

THE
ANNALS & MAGAZINE
OF
NATURAL HISTORY

(INCORPORATING 'THE JOURNAL OF BOTANY')

ZOOLOGY, BOTANY, AND GEOLOGY

BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH MESSRS.
LOUDON AND CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY'

CONDUCTED BY

HERBERT L. HAWKINS, D.Sc., F.R.S.

G. TAYLOR, D.Sc.

E. B. BRITTON, M.Sc.

AND

G. O. EVANS, M.Sc., Ph.D.

VOL. 3.—13TH SERIES

LONDON:

PRINTED IN ENGLAND AND PUBLISHED BY

TAYLOR & FRANCIS, LTD., RED LION COURT, FLEET ST., E.C.4

1960

A KEY TO THE ASCIDICOLOUS COPEPODS OF BRITISH WATERS WITH DISTRIBUTIONAL NOTES.

By R. V. GOTTO,

Department of Zoology, Queen's University, Belfast.

INTRODUCTION.

ASCIDIANS and copepods can fairly be regarded as two groups which have inspired a considerable volume of marine biological research. There exists, however, a field of investigation, scarcely explored as yet, where these very different animals overlap to provide notable examples of commensal and parasitic ways of life. Both Gray (1933) and, later, Illg (1958) have remarked on the paucity of information about copepods which dwell in ascidians, not only as to their taxonomy, but also as regards their distribution, life-cycles, and relations with the host organism. Even in an area as well known as the coastal waters of Britain, and as lately as 1935, Leigh-Sharpe was able to list only seven species of ascidicolous copepods. Today, over thirty have been recorded, and this number will probably be increased as more of the remaining three dozen species described from the Atlantic coasts of Europe and the Mediterranean are found to include our islands in their westward range.

Since courses at marine biological stations and university classes in Zoology provide frequent opportunities for the examination of fairly large numbers of ascidians, it should be possible to acquire much additional information about these interesting associates. The time may therefore be appropriate to present a key for the identification of British species. In constructing this key I have borne in mind the probability that those using it will not necessarily be copepod specialists, and have therefore tried whenever possible to select characters which will be familiar to those possessing a knowledge of crustacean morphology in general. A pair of fine dissecting needles, a micrometer eye-piece, and a fairly viscid mounting substance in which the copepod can be orientated on the slide, are all the equipment which should be necessary. The needles can be used almost wholly for simple manipulation of the specimen, since characters depending upon actual dissection have very largely been avoided.

Although other keys exist for the determination of certain groups of ascidicolous copepods, none is wholly satisfactory. Those of Schellenberg (in German) are somewhat out of date, having appeared in 1922, while the recent paper by Illg (1958), although extremely valuable, is concerned solely with the family Notodelphyidae, and largely with its North American representatives. The descriptions and illustrations of Sars (1918-21) remain indispensable and should always be consulted, but are now incomplete and do not provide keys.

GENERAL CONSIDERATIONS.

Broadly speaking, the ascidicolous copepods fall into two main groups. There are, first, several species of poecilostomatous cyclopoids belonging to the genera *Lichomolgus* and *Lichomolgides*, which, although constantly found within ascidians, retain in marked degree the structure and activity characteristic of free-living forms. Secondly, there is a large assemblage of copepods which show more or less obvious modifications towards a commensalistic or parasitic existence and which are, for the most part, sluggish in their behaviour. Up to the present, these latter have been lumped together as a very heterogeneous sub-order, the Notodelphyoida. The unreality of this sub-order as a natural unit has long been apparent, and Lang (1948) has presented convincing arguments for distributing its constituent genera amongst the gnathostomatous and poecilostomatous cyclopoids. There can be little doubt that any future classification of the groups involved will be considerably influenced by these proposals. However, since existing reference volumes utilise the divisions Cyclopoida and Notodelphyoida, these terms are retained as a matter of convenience in the present key.

