	1888–94	6	10	6	4	17	9
VI.	Parts I.–VIII.	1894–97	6	17	6	5	3	3
VII.	Parts I.–XI.	1896–1900.	6	7	9	4	15	0
VIII.	Parts I.–XIII.	1900–03.	6	14	9	5	1	3
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Part IX.	1909.	1	1	0	0	15	9
	Part X. (In progress.)	1911.	0	4	0	0	3	0

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.		When Published.	Price to the Public. £	*s.*	*d.*	Price to Fellows. £	*s.*	*d.*
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V.	1909.	0	2	0	0	1	6
	Part VI.	1910.	0	11	0	0	8	3
	Part VII.	1910.	0	5	0	0	3	9
	Part VIII.	1911.	0	4	0	0	3	0
	Part IX.	1911.	0	2	6	0	2	0
	Part X.	1911.	0	2	6	0	2	0
	Part XI. (In progress.)	1913.	0	4	0	0	3	0
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9
XIII.	Part I.	1909.	1	4	0	0	18	0
	Part II.	1910.	2	3	0	1	12	3
	Part III.	1910.	0	16	0	0	12	0
	Part IV.	1910. Index.	0	5	0	0	3	9
XIV.	Part I.	1910.	1	18	0	1	8	6
	Part II.	1911.	1	0	0	0	15	0
	Part III.	1911.	1	8	0	1	1	0
	Part IV.	1912. Index.	0	5	0	0	3	9
XV.	Part I.	1912.	1	9	0	1	1	9
	Part II.	1912.	1	4	3	0	16	9
	Part III.	1912.	1	6	0	0	19	6
	Part IV. Index (in preparation).							

2nd Ser. ZOOLOGY.] [VOL. XI. PART 12.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

CONTRIBUTIONS TO A KNOWLEDGE OF THE STRUCTURE AND BIOLOGY OF SOME INDIAN INSECTS.—II. ON EMBIA MAJOR, SP. NOV., FROM THE HIMALAYAS.

BY

A. D. IMMS, M.A., D.Sc., F.L.S.,

FOREST ZOOLOGIST TO THE GOVERNMENT OF INDIA, AND FELLOW OF THE UNIVERSITY OF ALLAHABAD.

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,

SOLD AT THE SOCIETY'S APARTMENTS, BURLINGTON-HOUSE, PICCADILLY, W.,

AND BY LONGMANS, GREEN, AND CO., PATERNOSTER-ROW.

June 1913.

LINNEAN SOCIETY OF LONDON.

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I.	Parts I.–VIII.	1875–79.	8	10	0	6	7	6
II.	Parts I.–XVIII.	1879–88.	7	17	0	5	18	5
III.	Parts I.–VI.	1884–88	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88	3	8	0	2	11	0
V.	Parts I.–XI.	1888–94	6	10	6	4	17	9
VI.	Parts I.–VIII.	1894–97	6	17	6	5	3	3
VII.	Parts I.–XI.	1896–1900.	6	7	9	4	15	9
VIII.	Parts I.–XIII.	1900–03.	6	14	9	5	1	3
IX.	Part I.	1903.	0	9	0	0	6	9
	Part II.	1903	0	8	0	0	6	0
	Part III.	1903.	1	4	0	0	18	0
	Part IV.	1904.	0	6	0	0	4	6
	Part V.	1904.	0	6	0	0	4	6
	Part VI.	1904.	0	6	0	0	4	6
	Part VII.	1904.	0	6	0	0	4	6
	Part VIII.	1904.	0	10	0	0	7	6
	Part IX.	1905.	0	6	0	0	4	6
	Part X.	1906.	0	12	0	0	9	0
	Part XI.	1907.	0	12	0	0	9	0
	Part XII.	1907.	0	3	0	0	2	3
	Part XIII.	1907.	0	6	0	0	4	6
	Part XIV.	1907. Index.	0	3	0	0	2	3
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Part IX.	1909.	1	1	0	0	15	9
	Part X.	1911.	0	4	0	0	3	0
	(In progress.)							

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.		When Published.	Price to the Public. £	*s.*	*d.*	Price to Fellows. £	*s.*	*d.*
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V.	1909.	0	2	0	0	1	6
	Part VI.	1910.	0	11	0	0	8	3
	Part VII.	1910.	0	5	0	0	3	9
	Part VIII.	1911.	0	4	0	0	3	0
	Part IX.	1911.	0	2	6	0	2	0
	Part X.	1911.	0	2	6	0	2	0
	Part XI.	1913.	0	4	0	0	3	0
	Part XII.	1913.	0	8	0	0	6	0
	(In progress.)							
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9
XIII.	Part I.	1909.	1	4	0	0	18	0
	Part II.	1910.	2	3	0	1	12	3
	Part III.	1910.	0	16	0	0	12	0
	Part IV.	1910. Index.	0	5	0	0	3	9
XIV.	Part I.	1910.	1	18	0	1	8	6
	Part II.	1911.	1	0	0	0	15	0
	Part III.	1911.	1	8	0	1	1	0
	Part IV.	1912. Index.	0	5	0	0	3	9
XV.	Part I.	1912.	1	9	0	1	1	9
	Part II.	1912.	1	4	3	0	16	9
	Part III.	1912.	1	6	0	0	19	6
	Part IV.	1913. Index.	0	12	0	0	9	0

