

The Euphausiidæ in the Neighbourhood of Plymouth.
 II. *Nyctiphanes Couchii* and *Meganyctiphanes norvegica*.

By

Marie V. Lebour D.Sc.,

Naturalist at the Plymouth Laboratory.

With Plates I-IX.

THE present paper is a continuation of last year's work on the Euphausiidæ in the neighbourhood of Plymouth (Lebour, 1924), in which the early larval stages were described of *Nyctiphanes Couchii*, *Meganyctiphanes norvegica* and, less fully, those of *Thysanoessa inermis* and *T. neglecta*. These two last-named forms are reserved for a detailed description in another paper, only *Nyctiphanes* and *Meganyctiphanes* being dealt with here. The first paper described these as far as the last Calyptopis stages, and it was shown that they were much alike although perfectly distinct, especially as regards colour. The nauplii and meta-nauplii were easily distinguishable. The whole of the remaining life-history of *Nyctiphanes Couchii* has now been elucidated and also that of *Meganyctiphanes norvegica*, with the exception of a few late larval stages. The absence of these, however, does not materially affect our knowledge of its life-history.

Much help has been obtained from Mr. C. F. Hickling, to whom my best thanks are due, who has kindly put at my disposal his collections from the Atlantic Slope from which I have been able to fill in gaps in the larval stages of both species.

Nyctiphanes Couchii being our only truly neritic species is obviously the easiest to study, and, as it is present on the Plymouth area more or less throughout the year, material of its various stages is easier to obtain than those of the other species which live commonly in the Atlantic and only come into the Channel occasionally and apparently at the breeding season. From two years' observations there is a distinct indication of both *Meganyctiphanes* and *Thysanoessa* entering the Channel to breed, and from Mr. Hickling's observations a tendency to come nearer inshore to breed is distinctly shown in both these genera. In his paper (1925) the notes on vertical migration of these euphausiids are extremely interesting, and the habit of living just above the bottom by

day, and presumably coming to the surface at night is borne out by our own observations in the Channel. His collections show clearly that *Nyctiphanes Couchii* is neritic and *Meganyctiphanes norvegica* and *Thysanoessa* oceanic. In his October collections *Nyctiphanes Couchii* only was breeding, several specimens carrying eggs and larvæ at various stages, whereas all the *Meganyctiphanes* and *Thysanoessa* were adolescent or, in the case of *Meganyctiphanes*, adult but not mature. In the writer's previous paper (1924) these were shown to be breeding in the Channel early in the year, together with *Nyctiphanes*. It is possible that the two oceanic species spawn usually at this time, but *Nyctiphanes* appears to spawn nearly all the year round, although chiefly in the spring. From Mr. Hickling's March collections, adult *Meganyctiphanes* and *Thysanoessa* were obtained, both of which were spawning.

It must be noted that the limb called here the first thoracic is regarded by Hansen in all his works as the maxillipede, and in this he is followed by many other workers. He thus admits only seven thoracic legs instead of eight. In this paper, which follows Calman (1909), the thoracic limbs are regarded as beginning after the second maxilla, and are therefore eight in number.

As Hansen (1908) has pointed out, the various larval stages in different genera do not always correspond (indeed they possibly do not always do so even in the various species), but the names used by Sars (1885) for the different stages have a certain significance. Thus the Calyptopis stages are characterised by having the carapace covering the eyes as the name implies. The Furcilia stages are characterised by having the carapace drawn away from the eyes so that they are exposed, and the antennæ are still retained as swimming organs, having two simple setose rami. The Cyrtopia stages are characterised by having the antennæ differentiated into a jointed and unjointed ramus, the flagellum and the scale, although the earliest Cyrtopia (*e.g.* in *Meganyctiphanes*) may show very little of this differentiation beyond having the flagellum three-jointed. Sars regards the post-larval stage as having all the limbs fully formed, and only differing from the adult in the absence or presence of certain setæ. The present observations show, however, that the Cyrtopia merges imperceptibly into the adult, and that both male and female may be mature before the appendages are fully formed as far as the exopodite of the male seventh thoracic limb is concerned, and also the number of gill lobes in both sexes. It has, therefore, been thought advisable to omit the term post-larva altogether, and regard the late Cyrtopia to be the direct predecessor of the adult.

Of the few workers who have attempted the life-histories of British euphausiids, Brook and Hoyle (1888) have given the most accurate and detailed information, although unfortunately *Meganyctiphanes norvegica*

and *Thysanoessa (Raschii and inermis)* are not separated. These they call *Nyctiphanes* and *Boreophausia* respectively. They recognise eleven Furcilia stages, twelve now being found, two late Furcilia stages being here shown to occur in both *Nyctiphanes* and *Meganyctiphanes* having all the pleopods biramous and setose.

The following notes on the Furcilia stages are given by these authors :

1. No rudiments of pleopods.
2. First pair of pleopods as simple rudiments.
3. Second ,, ,, ,, ,,
4. Third ,, ,, ,, ,,
5. Fourth ,, ,, ,, ,,
6. Fifth ,, ,, ,, ,,
7. First pair of pleopods biramous and setose.
8. Second ,, ,, ,, ,,
9. Third ,, ,, ,, ,,
10. Fourth ,, ,, ,, ,,
11. Fifth ,, ,, ,, ,,

And it is stated that in another form the anterior pair of pleopods become biramous and setose before the last are developed in rudiment. Now in the following account of *Nyctiphanes* and *Meganyctiphanes* it is shown that the pleopods in both are formed in this second way, the first to the fifth stage being formed as in the first form described, the sixth differing in having the first pair of the four present both biramous and setose. From observations on *Thysanoessa* from the Channel, we find that the sixth stage here has five simple rudiments. It, therefore, almost certainly follows that in *Thysanoessa inermis* (and probably *T. Raschii*) the Furcilia stages are as in the first form of Brook and Hoyle, and *Nyctiphanes Couchii* and *Meganyctiphanes norvegica* as in the second. They give four Calyptopis stages, whereas we find only three in all forms observed.

Elmhirst (1924) says of *M. norvegica* : "This species seems to pass through 2 Nauplius, 1 Metanauplius, 3 Calyptopis, 6 Furcilia and 5 Cyrtopia stages, *i.e.* 17 moults before the adult form is attained." A much underestimated statement, for we find 12 Furcilia and many Cyrtopia stages, although agreeing with him as to the nauplii, metanauplius and Calyptopis.

GENERAL REMARKS ON EUPHAUSIID LARVÆ.

The eggs of euphausiids are either shed directly into the sea or are carried for a longer or shorter period in an egg-sac, which may be double or single. In *Nyctiphanes Couchii* and in the other species of this genus the sac is double. The nauplii in *N. Couchii* are hatched in the sac and

retained therein for a considerable period, emerging into the water as pseudometanauplii, which almost immediately cast the skin and become true metanauplii. *Meganyctiphanes norvegica* apparently sheds its eggs into the sea in the one-celled stage. So far these have not been obtained direct from the parent, but eggs have been hatched out which produce *Meganyctiphanes* nauplii. Two naupliar stages and a metanauplius occur in this species. There are three Calyptopis stages in both *Nyctiphanes* and *Meganyctiphanes*, twelve Furcilia stages, and at least twelve Cyrtopia stages before maturity is reached.

The free-swimming nauplius, as in *Meganyctiphanes*, is a typical three-limbed nauplius with all limbs biramous. There is no mouth. The first nauplius has no spines behind, the second has two spines, and in the older specimens the metanauplius carapace and limbs can be seen through the skin. In *Nyctiphanes*, which carries its eggs, there is only one naupliar stage which has the mandible (third naupliar limb) only a uniramous stump, and, as stated above, emerges from the egg-sac of the female as a pseudometanauplius almost at once sloughing the skin which enwraps the metanauplius.

The metanauplius has a carapace covering most of the body, and a small abdominal piece protruding behind armed with spines at the end. There are buds present representing the two pairs of maxillæ and the first thoracic limbs. The median naupliar eye is present and the antennules project in front. The antennæ are the chief swimming organs, the mandibles being only stumps.

The three Calyptopis stages have the region of the compound eyes covered by the carapace, and a projecting abdomen which is unsegmented in the first stage and not separate from the telson. In the second stage it has five segments and in the third stage six segments besides the telson, which is armed with spines. The antennæ are still swimming organs, and persist as such all through the Furcilia stages. The two pairs of maxillæ and the first thoracic limb are well developed, but there are no other appendages although thoracic segments appear as narrow rings and the number of abdominal segments is complete in the third Calyptopis. Also the rudiments of the compound eyes appear as the ocular organs, and the eyes themselves are pigmented, with traces of the luminous organs. These characters are in all probability general, as they appear to exist in all the Calyptopis so far described.