Almost any region of the tunicate body may harbour ascidicoles. The pharynx is a favourite location for many species, but oesophagus, stomach, intestine and rectum are also liable to be infected. Similarly, the epicardium, the tunic, the matrix and cloacal cavities of compound forms, the canal system of botryllids, and even the ventral blood vessel may be tenanted. So little is known as to the mode of life that it is difficult to say with certainty where commensalism ends and parasitism begins. In general, ascidicolous copepods appear to have but little effect on their hosts. However, in colonial tunicates with small zooids displacement and deformation of the alimentary canal may occur as a result of the presence of enterocolids, and both enterocolids and haplostomids may inhibit or disturb the development of the ascidian's reproductive organs (Canu, 1892 ; Brément, 1911).

Male ascidicoles are known only in a relatively small number of genera. As Illg (*loc. cit.*) points out, this may mean either that they are predominantly free-swimming, or that they may leave the host subsequent to its capture but before it can be examined. The key is therefore confined to mature females. It should, however, be noted that in the genus *Agnathaner* Canu, only the male is known. This is not included in the key, but appears in the list at the end of this paper.

The list referred to is divided into two sections. The first section supplements the key in providing a record of the known hosts for each British species, the distribution of the copepod in the waters of Great Britain and Ireland from the Shetlands in the north to the Channel Isles in the south, its occurrence on the western European seaboard from northern Norway to Naples, and a reference to a fuller description of the species. Where known, the site occupied by the copepod within the ascidian is given in brackets after the list of hosts. The second section provides similar information for all the ascidicolous copepods so far

recorded from western Europe, but which have not, up to the present, been observed in our area. The references given after each species are not necessarily those of the original describers, but those which afford the best information for confirming identity. Illg's paper has been of great assistance in compiling the list of hosts, but I have endeavoured as far as possible to straighten out the synonymy of the ascidians concerned, a good many of which appear under different names—as, indeed, Illg himself realized. The copepod nomenclature is also based on that used by Illg.

KEY TO KNOWN BRITISH SPECIES.*

- A. Body form typically cyclopoid ; eggs small, numerous,
and carried in two elongate-oval egg-sacs (Fig. 1) . . . Cyclopoida.
B. Body form not cyclopoid ; eggs fewer, rather large,
and not carried in oval sacs Notodelphyoida.

A. CYCLOPOIDA.

1. Cephalic region sharply defined from rest of cephalo-
thorax ; a ventrally produced median structure
terminating in two slightly curved hooks occurs
just behind the mouth ; in colonies of *Trididem-
num tenerum* and perhaps in other didemnids . . . Lichomolgides (*cuanensis*).
(Fig. 28.)

Cephalic region not sharply defined from rest of
cephalothorax ; no post-oral hooked structure
(Fig. 1)