2nd Ser. ZOOLOGY.] [VOL. XI. PART 13.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

THE FORAMINIFERA OF THE WEST OF SCOTLAND. COLLECTED BY PROF. W. A. HERDMAN, F.R.S., ON THE CRUISE OF THE S.Y. 'RUNA,' JULY-SEPT. 1913. BEING A CONTRIBUTION TO 'SPOLIA RUNIANA'.

BY

EDWARD HERON-ALLEN, F.L.S., F.Z.S., F.R.M.S.,

AND

ARTHUR EARLAND, F.R.M.S.

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

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March 1916.

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II. Parts I.–XVIII.	1879–88.	7	17	0	5	18	5
III. Parts I.–VI.	1884–88	5	18	0	4	8	6
IV. Parts I.–III.	1886–88	3	8	0	2	11	0
V. Parts I.–XI.	1888–94	6	10	6	4	17	9
VI. Parts I.–VIII.	1894–97	6	17	6	5	3	3
VII. Parts I.–XI.	1896–1900.	6	7	9	4	15	9
VIII. Parts I.–XIII.	1900–03.	6	14	9	5	1	3
IX. Part I.	1903.	0	9	0	0	6	9
Part II.	1903	0	8	0	0	6	0
Part III.	1903.	1	4	0	0	18	0
Part IV.	1904.	0	6	0	0	4	6
Part V.	1904.	0	6	0	0	4	6
Part VI.	1904.	0	6	0	0	4	6
Part VII.	1904.	0	6	0	0	4	6
Part VIII.	1904.	0	10	0	0	7	6
Part IX.	1905.	0	6	0	0	4	6
Part X.	1906.	0	12	0	0	9	0
Part XI.	1907.	0	12	0	0	9	0
Part XII.	1907.	0	3	0	0	2	3
Part XIII.	1907.	0	6	0	0	4	6
Part XIV.	1907. Index.	0	3	0	0	2	3
X. Part I.	1904.	0	3	0	0	2	3
Part II.	1904.	0	8	0	0	6	0
Part III.	1905	0	9	0	0	6	9
Part IV.	1905.	0	10	0	0	7	6
Part V.	1906.	0	7	6	0	5	3
Part VI.	1906.	0	3	0	0	2	3
Part VII.	1907.	0	3	0	0	2	3
Part VIII.	1907.	0	4	0	0	3	0
Part IX.	1909.	1	1	0	0	15	9
Part X.	1911. (In progress.)	0	4	0	0	3	0

Second Series.—Zoology (*continued*).

Volume.	When Published.	Price to the Public. £	*s.*	*d.*	Price to Fellows. £	*s.*	*d.*
XI. Part I.	1908.	0	4	0	0	3	0
Part II.	1909.	0	8	0	0	6	0
Part III.	1909.	0	6	0	0	4	6
Part IV.	1909.	0	12	0	0	9	0
Part V.	1909.	0	2	0	0	1	6
Part VI.	1910.	0	11	0	0	8	3
Part VII.	1910.	0	5	0	0	3	9
Part VIII.	1911.	0	4	0	0	3	0
Part IX.	1911.	0	2	6	0	2	0
Part X.	1911.	0	2	6	0	2	0
Part XI.	1913.	0	4	0	0	3	0
Part XII.	1913.	0	8	0	0	5	0
Part XIII.	1916. (In progress.)	0	18	0	0	13	6
XII. Part I.	1907.	1	8	0	1	1	0
Part II.	1907.	1	4	0	0	18	0
Part III.	1908.	0	16	0	0	12	0
Part IV.	1909.	1	10	0	1	2	6
Part V.	1909. Index.	0	5	0	0	3	9
XIII. Part I.	1909.	1	4	0	0	18	0
Part II.	1910.	2	3	0	1	12	3
Part III.	1910.	0	16	0	0	12	0
Part IV.	1910. Index.	0	5	0	0	3	9
XIV. Part I.	1910.	1	18	0	1	8	6
Part II.	1911.	1	0	0	0	15	0
Part III.	1911.	1	8	0	1	1	0
Part IV.	1912. Index.	0	5	0	0	3	9
XV. Part I.	1912.	1	9	0	1	1	9
Part II.	1912.	1	4	3	0	16	9
Part III.	1912.	1	6	0	0	19	6
Part IV.	1913. Index.	0	12	0	0	9	0
XVI. Part I.	1913.	1	4	0	0	18	0
Part II.	1913.	1	1	0	0	15	9
Part III.	1913.	0	12	0	0	9	0
Part IV.	1914.	1	10	0	1	2	6
Part V.	1914. Index.	0	3	0	0	2	3
XVII. Part I.	1914.	2	0	0	1	10	0
Part II.	1916. (In the press.)						