The third Calyptopis changes into the first Furcilia, which has no pleopods in all those that are known. In my former paper the first Furcilia of both *Nyctiphanes* and *Meganyctiphanes* were described as having one rudimentary pair of pleopods, but later it was found that there was an earlier stage without pleopods, and although the Furcilia therein described (Lebour, 1924) was obtained from the sloughing of

a last Calyptopis it was probably abnormal, owing to captivity, and in reality represents the second Furcilia. After the first the Furcilia stages are to be distinguished from one another by the development of the pleopods which at first appear as simple buds, these giving place to setose biramous limbs. During the growth of the Furcilia the pleopods develop from one simple pair of buds to the five pairs all biramous and setose, slight differences in procedure occurring in the various genera, but from observations on many different forms it seems probable that they are the same in all species of a genus, and it is found here that in the closely related genera *Nyctiphanes* and *Meganyctiphanes* the order of development is the same. The thoracic limbs are developed progressively in the Furcilia, usually about as far as the rudiment of the fifth and sixth limb, the first, second and third being well developed. The antennæ are always still swimming organs and not differentiated into scale and flagellum, both rami being unjointed (with the exception of indications of joints at the tip of the scale ramus) and bearing long setæ. The antennules have a long spine (as in the Calyptopis) on the outside of the first peduncular joint, and the flagella are short and unjointed or only with very few inconspicuous indications of joints in the last stages. The luminous organs always occur on the eyes in all stages, those on the second thoracic limbs appearing in the later stages and on the first or also on the following abdominal segments. The telson undergoes characteristic changes during the later Furcilia and early Cyrtopia stages, during which from being of a square many-spined larval type it becomes the elongated pointed telson with two large and broad spines of the adult. These changes will be here briefly described as similar changes occur in all euphausiid larvæ, and the slight differences in these changes serve as important guides in distinguishing species. The typical early larval euphausiid telson is oblong, and armed laterally near the centre of its outer margins with a pair of short spines, one on each side. As these are universally present throughout all the stages they will not be referred to again. The terminal portion of the telson has in the Calyptopis (Lebour, 1924) one pair of short lateral spines on the outside (1), one pair of long, thin lateral spines inside these (2), one pair of long, usually thicker, lateral spines internal to 2 (3) and, typically, seven short terminal spines (Plate II, Fig. 1). As the larva grows the telson elongates and narrows, and most of these spines are gradually lost. The first change is the reduction of the seven terminal spines to five (Plate II, Fig. 4). This may occur in a late Furcilia stage or in an early Cyrtopia stage, the hind edge of the telson being gradually pulled out. In the next stage the terminal spines are reduced to three (Plate II, Fig. 5) and then to one (Plate II, Fig. 6), the lateral spines remaining as before but differing as to being ciliated or not, and finally the outer long, lateral pair (2) disappears (Plate II, Fig. 8). The

telson has now the ordinary adult number of spines, although the small pair disappear altogether in some adults. Instead of the outside long, lateral pair disappearing when there is only one terminal spine they may disappear when there are still three. This last form is apparently the usual one in *Meganyctiphanes norvegica*. This sequence described above, or a somewhat similar one, seems to occur in all euphausiids, but whereas the late Furcilia of one species may have reached the stage of Fig. 8, on the other hand the first Cyrtopia of another species may be still at stage one.

An interesting exception to the occurrence of seven terminal spines in the early larva of an euphausiid has recently been observed by the writer in *Stylocheiron Suhmi*, from plankton collected by Mr. F. S. Russell from near Alexandria, Egypt. A paper on these larvæ will, it is hoped, be ready shortly for publication. These had six terminal spines on the telson instead of seven, and this was a constant feature, occurring in all specimens which were quite frequent. In a later Furcilia these were reduced to four. This is apparently the only known exception.

The Furcilia now changes into the Cyrtopia with antennæ differentiated into scale and flagellum (Plate III, Figs. 3-5). The flagellum is always at least three-jointed, but may at first retain the shape of the unjointed ramus of the Furcilia, and still bear setæ both terminally and laterally. The scale may at first also closely resemble the Furcilia ramus, but is, however, always apparent as a scale in the second or third Cyrtopia if not in the first. The telson gradually changes to the adult shape. It may in the first Cyrtopia have seven, five or three terminal spines, which alter as described above. The thoracic limbs all appear and the remaining luminous organs. The antennules gradually assume the adult shape, and the male pleopods become modified. In fact, so gradually does the Cyrtopia change into the adult that it is almost impossible to fix a so-called post-larval stage (which is defined by Sars as having all the adult limbs, these only differing in setæ) for specimens may be mature before the limbs are perfect (*e.g.* before the exopodite is fully jointed in the seventh thoracic limb or the gills fully developed). Whilst the Cyrtopia changes the carapace alters considerably, the rostrum becoming more and more short and pointed, and in some cases the lateral denticle, present in most species in the early larvæ, disappearing (Plate II, Figs. 11-16). Sex may be discernible at an early age, sometimes as early as the third or fourth Cyrtopia, either by means of the modification of the male pleopods or in the modification of the penultimate thoracic limbs, when these are different in male and female. In some cases, however, the sex cannot be told until much later.

As stated above both males and females may be mature before being fully developed. For instance, *Nyctiphanes Couchii*, which may reach

a length of 17 mm., can breed at 9 mm., females carrying eggs and males with fully formed spermatophores being found at that size, in these cases the gills only having 8-10 lobes and the seventh thoracic male limb having the exopodite not fully jointed.

The male modified pleopods may be very different in the young stages from their form in the mature individual, and great care must be exercised in identifying such young males, especially as they may be very variable in size, and one may find a mature male in one locality which is hardly more than half the size of an adult from another locality, the young of the latter being quite different in regard to the pleopods when the same size as the former.

From these notes we may draw the following conclusions :

All euphausiids undergo similar or closely related changes in the larval telson, the number of spines being reduced in a certain order, but parallel stages are not always equally developed. Thus a late Furcilia of one species may have the telson more advanced than the Cyrtopia stage of another species. It is, therefore, unsafe to go by the telson in the identification of any stage unless the full life-history of the species is known.

The best way to distinguish a late Furcilia from an early Cyrtopia is by the flagellum of the antenna, which is unjointed in the Furcilia and jointed in the Cyrtopia.

Pleopods are not developed in the same order in all genera, although it is probable that all the species of a genus are similar in this respect, and also of closely related genera, such as *Nyctiphanes* and *Meganyciphanes*.

Irregular development may occur, and it is possible that temperature may hurry on growth. Furcilia and Cyrtopia stages have occasionally been found with the telson further developed than usual, such as a last Furcilia of *Nyctiphanes* with only one terminal spine to the telson, and one was found in Mediterranean plankton having three instead of five. Changes of skin under laboratory conditions may also be irregular, but on the whole the series described below for *Nyctiphanes* and *Meganyciphanes* appear to be fairly constant, and represent the normal method of development.

NYCTIPHANES COUCHII (Bell).

As stated above twelve Furcilia stages may clearly be made out. Some of these were obtained by the changing of skin in the Laboratory, but most of them were picked out from the plankton, either from material brought in by the *Salpa* from outside the Sound, chiefly from Station L4, half-way between Rame Head and the Eddystone, or they were obtained from Mr. Hickling's collections from the Atlantic.

All the Furcilia stages (Plate I) are clear and hyaline with orange-red

chromatophores above the telson, at the side of the thorax and round about the mouth region; otherwise they are colourless. The eyes are completely uncovered by the carapace, which now projects between them as an almost square rostrum, only very slightly emarginate in the earlier stages, reaching to about the level of half the eye or slightly further. The carapace is very slightly carinate dorsally near the middle where there is a small projection, not always perceptible and disappearing in the older stages. A distinct lateral tooth is present near the posterior end in all the Furcilia stages, and the posterior margin beginning as a simple convex curve gradually becomes indented and sinuate. The telson at first almost square at the end like the Calyptopis gradually tapers, and becomes triangular at the end with a truncated base. It is armed with seven terminal spines as described above. These are very nearly equal in length, and the three pairs of lateral spines all possess one large spine and two long laterals besides, the terminal spines are ciliated, the latter on both sides, the laterals on the inside only. The armature of the spines gradually disappears. The uropods are present in all the Furcilia stages, having first appeared in the last Calyptopis, and gradually elongate and become more setose. The antennæ are swimming organs, have two unjointed rami with long setæ and alter little in the various stages. The antennules have a long, thick spine at the outer side of the terminal portion of the first joint of the peduncle. (This is present in all euphausiid larvæ, but in *Nyctiphanes* and *Meganyctiphanes* persists in the adult, although much reduced, and is connected with the leaflet arming this joint which is typical of these two genera). The flagella at first very short with long setæ gradually elongate, lose their terminal setæ, and tend to be jointed. The mandibles in all the Furcilia stages have only the rudiment of a palp hardly more developed than in the last Calyptopis (Plate III, Fig. 6). The first and second maxillæ are also much like the Calyptopis. The first thoracic limb is well formed in all the Furcilia stages, the other thoracic limbs, beginning with a bud in the early stages, in the last reach four jointed legs with gills and the rudiment of a fifth. The pleopods beginning at the second Furcilia as a pair of simple non-setose protrusions are biramous with both rami setose in the penultimate and in the last. Luminous organs are present on the eyes in all the stages, and a pair on the second are present in the ninth Furcilia. All those on the abdominal segments present in the twelfth and last. The spine below the telson occurs in the third, the spine above the telson in the eleventh Furcilia.

First Furcilia (Plate I, 1, and Plate II, 1), 2.5 mm. long.* Carapace

* All measurements of the whole animal are from the tip of the rostrum to the end of the median spine of the telson. Those here given are for typical examples and may be slightly larger or smaller.

rounded posteriorly. Rostrum broader than long. Outer uropods reaching about half-way down the telson, inner shorter. No pleopods. Second thoracic limbs occur as small buds.

Second Furcilia (Plate I, 2 and 13), 2.5-2.6 mm. long. Differs from first only in having the first pair of pleopods developed, each divided into a basal and terminal non-setose portion.

Third Furcilia (Plate I, 3, and Plate II, 11), 2.8-3 mm. long. Two pairs of pleopods similar to the second stage. Carapace still rounded posteriorly. Telson narrower with terminal angles more cut off. Spine below telson present. Inner uropods longer. Second thoracic leg jointed. Rudiment of third.

Fourth Furcilia (Plate I, 4, and Plate II, 2), 2.8-3.3 mm. long. May be the same size as the third or smaller or larger. Three pairs of simple pleopods. Second thoracic limb setose.

Fifth Furcilia (Plate I, 5), 3.2-3.5 mm. long. Four pairs of simple pleopods.

Sixth Furcilia (Plate I, 6), 3.2-3.5 mm. long. Four pairs of pleopods, the first biramous and setose, the inner ramus very short with one seta. The other three pairs of pleopods simple as before.