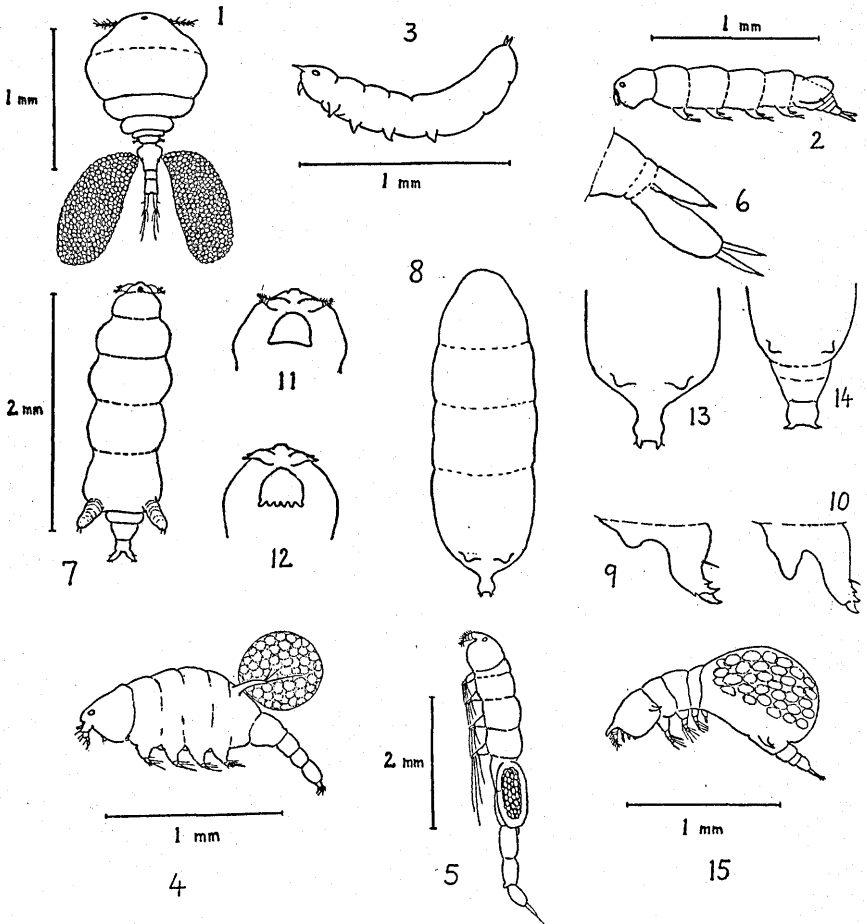
2. Furcal setae less than $\frac{1}{2}$ the length of the ramus ; in
simple ascidians 3.
Furcal setae at least 1.5 times as long as the ramus . . . 4.
Furcal setae not bearing either of the above relations
to length of ramus 5.
3. Furcal rami very slender and elongated, somewhat
bent slightly anterior to the middle ; anal seg-
ment very long ; last three abdominal segments
combined slightly shorter than ramus (fig. 29) . . . *L. forficula*.
Furcal rami long, but not as slender as in the
preceding species, and not bent ; last three
abdominal segments combined about equal in
length to the ramus *L. marginatus*.
4. Furcal rami at least twice the length of the anal
segment, initially tapered but with a slight distal
expansion (fig. 30) *L. tenuifurcatus*.
Furcal rami equal in length to the anal segment ;
in *Didemnum maculosum* *L. didemni*. (Fig. 1.)
5. Furcal setae approximately $\frac{1}{2}$ the length of the
ramus ; anal segment slightly longer than broad
Furcal setae approximately equal in length to
ramus ; anal segment slightly broader than long
L. albens.
L. furcillatus.

B. NOTODELPHYOIDA.

1. Body caterpillar-like or sausage-shaped (figs. 2, 3) ;
no brood pouch ; appendages somewhat reduced 2.
Body form various, but neither caterpillar-like nor
sausage-shaped 6.

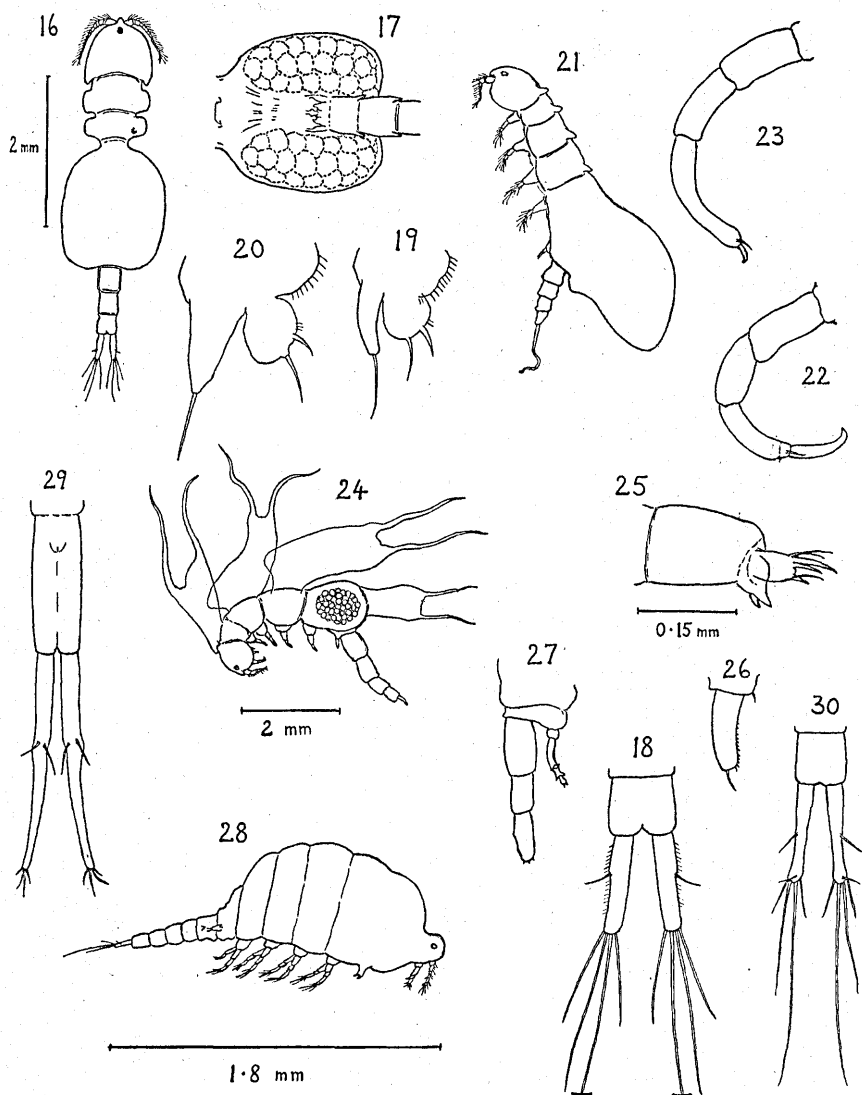
* *Notodelphys rufescens* and *N. tenera* are included in this key, although not so far recorded from British waters. However, they so closely resemble other members of the genus that they may have been overlooked.