2nd Ser. ZOOLOGY.] [VOL. XI. PART 14.

THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY OF LONDON.

TITLEPAGE, CONTENTS, AND INDEX.

LONDON:

PRINTED FOR THE LINNEAN SOCIETY

BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,

SOLD AT THE SOCIETY'S APARTMENTS, BURLINGTON-HOUSE, PICCADILLY, W. 1,

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July 1922.

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II.	Parts I.–XVIII.	1879–88.	7	17	0	5	18	5
III.	Parts I.–VI.	1884–88	5	18	0	4	8	6
IV.	Parts I.–III.	1886–88	3	8	0	2	11	0
V.	Parts I.–XI.	1888–94	6	10	6	4	17	9
VI.	Parts I.–VIII.	1894–97.	6	17	6	5	3	3
VII.	Parts I.–XI.	1896–1900.	6	7	9	4	15	9
VIII.	Parts I.–XIII.	1900–03.	7	14	9	5	1	3
IX.	Parts I.–XIV.	1903–07.	5	17	0	4	7	9
X.	Part I.	1904.	0	3	0	0	2	3
	Part II.	1904.	0	8	0	0	6	0
	Part III.	1905	0	9	0	0	6	9
	Part IV.	1905.	0	10	0	0	7	6
	Part V.	1906.	0	7	6	0	5	3
	Part VI.	1906.	0	3	0	0	2	3
	Part VII.	1907.	0	3	0	0	2	3
	Part VIII.	1907.	0	4	0	0	3	0
	Part IX.	1909.	1	1	0	0	15	9
	Part X.	1911.	0	4	0	0	3	0
	Part XI.	1922. Index.	0	3	0	0	2	3
XI.	Part I.	1908.	0	4	0	0	3	0
	Part II.	1909.	0	8	0	0	6	0
	Part III.	1909.	0	6	0	0	4	6
	Part IV.	1909.	0	12	0	0	9	0
	Part V.	1909.	0	2	0	0	1	6
	Part VI.	1910.	0	11	0	0	8	3
	Part VII.	1910.	0	5	0	0	3	9
	Part VIII.	1911.	0	4	0	0	3	0
	Part IX.	1911.	0	2	6	0	2	0
	Part X.	1911.	0	2	6	0	2	0
	Part XI.	1913.	0	4	0	0	3	0
	Part XII.	1913.	0	8	0	0	6	0
	Part XIII.	1916.	0	18	0	0	13	6
	Part XIV.	1922. Index.	0	4	0	0	3	6

SECOND SERIES.—ZOOLOGY (*continued*).

Volume.		When Published.	Price to the Public. £	*s.*	*d.*	Price to Fellows. £	*s.*	*d.*
XII.	Part I.	1907.	1	8	0	1	1	0
	Part II.	1907.	1	4	0	0	18	0
	Part III.	1908.	0	16	0	0	12	0
	Part IV.	1909.	1	10	0	1	2	6
	Part V.	1909. Index.	0	5	0	0	3	9
XIII.	Part I.	1909.	1	4	0	0	18	0
	Part II.	1910.	2	3	0	1	12	3
	Part III.	1910.	0	16	0	0	12	0
	Part IV.	1910. Index.	0	5	0	0	3	9
XIV.	Part I.	1910.	1	18	0	1	8	6
	Part II.	1911.	1	0	0	0	15	0
	Part III.	1911.	1	8	0	1	1	0
	Part IV.	1912. Index.	0	5	0	0	3	9
XV.	Part I.	1912.	1	9	0	1	1	9
	Part II.	1912.	1	4	0	0	18	0
	Part III.	1912.	1	6	0	0	19	6
	Part IV.	1913. Index.	0	12	0	0	9	0
XVI.	Part I.	1913.	1	4	0	0	18	0
	Part II.	1913.	1	1	0	0	15	9
	Part III.	1913.	0	12	0	0	9	0
	Part IV.	1914.	1	10	0	1	2	6
	Part V.	1914. Index.	0	3	0	0	2	3
XVII.	Part I.	1914.	2	0	0	1	10	0
	Part II.	1916.	1	3	0	0	17	3
	Part III.	1917.	1	5	0	0	18	9
	Part IV.	1921. Index.	0	12	0	0	9	0
XVIII.	Part I.	1922.	4	6	0	3	4	6

(In progress.)