Seventh Furcilia (Plate I, 7 and 14), 3.5-3.6 mm. long. Four pairs of pleopods: the first two biramous and setose, the third and fourth simple, uropods longer.

Eighth Furcilia (Plate I, 8), 3.2-3.6 mm. long. Five pairs of pleopods, the first two biramous and setose, the last three simple.

Ninth Furcilia (Plate I, 9), 3.8 mm. long. Three pairs of pleopods biramous and setose, two pairs simple. Second thoracic leg five-jointed, short, with two-lobed gill. Third and fourth unjointed. Luminous organs on second thoracic legs and between first pleopods.

Tenth Furcilia (Plate I, 10, and Plate II, 3), 3.8-4 mm. long. Four pairs of setose biramous pleopods, one pair simple. Gills beginning on second and third thoracic legs.

Eleventh Furcilia (Plate I, 11), 4-4.3 mm. long. All pleopods setose and biramous. Second thoracic leg long, third jointed, fourth rudimentary. Still with seven terminal spines to telson.

Twelfth and last Furcilia (Plate I, 12 and 15; Plate II, 4; Plate III, 1, 3, 6, 11-16), 4.3 mm. long. Five terminal spines to telson. Flagella of antennules slightly jointed. Second and third thoracic leg with all joints, the second bent. Two-lobed gills, tending to be three-lobed to second and third leg. Fourth and fifth unjointed with rudimentary gill. Luminous organs on four abdominal segments, or sometimes on only three. This last *Furcilia* now changes into the first *Cyrtopia*. As several times the change has taken place in a finger-bowl in the laboratory, the normal form seems to be a *Cyrtopia* with three terminal spines to the

telson coming from a five-spined Furcilia, these corresponding with numerous specimens of both from the plankton. A few variations have occurred, however, the Furcilia occasionally only having three or one terminal spine. The Cyrtopia of *Nyctiphanes Couchii* has not been found with more than three terminal spines.

The Cyrtopia stages all have one antennal ramus jointed, the flagellum, the other ramus remaining unjointed as the setose scale. They gradually change into the adults, as described above, and the term Cyrtopia is here used to cover the early stages after the Furcilia as well as those hitherto referred to as post-larval.

At first the carapace (Plate II, 12-16) is still notched laterally, but this soon disappears; the rostrum gradually diminishes and becomes more pointed and the carapace has the adult appearance. The antennules at first still have the large larval spine on the first peduncular joint, but soon this becomes smaller and the reflexed leaflet begins to be formed. The flagella, at first about the same length as the peduncle, elongate fast, the thoracic legs quickly develop from six to eight, at first with biramous gills which soon reach eight or ten. The mandibles have a palp, at first unjointed, soon reaching the adult jointed setose state. The telson at first with three terminal spines changes to one in the second Cyrtopia stage, then loses the outer long lateral spines, and soon has the adult appearance. In the first Cyrtopia all the luminous organs are present except those in the seventh thoracic limb, but this appears in the second stage. The last parts to develop are the exopodite of the last functional legs and the final gill lobes, but the animal may reach maturity before these are fully formed (Plate IV).

First Cyrtopia (Plate II, 5, 12; Plate III, 2, 4, 7, 9, 10, 17, 18, 19), 4.5 mm. long. Three terminal spines to telson. Rostrum long and broad, slightly more pointed than in the last Furcilia. Antennules with jointed setose flagella equal in length to the peduncles. Antennæ with a three-jointed non-setose flagellum, only very slightly longer than the scale which is armed with setæ terminally and on its inner edge for the last third of its length. Second thoracic leg long and bent with setose unjointed exopodite and two-lobed gill, third also bent with exopodite with one seta, fourth leg not bent but with full number of joints in the endopodite, and two-lobed gill, but no exopodite, fifth, sixth and seventh limb rudimentary, seventh only a small protruberance.

Second Cyrtopia (Plate II, 6; Plate IV, 1), 4.5-4.75 mm. long. Telson with one terminal spine and both lateral pairs of long spines, the large inner laterals having lost the cilia with which they were armed on their inner edges. All luminous organs present. Carapace still with lateral tooth, rostrum narrower. Antennules with long flagella and process standing up on the first peduncular joint. Antennæ with three-

jointed base to the flagellum, the flagellum itself reaching beyond the scale for more than half of its own length. Scale with setæ all along its inner margin and a spine at its base on the outside. Thoracic limbs two to five bent and with the endopodites fully jointed, the sixth four-jointed with rudimentary exopodite in male and bi-lobed gill, the seventh with luminous organs, unjointed endopodite and bilobed gill. The gill lobes of the eighth appendage beginning. Mandible with three-jointed palp armed with two terminal setæ.

Third Cyrtopia (Plate II, 7, 13; Plate III, 8), 4.75-5.5 mm. long. The telson is almost the same as in the second, but rather more elongated and with the outer long lateral spine without cilia. The seventh thoracic limb still unjointed, but slightly longer than in the second. There is very little difference between this and the second *Cyrtopia*, and they would have been regarded as identical if it had not been that several times the third was procured from the second by sloughing of the skin in the laboratory.

Fourth Cyrtopia (Plate II, 14; Plate IV, 2), 5.5-5.75 mm. long. The telson has lost the outer long lateral spine, the terminal portion being much elongated. The carapace has a much shorter rostrum, and the lateral denticle is smaller. The seventh thoracic limb has a one-jointed endopodite and a three-lobed gill.

Fifth Cyrtopia (Plate II, 8, 15; Plate V, 5, 6, 9), 6-6.2 mm. long. Telson as in the fourth stage. Lateral denticle of the carapace gone, but the margin still angular where it has been. Endopodite of seventh thoracic leg two-jointed with a terminal seta. Rudimentary eighth with eight-lobed gill. In the male the first two pairs of pleopods begin to be modified so that the sex can now be recognised, and the sixth thoracic leg has an exopodite and three-lobed gill. Exopodite also on the seventh thoracic leg, which is still two-jointed, but longer. Thoracic legs three and four setose with three-lobed gills.

Sixth Cyrtopia (Plate IV, 3), 6.5 mm. long. Seventh thoracic leg longer, endopodite two-jointed with one terminal seta; three-lobed gill.

Seventh Cyrtopia (Plate IV, 4), 7 mm. long. Seventh thoracic leg longer with exopodite in male still a simple lobe and a five-lobed gill. Rudimentary eighth leg fully formed.

Eighth Cyrtopia (Plate IV, 5), 7.5 mm. long. Much the same as seven with seventh thoracic leg longer.

Ninth Cyrtopia (Plate IV, 6; Plate V, 7, 10), 8 mm. long. Much the same as seven with seventh thoracic leg still longer.

Tenth Cyrtopia (Plate IV, 7), 8.5 mm. long. Gill to seventh thoracic leg six-lobed, with exopodite in male having two terminal setæ.

Eleventh Cyrtopia (Plate IV, 8), 9 mm. long. Exopodite of male seventh thoracic leg with two joints and two terminal setæ. At this stage both

male and female may breed, although the gills and exopodites have not attained their full development.

Twelfth Cyrtopia (Plate IV, 9), 9.5 mm. long. Exopodite of male seventh thoracic limb two-jointed with four terminal setæ and seven to ten lobes to gill.

Thirteenth Cyrtopia (Plate IV, 10), 10 mm. long. Exopodite of male seventh thoracic leg with five segments and seven to ten lobes to gill.

The *Nyctiphanes* may now be regarded as adult, although still continuing to develop, the male seventh thoracic leg having eventually six segments to the exopodite, with twelve setæ and the gill having thirteen lobes in a specimen 13 mm. long (Plate IV, 11). Certainly it may breed at 9 mm., at that size the male and female organs being ripe, the male copulatory organs fully developed, and only slight differences, such as the number of gill lobes and segments in the male exopodites of the seventh thoracic leg showing there is any difference from the fully formed adult. We may, therefore, take the form at 10 mm. to be the last *Cyrtopia*, although it can breed at 9 mm. and still go on developing up to 12 or 13 mm., the adult sometimes reaching 17 mm. in length. We thus have thirteen *Cyrtopia* stages leading up gradually to the adult form.

Hansen (1911) describes a few larval stages of *Nyctiphanes Couchii* from the Atlantic Monaco material which correspond well with those described above. The first specimen of 4.5 mm. is evidently the first *Cyrtopia*. In the second specimen he describes the disappearance of the lateral denticle of the carapace at the same stage as our own specimens, and one of his at 6 mm. corresponds almost exactly with ours. The only difference appears to be the rostrum, which in the early stages Hansen describes as emarginate, whilst in ours, except in the very early *Furcilia*, it is usually straight. Hansen believes Illig's *Nyctiphanes obtusifrons* (1909) to be the young of *N. Couchii*, which seems to be extremely likely.

A comparison with the larval stages of *N. simplex* Hansen, from the "Albatross" material (1912), shows that his "Intermediate *Furcilia* Stage" (p. 288, Plate 12, Figs. 3a-3f) corresponds with the eighth *Furcilia* of *Nyctiphanes Couchii*, having two biramous pleopods and three simple and uniramous, a difference being that in *N. Couchii* the inner ramus of the two first have each one seta and in *N. simplex* these are absent, and in *N. simplex* the rostrum is slightly emarginate, whilst in *N. Couchii* it is rounded. The length is the same and the other features are much alike. It, therefore, seems that in species of the same genus we may expect equivalent larval stages. The last *Furcilia* of *N. simplex*, as described by Hansen, corresponds with the penultimate *Furcilia* of *N. Couchii*, as it still has seven terminal spines to the telson, the last *Furcilia* of *N. Couchii* having five.

The life-history of *Meganyctiphanes norvegica* may now be compared with that of *Nyctiphanes Couchii*, and it is found to be very similar.