Figs. 1-15.



1. *Lichomolgus didemni* with egg-sacs, dorsal view.
2. *Enterocola fulgens*, lateral view.
3. *Mycophilus roseus*, lateral view.
4. *Botryllophilus ruber* with egg-sac, lateral view.
5. *Ascidicola rosea* with egg-masses, lateral view.
6. Fourth leg of *Enterocola fulgens*, showing the two endopodal setae.
7. *Haplostoma brevicauda*, dorsal view, showing the two blunt dorso-lateral cones (modified fifth legs) on the last thoracic segment.
8. *Haplostomides hibernicus*, dorsal view.
9. Leg of *H. hibernicus*, showing exopod bearing claws, and endopod reduced to a slight swelling.
10. Leg of *Haplostomides scotti*, showing triangular endopod.
11. Cephalic area of *Haplostoma brevicauda*, ventral view, showing bell-shaped anterior lip with smooth posterior margin.
12. Similar view of *Haplostoma banyulensis*, showing notched posterior margin of anterior lip.
13. Posterior part of metasome and urosome of *Haplostomides hibernicus*, dorsal view, showing small dorso-lateral cones and posteriorly-pointing furcal claws.
14. Similar view of *H. scotti*, showing furcal claws pointing ventro-laterally.
15. *Doroizys uncinata*, lateral view.

Figs. 16-30.



16. *Notodelphys allmani*, dorsal view. 17. Brood pouch of *N. allmani*, ventral view, showing the small fifth pair of legs, centrally situated. 18. Anal segment and caudal rami of *Notodelphys allmani*. 19. Fifth leg of *Notodelphys elegans*. 20. Fifth leg of *N. allmani*. 21. *Doropygella porcicauda*, lateral view. 22. Antenna of *Doropygella pulex*. 23. Antenna of *Doropygella psyllus*. 24. *Notopterochorus papilio*, lateral view. 25. Anal segment, showing the two short ventral projections, and caudal rami of *Botachus cylindratus*, lateral view. 26. Fifth leg of *Pachypygus gibber*. 27. Third leg of *Gunenotophorus globularis*. 28. *Lichomolgus cuanensis*, lateral view. 29. Anal segment and caudal rami of *Lichomolgus forficula*. 30. Anal segment and caudal rami of *Lichomolgus tenuifurcatus*. Several of the figures are based on those of Sars, Canu, Chatton and Brément.