MEGANYCTIPHANES NORVEGICA (M. Sars).

The larvæ of *Meganyctiphanes norvegica* have been secured from the Channel from the egg through two naupliar stages, one metanauplius and three Calyptopis stages, which are described and figured in an earlier paper (Lebour, 1924), and later, also from the Channel, the Furcilia stages and many of the earlier Cyrtopia stages were identified. It is probable that this species goes into deeper and more open water when older and approaches the coast again to breed. Mr. Hickling has collected many adolescent and adult stages from the Atlantic, and in March these were breeding in the shallower water, eggs and early larvæ being abundant.

We thus have the life-history almost complete, for there is only a gap after the Cyrtopia of 9.5 mm. long and one of 13 mm., and these stages are so much alike and already show characters which identify them that the absence of these few intermediate stages is of no importance.

We have a series of larvæ closely resembling in the early stages those of *Nyctiphanes*, but always distinguishable. The first difference is the colour. This is only useful when we have fresh specimens, but then is very distinct, *Meganyctiphanes* being pinkish with very distinct red pigment round the mouth and on the back, and later on the legs, *Nyctiphanes* in its early stages being clear and colourless except for distinct red chromatophores at the base of the telson and in the mouth region. The early larvæ of *Meganyctiphanes* may have a trace of red chromatophores at the base of the telson, so that in preserved specimens it is not always easy to separate them by this character, although when alive this can always be done as *Meganyctiphanes* is always a diffuse pinkish colour all over.

The second difference is size, and this is very apparent in the later larvæ. Even, however, in the first Furcilia *Meganyctiphanes* is usually larger and of a somewhat heavier build. We may, however, have a large specimen of *Nyctiphanes* and a small specimen of *Meganyctiphanes* which are about the same size in the very early Furcilia stages only.

The third difference is the size of the eyes, which are always larger and very pronounced in *Meganyctiphanes*.

The fourth difference is the broader carapace of *Meganyctiphanes* which retains its larval characters much longer than *Nyctiphanes*. Dissecting off the carapace of any of the Furcilia stages and laying it out flat will distinguish it at once as being *Nyctiphanes* or *Meganyctiphanes*.

The Furcilia stages (Plate VI) correspond exactly with those of *Nyctiphanes*, twelve stages in all, the first without pleopods, the last two with

all the pleopods setose and biramous. There is, however, the difference in the last that it still has seven terminal spines on the telson instead of the five in *Nyctiphanes*. In size they range from 2.6 mm. in the first *Furcilia* to 5 mm. in length in the last, which is slightly larger than those of *Nyctiphanes*. As the *Furcilia* grows its proportional size grows, compared with *Nyctiphanes*, and after the last *Furcilia* the large size is so marked that it is impossible to mistake them, even if they did not differ in other ways.

The eyes are completely uncovered by the carapace, which is very square and only slightly emarginate in the younger stages, and still square in the last *Furcilia*. There is a distinct carination dorsally in the younger forms which tends to disappear, and often is not easily seen in preserved specimens. The very distinct lateral denticle occurs near the hind end, and the posterior margin, at first rounded, is only slightly and smoothly indented in the last *Furcilia*, and much further back in development than in the last *Furcilia* of *Nyctiphanes* (Plate IX, 12-14). The lateral spines on the telson are armed with one spine each in the early stages, and are ciliated on their inner margins, both spines and cilia disappearing later. The uropods gradually lengthen, and the antennæ are much the same in all the *Furcilia* stages with two unjointed rami with setæ. The antennules gradually growing longer do not alter much from the first to the last *Furcilia*, the flagella not being jointed at all and the general appearance being much like *Nyctiphanes*. In the last *Furcilia* there are no terminal setæ on the flagella. The mandibles are very backward and only show a small pointed rudiment of a palp in the last stage, the two pairs of maxillæ altering little. The first thoracic limb is well formed in all the stages, the other thoracic limbs gradually developing until in the last *Furcilia* the third is jointed, the fourth very short, and the fifth merely a small protuberance. The pleopods are developed exactly as in *Nyctiphanes*.

First Furcilia (Plate VI, 1; Plate IX, 3), 2.8 mm. long. Carapace very broad and rounded posteriorly. Eyes dark and very conspicuous, which is the case in all stages. Rostrum very broad. No pleopods.

Second Furcilia (Plate VI, 2), 3 mm. long. One pair of simple pleopods as in *Nyctiphanes*.

Third Furcilia (Plate VI, 3, 12; Plate IX, 12), 3 mm. long. Two pairs of simple pleopods.

Fourth Furcilia (Plate VI, 4; Plate IX, 4), 3.3-3.5 mm. long. Three pairs of simple pleopods. Spine below telson developed.

Fifth Furcilia (Plate VI, 5), 3.3-3.5 mm. long. Four pairs of simple pleopods.

Sixth Furcilia (Plate VI, 6), 3.8 mm. long. Four pairs of pleopods, the first biramous and setose, the three others simple.

Seventh Furcilia (Plate VI, 7), 3.8 mm. long. Two pairs of biramous setose pleopods, two pairs simple.

Eighth Furcilia (Plate VI, 8), 3.8–4 mm. long. Two pairs of biramous setose pleopods, three pairs simple.

Ninth Furcilia (Plate VI, 9), 4.4–4.5 mm. long. Three pairs of biramous setose pleopods, two pairs simple. Second thoracic leg jointed, third and fourth unjointed with rudimentary gills. No luminous organs except on eyes.

Tenth Furcilia (Plate VI, 10, 13), 4.6 mm. long. About the same size as the ninth. Four biramous setose pleopods, one pair simple.

Eleventh Furcilia, 4.8 mm. long. Much like the twelfth, but smaller and not quite so far advanced with regard to appendages. All pleopods biramous and setose.

Twelfth Furcilia (Plate VI, 11; Plate VII, 1, 4, 5, 6, 7, 8, 9, 10, 11; Plate IX, 5, 13), 5 mm. long. Still with seven terminal spines to telson. Rostrum narrower but still very square. Antennule with longer flagella but still unjointed. Antennæ as before. Mandible with a very short-pointed rudiment of a palp. Second thoracic leg five-jointed with setose exopod and two-lobed gill and with luminous organ, third leg five-jointed with non-setose exopod and one-lobed gill, fourth leg unjointed with two terminal setæ, exopod and no gill, fifth limb rudimentary. Telson still broad, but rather more elongated. Three luminous organs on abdomen. The last *Furcilia* is thus very like that of *Nyctiphanes Couchii*, but is larger in every way and nearly 1 mm. longer. It is, however, further back in development as regards its rostrum, which is still very square, its having only three abdominal luminous organs and the telson with seven terminal spines.

The *Cyrtopia* stages, as in *Nyctiphanes*, lead gradually to the adult, and although very similar in many ways to those of *Nyctiphanes* still differ materially, so that they cannot easily be confused. They are all much bigger than the corresponding stages of *Nyctiphanes*; the telson differs in all, but most conspicuously in the younger stages, and the absence of the spine above the telson is a noteworthy feature. The eyes are still a good deal larger and more conspicuous than in *Nyctiphanes*.

The first *Cyrtopia* measures 5.5–5.6 mm. in length and has a jointed flagellum to the antennule. This is, however, still provided with setæ, and the scale is still very like the first *Furcilia*, in fact it apparently has not ceased to be a swimming organ. In the next stage it is very little different, and only in the third *Cyrtopia* do the two branches tend to be like the adult. The telson beginning with seven spines in the first *Cyrtopia* changes to five in the second, and there are three stages with five spines, then three and, finally, one. There is a difference, however, from *Nyctiphanes* for the outer long lateral spines disappear when there

are still three terminal spines, whilst in *Nyctiphanes* they disappear after the change to one terminal spine. The carapace is at first still very broad and only slightly indented behind, taking on the adult form very late. The antennules have the large lateral spine of the first peduncular segment hardly reduced at all for several *Cyrtopia* stages, at about the ninth *Cyrtopia* having the leaflet sticking up, the flagella elongating. The thoracic legs are very slightly more advanced in the first *Cyrtopia* than in *Nyctiphanes*, having the seventh leg with the rudiment of the luminous organ and gill, although only one-jointed. In the following *Cyrtopia* stages this seventh limb develops more quickly than in *Nyctiphanes* with a well-grown exopodite. Both sexes being alike as to the presence of exopodites it is not possible to tell the sex so soon as in *Nyctiphanes*, and it is only at about 13 mm. that the male pleopods begin to be modified, so that they can be distinguished from those of the female. The mandibles are slow in developing, being three-jointed at the fifth *Cyrtopia*. The gills many-lobed in the adult do not take on the final appearance for some time. At about 20 mm. the animal appears to have all the adult characters and the male pleopods are fully formed. *Meganycytiphanes norvegica* can, however, reach 40 mm. or more in length. It has not been possible to ascertain absolutely certainly the size at which it breeds, but circumstances point to any size from 20 mm., 20-35 mm. being the size of those found together with free eggs in the coastal Atlantic.

First Cyrtopia (Plate VII, 2, 12; Plate VIII, 1-15; Plate IX, 1, 6, 14), 5.5-5.6 mm. in length. Seven terminal spines to telson. All luminous organs present, those on the seventh thoracic being not quite perfect. Antennules still having the appearance of swimming organs, both rami being setose, the flagellum, however, being three-jointed, but about equal in length to the scale and armed with long terminal setæ.

Second Cyrtopia, 6-6.5 mm. long. Five terminal spines to telson. Antennules more distinctly differentiated into flagellum and scale. Rostrum more pointed, but still broad.

Third Cyrtopia, 7 mm. long. Five terminal spines to telson. Seventh thoracic leg unjointed with fully formed luminous organ, two-lobed gill and exopodite nearly half as long as the endopodite.

Fourth Cyrtopia (Plate VII, 3, 13; Plate IX, 7), 7.5-8 mm. long. Five terminal spines to telson. Flagella of antennule and antenna longer. Seventh thoracic leg with two-jointed setose endopodite, four-lobed gill and exopodite equal in length to the first joint of the endopodite. Here the size varies, and the fourth, fifth, sixth and seventh *Cyrtopia* may vary from about 7.5 to 8 mm. in length, the development of the seventh thoracic limb being the best point to show in which stage the *Cyrtopia* is. We may have the fourth *Cyrtopia* measuring 7.5 to 8 mm., having five

terminal spines, or the fifth *Cyrtopia* measuring 7.5 to 8 mm., having three terminal spines, or the sixth *Cyrtopia* measuring 7.5–8.5 mm., having three terminal spines, but the outer laterals gone, or the seventh *Cyrtopia* measuring 7.5 mm., with one terminal spine and no laterals. All of these stages showing a gradual lengthening of flagella and seventh thoracic limbs.

Fifth Cyrtopia (Plate IX, 8), 7.5–8 mm. long. Three terminal spines to telson, with outer laterals present. Flagella rather longer than in fourth stage. Seventh thoracic leg longer.

Sixth Cyrtopia (Plate IX, 9), 7.5–8.5 mm. long. Three terminal spines to telson, outer laterals gone. Flagella and seventh thoracic legs rather more advanced.

Seventh Cyrtopia, 7.5–8.5 mm. long. One terminal spine to telson, no outer laterals. Flagella and seventh thoracic leg rather more advanced.

Eighth Cyrtopia, 9 mm. long. Telson the same as in the seventh stage, but rather longer. Leaflet sticking up on first peduncular segment of antennule. Flagella and seventh thoracic legs still more advanced.

The *Cyrtopia* can now be easily recognised as *Meganyctiphanes*, and there is a gap in the material from 9 mm. (Plate IX, 10) until about 13 mm. (Plate IX, 15), when various sizes occur up to the adult. There is little difference in those of 9.5 and 13 mm., but in the males the pleopods are very slightly modified at 13 mm., just showing the rudiments of the specialised pleopods. It is interesting to follow up the development of the male organs and see how very different are the modifications in the adolescent and the adult (Plate IX, 15 to 18). It is then at 13 mm. that the sexes may be differentiated in *Meganyctiphanes*, and from that size onwards there is only a very gradual change until the adult is reached at about 20 mm.

It is thus seen that *Nyctiphanes Couchii* and *Meganyctiphanes norvegica* develop in essentially the same way even to the exact sequence in appearance of the pleopods, but in certain minor details they differ, so that they can be distinguished at any stage.

A tabular comparison may now be made with advantage:—

Larval Stage.	<i>Nyctiphanes Couchii</i> .	<i>Meganyctiphanes norvegica</i> .
Egg	Carried by ♀ in sacs.	Shed into water.
1st Nauplius.	} Only one nauplius without biramous mandibles and with 2 terminal setæ. Carried by ♀ in sacs.	Oval with biramous mandibles, no terminal setæ.
2nd Nauplius.		With 2 terminal setæ.
Pseudometanauplius.	Like metanauplius, only with skin covering true metanauplius. Hatched from sac at this stage.	Not present.
Metanauplius.	With simple margin to carapace.	With spiny margin to carapace.

Larval Stage.	<i>Nyctiphanes.</i>	<i>Meganyciphanes norvegica.</i>
1st Calyptopis.	Colourless, with red spot at base of telson, abdomen unsegmented. (Colour applies to all larval stages.)	Pinkish with diffuse red, especially in thoracic region, abdomen unsegmented. (Colour applies to all larval stages.)
2nd Calyptopis.	5 segments to abdomen.	5 segments to abdomen, slightly stouter than <i>Nyctiphanes</i> .
3rd Calyptopis.	6 segments to abdomen.	6 segments to abdomen, slightly larger than <i>Nyctiphanes</i> .
1st Furcilia.	No pleopods.	No pleopods, eyes larger than <i>Nyctiphanes</i> and carapace broader, whole animal stouter and longer (this applies to all following stages).
2nd Furcilia.	1 pair of simple pleopods.	1 pair of simple pleopods.
3rd Furcilia.	2 pairs of simple pleopods.	2 pairs of simple pleopods.
4th Furcilia.	3 pairs of simple pleopods.	3 pairs of simple pleopods.
5th Furcilia.	4 pairs of simple pleopods.	4 pairs of simple pleopods.
6th Furcilia.	1 pair setose, 3 pairs simple pleopods.	1 pair setose, 3 pairs simple pleopods.
7th Furcilia.	2 pairs setose, 2 pairs simple pleopods.	2 pairs setose, 2 pairs simple pleopods.
8th Furcilia.	2 pairs setose, 3 pairs simple pleopods.	2 pairs setose, 3 pairs simple pleopods.
9th Furcilia.	3 pairs setose, 2 pairs simple pleopods.	3 pairs setose, 2 pairs simple pleopods.
10th Furcilia.	4 pairs setose, 1 pair simple pleopods.	4 pairs setose, 1 pair simple pleopods.
11th Furcilia.	All pleopods setose and biramous.	All pleopods setose and biramous.
12th Furcilia.	5 terminal spines to telson.	7 terminal spines to telson.
1st Cyrtopia.	3 terminal spines to telson.	7 terminal spines to telson.
2nd Cyrtopia.	1 terminal spine to telson. Both pair of long laterals present.	5 terminal spines to telson.
3rd Cyrtopia.	1 terminal spine to telson, outer long lateral gone.	5 terminal spines to telson.
4th Cyrtopia.	Tip of telson elongates until adult stage is reached, 7th thoracic legs become longer, gills and exopodites develop further until at about 13 mm. adult stage is reached. May reach 17 mm.	5 terminal spines to telson.
5th Cyrtopia.		3 terminal spines to telson, outer laterals present.
6th Cyrtopia.		3 terminal spines to telson, outer laterals gone.
7th Cyrtopia.		1 terminal spine to telson, outer laterals gone. Tip of telson elongates until adult stage is reached, 7th thoracic legs become longer, gills and exopodite develop further until at about 20 mm. adult stage is reached. May reach 40 mm.

LITERATURE.

1888. BROOK, G., and HOYLE, W. E. The Metamorphosis of British Euphausiidae. Proc. Roy. Soc., Edinburgh, July 2.
1909. CALMAN, W. T. "Crustacea," in A Treatise on Zoology, edited by Sir Ray Lankester, Pt. VII, page 3.
1924. ELMHIRST, R. Annual Report, Scottish Marine Biological Association for 1922.
1908. HANSEN, H. J. Schizopoda and Cumacea. Résultats du Voyage du S. Z. Belgica. Rapp. Sci. Zool.
1911. HANSEN, H. J. The Genera and Species of the Order Euphausiacea, with Account of Remarkable Variation. Bull. de l'Inst. Océanographique, No. 210, May.
1912. HANSEN, H. J. The Schizopoda. Rep. Sci. Results of the Exp. to the E. Tropical Pacific, etc., by the U.S. Fish Comm. steamer *Albatross*. Comp. Zool., Harvard, Vol. XXXV, No. 4.
1925. HICKLING, C. F. Notes on Euphausiids. Journ. Mar. Biol. Assoc., XIII, No. 3.
1909. ILLIG, H. J. Ein Weitere Bericht über die Schizopoden der Deutschen Tiefsee Exp., 1898-9. *Nyctiphanes latifrons*, n.sp; Zool. Anz., Bd. XXXIII, 9.
1924. LEBOUR, M. V. The Euphausiidae in the Neighbourhood of Plymouth and their Importance as Herring Food. Jour. Mar. Biol. Assoc., XIII, No. 2.
1885. SARS, G. O. Report on the Schizopoda collected by H.M.S. *Challenger*, etc.

EXPLANATION OF PLATES.

ALL figures of the whole animal are drawn to one scale and those of the appendages to another scale, so that the sizes are proportional.

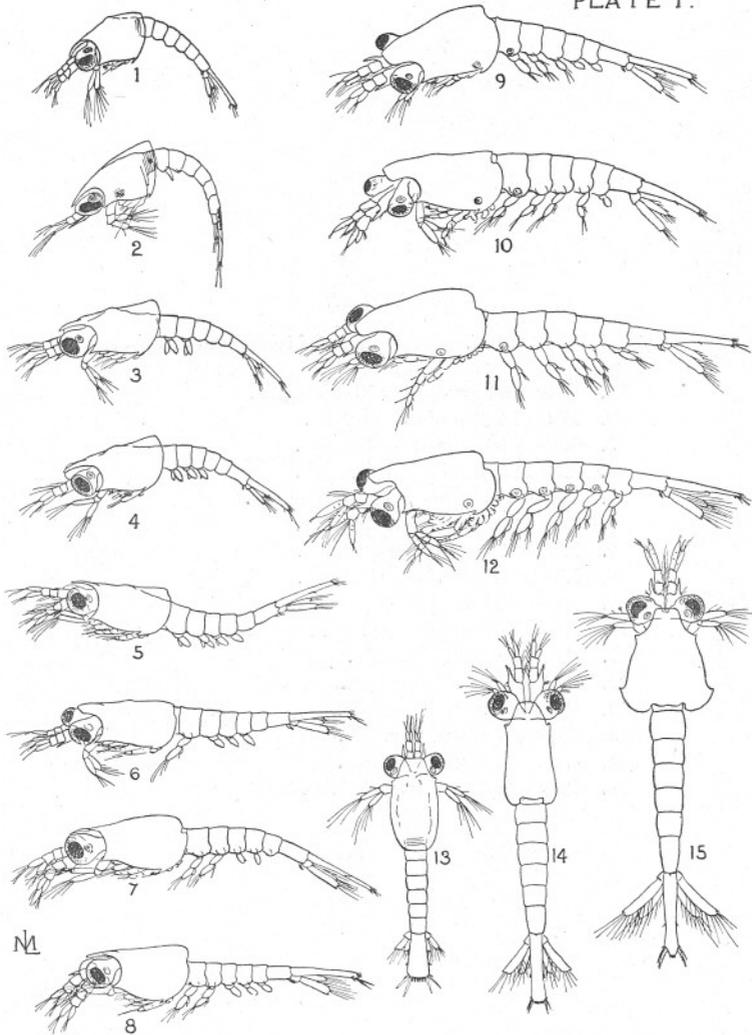
PLATE I.