2. Body sausage-shaped, with or without a distinct urosome (figs. 3, 7, 8) 3.
 Body caterpillar-like, urosome distinct; broad dorso-lateral lamellæ on last thoracic segment (fig. 2) 5.
3. No distinct urosome; fifth legs missing, others reduced to short, simple cones; furca reduced to two spatulate projections; eggs laid singly or in groups; both eggs and adult various shades of red; in botryllids *Mycophilus (roseus)*. (Fig. 3.)
 Urosome small but distinct; four ventral pairs of legs present, markedly reduced, with exopod longer than endopod and bearing a few short claws (figs. 7, 8, 9, 10) 4.
4. Two blunt cones situated dorso-laterally on last thoracic segment; caudal rami at least $\frac{2}{3}$ the length of the anal segment; maxillules and maxillæ absent *Haplostoma* (i).
 (i) Posterior margin of anterior lip smooth (fig. 11) *H. brevicauda*.
 Posterior margin of anterior lip with several distinct notches (fig. 12) (ii).
 (ii) Egg-strings long and moniliform; in didemnids *H. banyulensis*.
 Egg-strings long but not moniliform; in simple ascidians *H. eruca*.
- The two blunt dorso-lateral cones very small and inconspicuous, as are the legs; caudal rami not exceeding half the length of the anal segment; maxillules and maxillæ present (figs. 8, 13, 14) .. *Haplostomides* (iii).
 (iii) Urosome narrows gradually to anal segment; furcal claws point ventro-laterally (fig. 14); endopod prominent and triangular (fig. 10) *H. scotti*.
 Urosome abruptly defined from metasome; tips of furca point horizontally and posteriorly (fig. 13); endopod represented only by a slight swelling (fig. 9) *H. hibernicus*. (Fig. 8.)
5. Four ventral pairs of legs present, somewhat reduced, with endopod longer than exopod and bearing only two setæ terminally situated (fig. 6); last thoracic segment with a pair of broad dorso-lateral lamellæ which protect the proximal ends of ovisacs containing large red or violet eggs. *Enterocola* (iv).
 (iv) Dorsal surface of metasome with four pairs of overlapping folds; in didemnids *E. pterophora*.
 Dorsal surface without overlapping folds *E. fulgens*. (Fig. 2.)
6. Eggs contained in a brood pouch 7.
 Eggs either carried dorsally as an unprotected globular mass (fig. 4), or as two flattened ovate masses completely protected by lamellate oostegites (fig. 5) 8.
7. Host a simple ascidian 9.
 Host a compound ascidian; large dorsal brood pouch; last pair of legs inconspicuous, uniramous, spur-like; hook present near postero-ventral edge of cephalic segment; rostrum pronounced *Doroixys (uncinata)*. (Fig. 15.)
8. Fifth pair of legs attenuated cylindrical uniramous projections situated dorso-laterally and supporting the unprotected globular egg-mass; in compound ascidians *Botryllophilus (ruber)*. (Fig. 4.)
- Body narrow, elongate; endopods bearing several exceptionally long setæ; two flattened ovate egg-masses completely overarched by large lamellate oostegites; in simple ascidians *Ascidicola (rosea)*. (Fig. 5.)