Nyctiphanes Couchii. Furcilia stages.

FIG.

1. First Furcilia, 2.5 mm. long. Mr. Hickling's Atlantic material, near coast, Oct., 1924.
2. Second Furcilia, 2.5 mm. long. Station L4, off Plymouth, March, 1924.
3. Third Furcilia, 2.8 mm. long. Station L4, off Plymouth, March, 1924.
4. Fourth Furcilia, 2.8 mm. long. Mr. Hickling's Atlantic material, near coast, Oct., 1924.
5. Fifth Furcilia, 3.2-3.5 mm. long. Mr. Hickling's Atlantic material, near coast, Oct., 1924.
6. Sixth Furcilia, 3.2-3.5 mm. long. Mr. Hickling's Atlantic material, near coast, Oct., 1924.
7. Seventh Furcilia, 3.5-3.6 mm. long. Mr. Hickling's Atlantic material, near coast, Oct., 1924.
8. Eighth Furcilia, 3.2-3.6 mm. long. Mr. Hickling's Atlantic material, near coast, Oct., 1924.
9. Ninth Furcilia, 3.8 mm. long. Mr. Hickling's Atlantic material, near coast, Oct., 1924.
10. Tenth Furcilia, 4 mm. long. Station L4, off Plymouth, June, 1924.
11. Eleventh Furcilia, 4.3 mm. long. Station L4, off Plymouth, June, 1924.
12. Twelfth and last Furcilia, 4.3 mm. long. Station L4, off Plymouth, June, 1924.
13. Dorsal view of 2.
14. Dorsal view of 7.
15. Dorsal view of 12.

PLATE I.



Nyctiphanes Couchii.

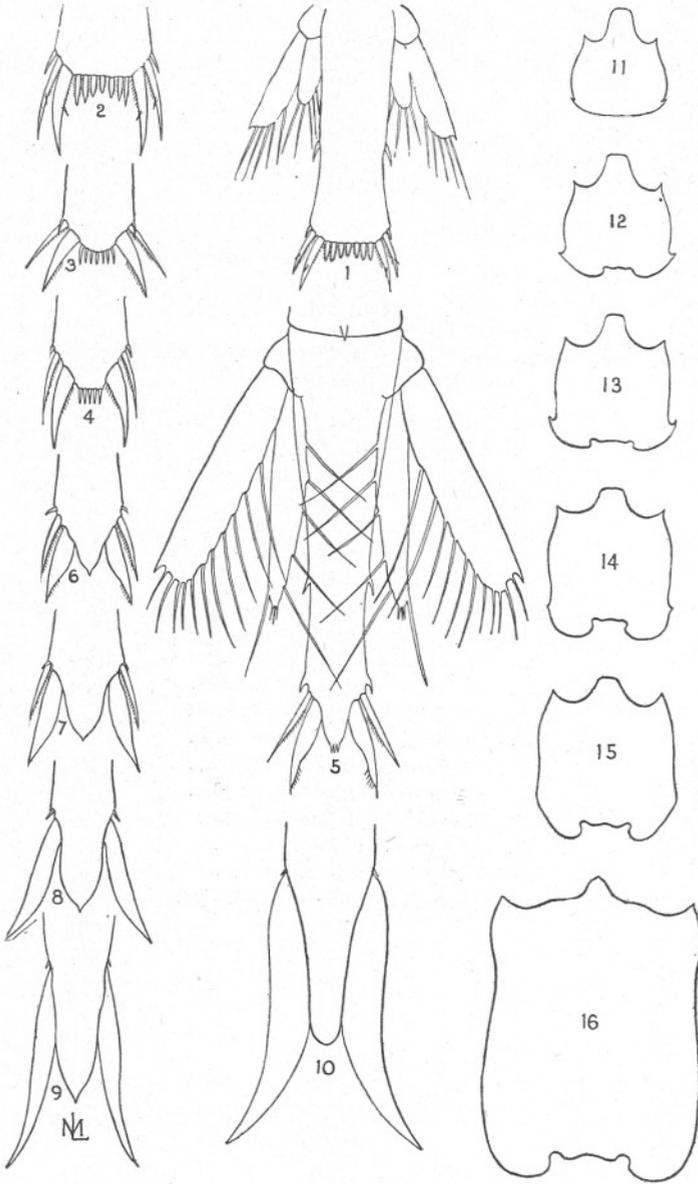
PLATE II.

Nyctiphanes Couchii. Development of telson and carapace.

FIG.

1. Telson and uropods of 1st Furcilia.
2. End of telson of 4th Furcilia.
3. End of telson of 10th Furcilia.
4. End of telson of 12th Furcilia.
5. Telson and uropods of 1st Cyrtopia.
6. End of telson of 2nd Cyrtopia.
7. End of telson of 3rd Cyrtopia.
8. End of telson of 5th Cyrtopia.
9. End of telson of 9th Cyrtopia.
10. End of telson of a specimen 12 mm. long.
11. Carapace of 3rd Furcilia.
12. Carapace of 1st Cyrtopia.
13. Carapace of 3rd Cyrtopia.
14. Carapace of 4th Cyrtopia.
15. Carapace of 5th Cyrtopia.
16. Carapace of specimen 15 mm. long.

PLATE II



Nyctiphanes Couchii.

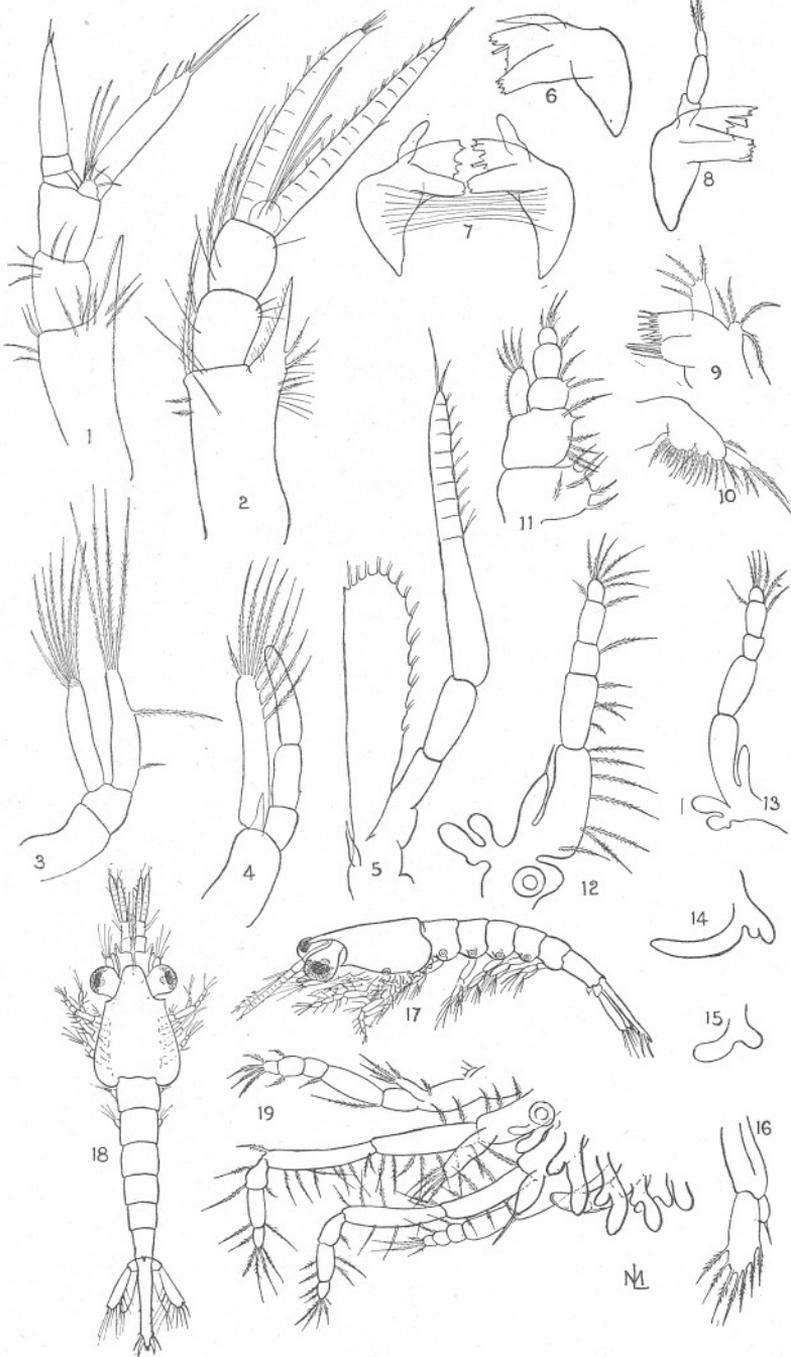
PLATE III.

Nyctiphanes Couchii. 1st Cyrtopia and appendages of last Furcilia and 1st and 3rd Cyrtopia.

FIG.

1. Antennule of last (12th) Furcilia.
2. Antennule of 1st Cyrtopia.
3. Antenna of last Furcilia.
4. Antenna of 1st Cyrtopia.
5. Antenna of 3rd Cyrtopia.
6. Mandible of last Furcilia.
7. Mandible of 1st Cyrtopia.
8. Mandible of 3rd Cyrtopia.
9. 1st maxilla of 1st Cyrtopia.
10. 2nd maxilla of 1st Cyrtopia.
11. 1st thoracic leg of last Furcilia.
12. 2nd thoracic leg of last Furcilia.
13. 3rd thoracic leg of last Furcilia.
14. 4th thoracic leg of last Furcilia.
15. 5th thoracic leg of last Furcilia.
16. Pleopod of last Furcilia.
17. 1st Cyrtopia: side view.
18. 1st Cyrtopia: dorsal view.
19. Thoracic appendages of 1st Cyrtopia.

PLATE III.



Nyctiphanes Couchii.

PLATE IV.

Nyctiphanes Couchii. Development of 7th thoracic leg in ♂

FIG.

1. 2nd Cyrtopia.
2. 3rd Cyrtopia.
3. 6th Cyrtopia.
4. 7th Cyrtopia.
5. 8th Cyrtopia.
6. 9th Cyrtopia.
7. 10th Cyrtopia.
8. 11th Cyrtopia.
9. 12th Cyrtopia.
10. 13th Cyrtopia.
11. Adult, 13 mm.

PLATE IV



Nyctiphanes Couchii

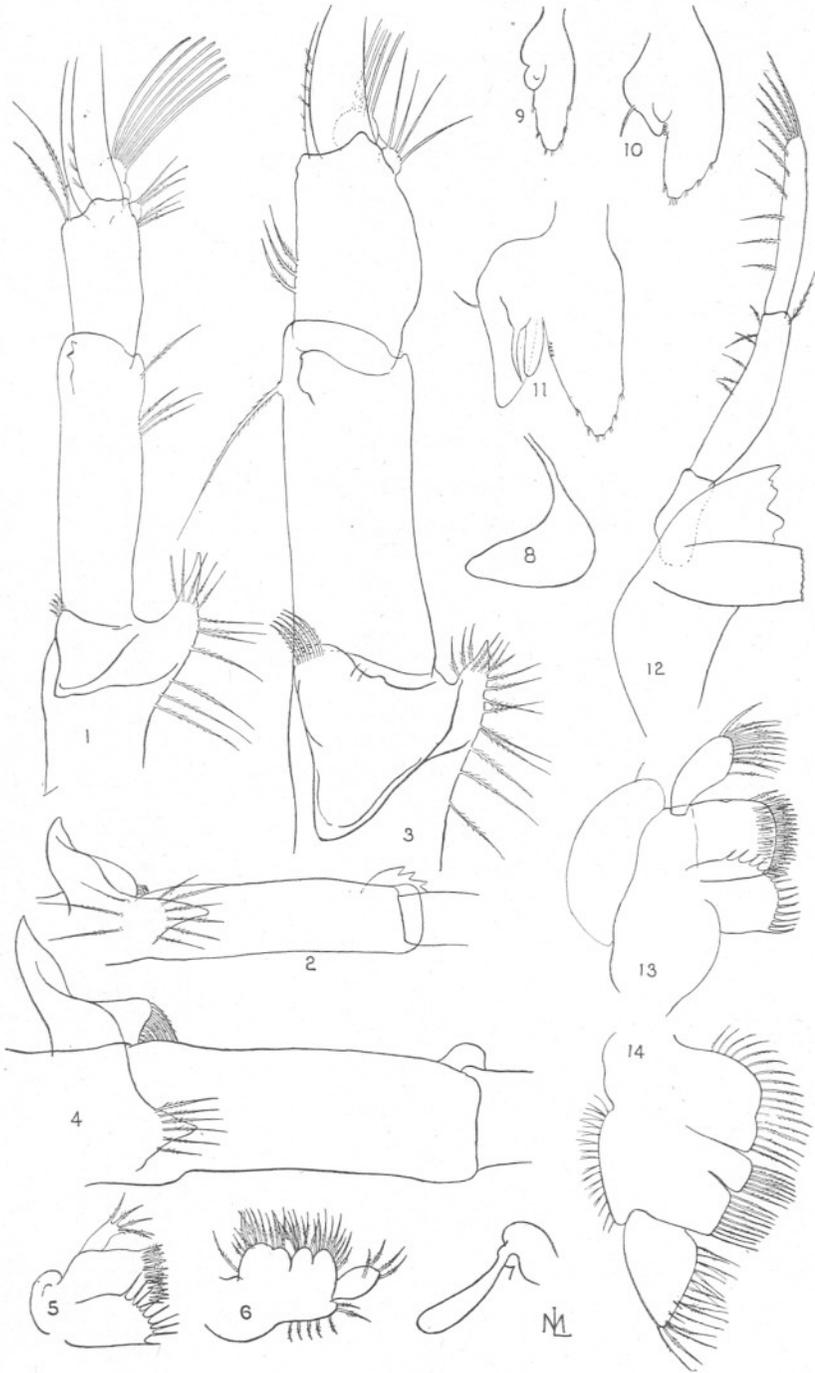
PLATE V.

Nyctiphanes Couchii. Appendages of later Cyrtopia and adult.

FIG.

1. Antennule of adult ♀, 14 mm. long, dorsal view.
2. Part of the same, side view, showing processes of first and second joints.
3. Antennule of adult ♂, 14 mm. long, dorsal view.
4. Part of the same, side view, showing processes on first and second joints.
5. 1st maxilla of 5th Cyrtopia, 6 mm. long.
6. 2nd maxilla of 5th Cyrtopia, 6 mm. long.
7. 8th thoracic leg of 9th Cyrtopia, 8 mm. long.
8. Spermatophore of ♂ of 9 mm.
9. Inner ramus of 1st pleopod of ♂ 5th Cyrtopia, 6 mm. long.
10. Inner ramus of 1st pleopod of ♂ 9th Cyrtopia, 8 mm. long.
11. Inner ramus of 1st pleopod of adult ♂, 14 mm. long.
12. Mandible of adult, 14 mm.
13. 1st maxilla of adult, 14 mm.
14. 2nd maxilla of adult, 14 mm.

PLATE V



Nyctiphanes Couchii

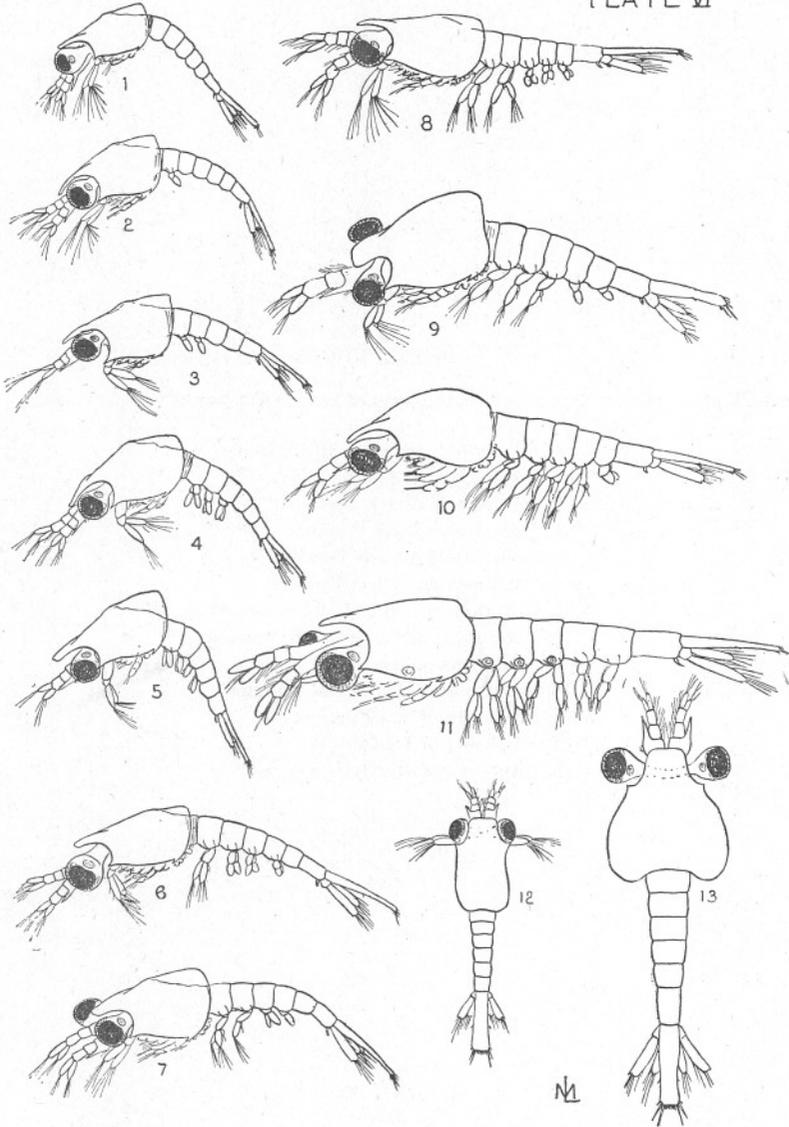
PLATE VI.

Meganyctiphanes norvegica. Furcilia stages.

FIG.

1. 1st Furcilia, 2.8 mm. long, beyond Eddystone, May, 1925.
2. 2nd Furcilia, 3 mm. long, beyond Eddystone, May, 1925.
3. 3rd Furcilia, 3 mm. long, Station E1, April, 1924.
4. 4th Furcilia, 3.5 mm. long, Station E1, April, 1924.
5. 5th Furcilia, 3.5 mm. long, beyond Eddystone, May, 1925.
6. 6th Furcilia, 3.8 mm. long, beyond Eddystone, May, 1925.
7. 7th Furcilia, 3.8 mm. long, beyond Eddystone, May, 1925.
8. 8th Furcilia, 4 mm. long, Station E1, April, 1924.
9. 9th Furcilia, 4.4 mm. long, Station E1, April, 1924.
10. 10th Furcilia, 4.6 mm. long, Station E1, April, 1924.
11. 12th Furcilia, 5 mm. long, Station L4, May, 1924.
12. Dorsal view of 3.
13. Dorsal view of 10.