9. Body more or less depressed ; last pair of legs biramous, but very small and inconspicuous ; furcal setae long and plumose ; brood pouch prominent, somewhat rounded in lateral view ; comparatively active forms (figs. 16, 17)..... Notodelphys (v).
 These characters not united 10.
- (v) Caudal ramus shorter than anal segment.... *N. prasina*.
 Caudal ramus equal to, or longer than anal segment (vi).
- (vi) Brood pouch rounded and as broad as, or broader than it is long *N. tenera*.
 Brood pouch longer than broad (vii).
- (vii) Caudal rami ciliated along their outer edges, but lacking ciliation on the inner edges almost completely (viii).
 Caudal rami ciliated along their outer edges and along the greater part of their inner edges as well (ix).
- (viii) Outer edge seta of ramus situated at least half way along ramus from distal end ; brood pouch oval (fig. 18) *N. agilis*.
- (ix) Outer edge seta situated $\frac{1}{4}$ — $\frac{1}{2}$ way along ramus from distal end (x).
- (x) Exopod of fifth leg of nearly equal width throughout its length (fig. 19) *N. elegans*.
 Exopod of fifth leg noticeably tapers towards its distal end (fig. 20) (xi).
- (xi) Brood pouch rectangular (almost square) in outline when viewed dorsally..... *N. allmani*. (Fig. 16.)
 Brood pouch oval in outline (xii).
- (xii) Antennal claw about half the length of the joint which bears it ; outer edge seta situated about $\frac{1}{3}$ from the distal end *N. rufescens*.
 Antennal claw $\frac{1}{2}$ the length of joint ; outer edge seta situated almost half way from distal end *N. caerulea*.
10. Body more or less compressed ; caudal rami straight, longer than anal segment, lacking claws, and either rectilinear in form or else produced distally into a long, mobile lash ; furcal setae, if present, very short ; a prominent brood pouch overhangs urosome, giving a marked "hunch-back" effect in lateral view ; sluggish forms.... Doropygus or Doropygella.
 These characters not united 11. (xiii).
- (xiii) Caudal ramus drawn distally into a long mobile lash ; a small knob-like protuberance is present on each side at the postero-dorsal borders of the cephalic and anterior thoracic segments Doropygella (*porcicauda*).
 (Fig. 21.)
- Caudal ramus tapered and bearing very short rudimentary setae at its tip ; no postero-dorsal protuberances..... (xiv).
- (xiv) Brood pouch produced to a blunt point posteriorly ; terminal claw of antenna strong and about half as long as the joint which bears it (fig. 22) Doropygus (*pulex*).
 Brood pouch evenly rounded posteriorly ; terminal claw of antenna weak and only about one-eighth as long as the joint which bears it (fig. 23) Doropygella (*psyllus*).

- | | |
|---|--------------------------------------|
| 11. Thoracic segments produced dorsally into three large rounded humps, or into very large alate processes ending distally in thread-like projections (xv) Three large rounded humps on thoracic segments | Notopterophorus (xv). |
| Conspicuous alate processes on dorsal surface of thorax | <i>N. auritus</i> . |
| Thoracic segments not produced in either of the above ways | <i>N. papilio</i> . (Fig. 24.) |
| 12. Caudal rami curved; furcal claws, if present, considerably shorter than ramus | 12. |
| Caudal rami short, straight, and bearing claws equal in length to the ramus | 13. |
| 13. Large copepods (over 3.5 mm. long), of a globular appearance, due to the dome-like brood pouch .. | 14. |
| 14. Small copepods (less than 2.5 mm. long), of elongate form; anal segment produced ventrally into two short projections (fig. 25) | 15. |
| 15. First four pairs of legs with strongly developed spines and setæ; fifth leg small and uniramous (fig. 26) | <i>Botachus (cylindratus)</i> . |
| Second, third and fourth legs almost completely devoid of spines and setæ; fifth leg absent (fig. 27) | <i>Pachypygus (gibber)</i> . |
| | <i>Gunenotophorus (globularis)</i> . |

SPECIES RECORDED FROM BRITISH WATERS.

Notodelphys allmani Thorell.

Hosts : *Ascidia mentula*; *A. virginea*; *A. conchilega*; *A. obliqua*; *A. sydneyensis*; *Ascidiella aspersa*; *A. opalina*; *Phallusia mammillata*; *P. fumigata*; *Ciona intestinalis*; *C. papillosa* (Pharynx).

Distribution : British Isles—widely distributed. Western Europe—Scandinavian coasts to Mediterranean.

Reference : Sars, 1921.

Notodelphys caerulea Thorell.

Hosts : *Ascidia virginea*; ? *A. mentula*; *Corella parallelogramma* (Pharynx).

Distribution : British Isles—Shetlands, north-east England, western Ireland. Western Europe—Atlantic coast to Norway and Sweden.

Reference : Sars, 1921.

Notodelphys agilis Thorell.

Hosts : *Ascidia mentula*; *A. virginea*; *A. obliqua*; *Ascidiella aspersa*; *A. opalina*; *A. patula*; *Ciona intestinalis*; *Corella parallelogramma*; *Molgula manhattensis*; *M. holtiana*; *Polycarpa fibrosa*; *P. gracilis* (Pharynx).

Distribution : British Isles—widely distributed. Western Europe—Atlantic coast and Mediterranean.