PLATE VI



Meganyctiphanes norvegica.

PLATE VII.

Meganyctiphanes norvegica. Appendages of last Furcilia and Cyrtopia stages.

FIG.

1. Antennule of last (12th) Furcilia.
2. Antennule of 1st Cyrtopia.
3. Antennule of 4th Cyrtopia.
4. Mandible of last Furcilia.
5. 1st maxilla of last Furcilia.
6. 2nd maxilla of last Furcilia.
7. 1st thoracic leg of last Furcilia.
8. 2nd thoracic leg of last Furcilia.
9. 3rd thoracic leg of last Furcilia.
10. 4th thoracic leg of last Furcilia.
11. Antenna of last Furcilia.
12. Antenna of 1st Cyrtopia.
13. Antenna of 4th Cyrtopia.



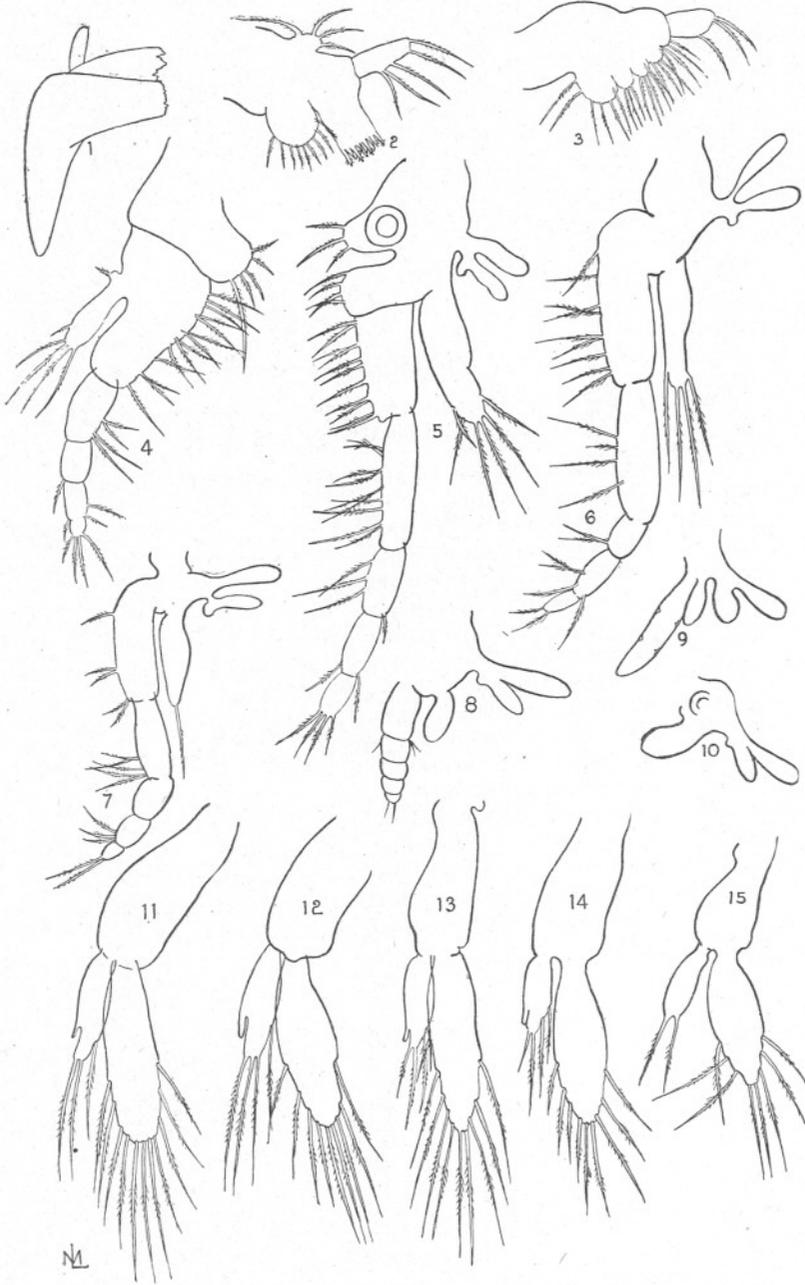
Meganyctiphanes norvegica.

PLATE VIII.

Meganyctiphanes norvegica. Appendages of 1st Cyrtopia

FIG.

1. Mandible.
2. 1st maxilla.
3. 2nd maxilla.
4. 1st thoracic leg.
5. 2nd thoracic leg.
6. 3rd thoracic leg.
7. 4th thoracic leg of 1st Cyrtopia.
8. 5th thoracic leg of 1st Cyrtopia.
9. 6th thoracic leg of 1st Cyrtopia.
10. 7th thoracic leg of 1st Cyrtopia.
11. 1st pleopod of 1st Cyrtopia.
12. 2nd pleopod of 1st Cyrtopia.
13. 3rd pleopod of 1st Cyrtopia.
14. 4th pleopod of 1st Cyrtopia.
15. 5th pleopod of 1st Cyrtopia.



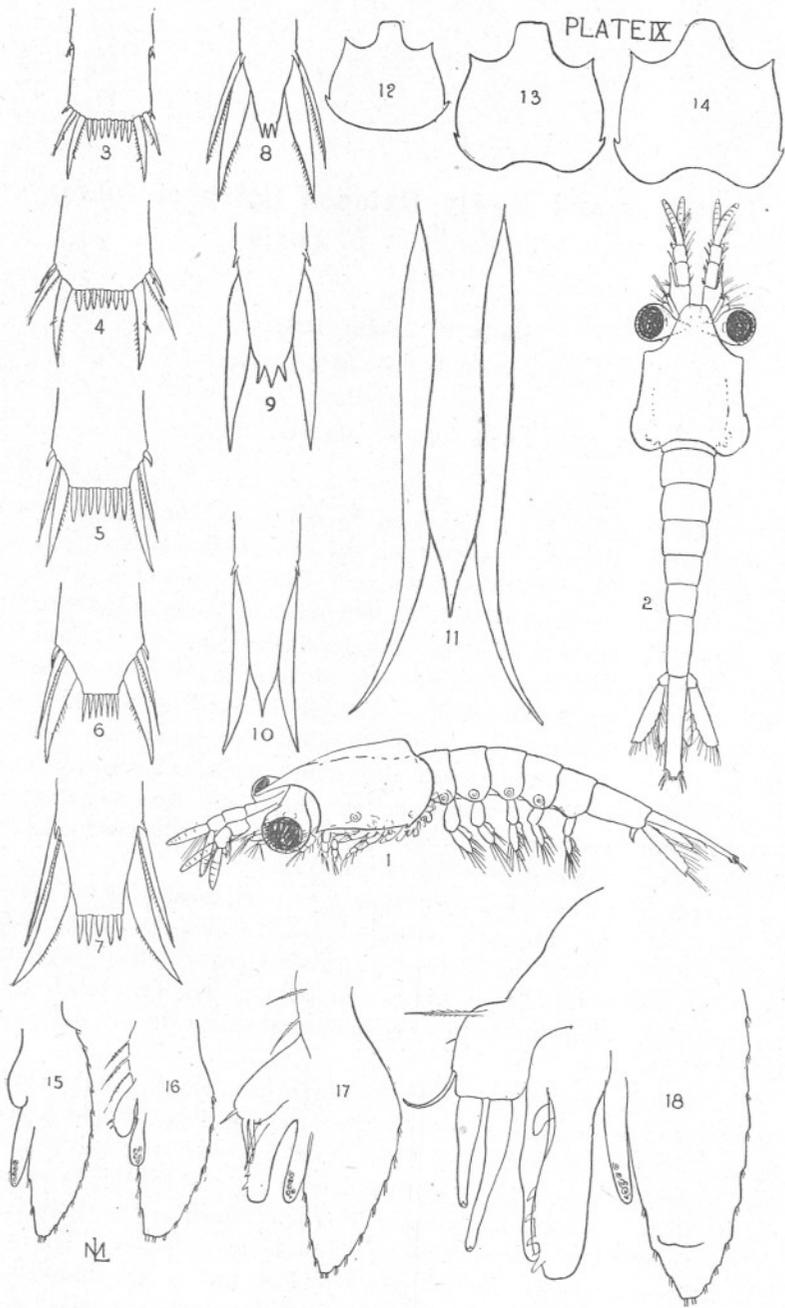
Meganyctiphanes norvegica.

PLATE IX.

Meganyctiphanes norvegica. 1st Cyrtopia; development of telson and carapace in Furcilia and Cyrtopia.

FIG.

1. 1st Cyrtopia, 5.6 mm. long, side view, Station L4, June, 1924.
2. The same, dorsal view.
3. End of telson of 1st Furcilia.
4. End of telson of 4th Furcilia.
5. End of telson of 12th Furcilia.
6. End of telson of 1st Cyrtopia.
7. End of telson of 4th Cyrtopia.
8. End of telson of 5th Cyrtopia, 7.5 mm. long.
9. End of telson of 6th Cyrtopia, 8.5 mm. long.
10. End of telson of 8th Cyrtopia, 9 mm. long.
11. End of telson of adult, 20 mm. long.
12. Carapace of 3rd Furcilia.
13. Carapace of last Furcilia.
14. Carapace of 1st Cyrtopia.
15. Inner ramus of 1st pleopod of ♂, 13 mm. long.
16. Inner ramus of 1st pleopod of ♂, 15 mm. long.
17. Inner ramus of 1st pleopod of ♂, 17 mm. long.
18. Inner ramus of 1st pleopod of ♂ adult, 25 mm. long.



Meganyctiphanes norvegica.