Reference : Sars, 1921.

Notodelphys elegans Thorell.

Host : *Ciona intestinalis* (Pharynx).

Distribution : British Isles—Southampton ; Jersey. Western Europe—Norway and Sweden to Mediterranean.

Reference : Sars, 1921.

Notodelphys prasina Thorell.

Hosts : *Ascidia mentula*; *Ascidiella aspersa*; *Phallusia mammillata*; *Ciona intestinalis* (Pharynx).

Distribution : British Isles—Shetlands ; north Scotland ; Plymouth. Western Europe—Norwegian and Swedish coasts ; Mediterranean.

Reference : Sars, 1921.

Agnathaner typicus Canu. (Male only known.)

Hosts : *Polycarpa rustica*; *Dendrodoa (Styelopsis) grossularia*; and in dredged material.

Distribution : British Isles—Plymouth. Western Europe—south coast of Norway ; north coast of France.

Reference : Sars, 1921.

Doropygus pulex Thorell.

Hosts : *Ascidia mentula*; *A. virginea*; *A. conchilega*; *A. obliqua*; *Ascidiella aspersa*; *A. scabra*; *A. patula*; *A. opalina*; *Ciona intestinalis*; *Corella parallelogramma*; *Pyura microcosmus*; *P. momus*; *P. squamulosa*; *P. stolonifera*; *P. tessellata*; *Polycarpa pomaria*; ? *Styela partita*; *S. coriacea*; *S. rustica*; *Dendrodoa (Styelopsis) grossularia* (Pharynx).

Distribution : British Isles—widely distributed. Western Europe—Scandinavia to Mediterranean.

Reference : Sars, 1921.

Doropygella psyllus (Thorell).

Hosts : *Ascidia virginea*; *A. conchilega*; *Ascidiella aspersa*; *A. patula*; *Phallusia fumigata* (Pharynx).

Distribution : British Isles—south-west Scotland ; north-east Ireland. Western Europe—Norwegian and Swedish coasts ; Channel coast of France ; Mediterranean.

Reference : Sars, 1921 (under *Doropygus*).

Doropygella porcicauda (Brady).

Hosts : *Ascidia conchilega*; *Corella parallelogramma* (Pharynx).

Distribution : British Isles—south-west Scotland ; west and north-east Ireland ; north-east England ; Isle of Man. Western Europe—west coast of Norway.

Reference : Sars, 1921 (under *Doropygus*).

A doropygid originally found by Norman (see Brady, 1878), and given the name *Doropygus normani* has been recorded from western Ireland,

southern England and the Mediterranean. It apparently bears a close superficial resemblance to *Doropygella psyllus*, but has never been adequately described, so that its exact identity remains uncertain.

Pachypygus gibber (Thorell).

Hosts : *Ascidia mentula*; *A. obliqua*; *A. virginea*; *Ascidiella aspersa*; *A. patula*; *Phallusia fumigata*; *Ciona intestinalis*; *Corella parallelogramma*; *Clavelina lepadiformis*; *Molgula manhattensis*; *M. oculata*; *Polycarpa fibrosa*; *P. gracilis*; *Pyura microcosmus* (Oesophagus).

Distribution : British Isles—south-west Scotland ; north-east Ireland ; southern England. Western Europe—Norway and Sweden to Mediterranean.

Reference : Sars, 1921.

Notopterophorus auritus (Thorell).

Hosts : *Ascidia mentula*; *A. obliqua*; *A. virginea*; *Ciona intestinalis* (Pharynx).

Distribution : British Isles—Shetlands ; western Ireland ; Cornwall. Western Europe—Norwegian and Swedish coasts.

Reference : Sars, 1921.

Notopterophorus papilio Hesse.

Hosts : *Ascidia mentula*; *A. obliqua*; ? *A. virginea*; *Ciona intestinalis* (Pharynx).

Distribution : British Isles—Shetlands ; north and west Scotland ; north-east and west Ireland ; Isle of Man ; south England ; Channel Isles. Western Europe—Norwegian coast to Mediterranean.

Reference : Sars, 1921.

Botachus cylindratus Thorell.

Hosts : *Ascidia mentula*; *A. conchilega*; *A. obliqua*; *Ascidiella scabra*; *Phallusia mammillata*; *Ciona intestinalis* (Pharynx, intestine).

Distribution : British Isles—Shetlands ; north and west Scotland ; north-east Ireland ; Isle of Man ; south England. Western Europe—Norway and Sweden to Mediterranean.

Reference : Sars, 1921.

Gunenotophorus globularis Buchholz.

Hosts : *Ascidia mentula*; *A. conchilega*; *A. obliqua*; *A. prunum*; *Phallusia mammillata*; *Ciona intestinalis*; *Microcosmus sulcatus*; *Molgula manhattensis*; *Pyura lurida*; *Polycarpa fibrosa*; *P. pomaria*; *Styela coriacea*; *S. rustica*; *S. plicata*; *Dendrodoa (Styelopsis) grossularia* (Pharynx).

Distribution : British Isles—south-west Scotland ; north-east and south England ; north-east Ireland. Western Europe—Norway and Sweden to Mediterranean.

Reference : Sars, 1921.

Doroicyx uncinata Kerschner.

Hosts : *Polyclinum aurantium*; *Morchellium argus*; *Aplidium* (*Amaroucium*) *punctum*; *A. crystallinum*; *A. gibbulosum*; *Sidnyum turbinatum*; *S. elegans*; *Diazona violacea*; *Perophora listeri*; *Botryllus schlosseri*; *Botrylloides* sp. (Pharynx).

Distribution : British Isles—north-east Ireland. Western Europe—north coast of France ; Mediterranean.

Reference : Canu, 1892.

Ascidicola rosea Thorell.

Hosts : *Ascidia mentula*; *A. obliqua*; *Ascidiella aspersa*; *A. opalina*; *Ciona intestinalis*; *Halocynthia papillosa*; *Corella parallelogramma*; *Pyura squamulosa* (Pharynx, oesophagus, stomach, intestine and rectum).

Distribution : British Isles—widely distributed. Western Europe—Scandinavian coasts to Mediterranean.

Reference : Sars, 1921, and see Gotto, 1957 b.

Botryllophilus ruber Hesse.

Hosts : *Botryllus schlosseri*; *Botrylloides leachi*; *Aplidium* (*Amaroucium*) *punctum*; *A. (A.) proliferum*; *Amaroucium lacteum*; *Morchellium argus*; *Polycarpa pomaria*; *Sidnyum elegans*; *Molgula complanata*; *Polycitor pancerii*; *Leptoclinides faeroensis*.

Distribution : British Isles—Clyde and Moray Firths ; south Devon ; north-east Ireland. Western Europe—Scandinavia to Mediterranean.

Reference : Sars, 1921, and see Lang, 1948.

Enterocola fulgens P. J. van Beneden. (= *E. betencourti* Canu.)

Hosts : *Polyclinum aurantium*; *Synoicum pulmonaria*; *Aplidium pallidum*; *A. crystallinum*; *A. gibbulosum*; *Sidnyum turbinatum*; *Botryllus schlosseri* (Pharynx ; stomach).

Distribution : British Isles—Isle of Jura ; north-east Ireland ; south Devon. Western Europe—Belgian coast ; French Channel coast ; Mediterranean.

Reference : Canu, 1892.

Enterocola pterophora Chatton & Brément.

Hosts : *Didemnum fulgens* and various other colonial ascidians (Stomach).

Distribution : British Isles—north-east Ireland. Western Europe—French Mediterranean coast.

Reference : Chatton and Brément, 1909 b.

Mycophilus roseus Hesse.

Hosts : *Botryllus schlosseri*; *Botrylloides leachi* (Canal system).

Distribution : British Isles—Moray Firth ; Isle of Cumbrae ; north-east Ireland. Western Europe—west coasts of Norway and Sweden ; French Atlantic coast ; Mediterranean.

Reference : Sars, 1921 and see Gotto, 1954 a.

Haplostoma brevicauda (Canu).

Hosts : *Polyclinum aurantium*; *Morchellium argus*; *Aplidium* (*Amaroucium*) *nordmanni*; *Sidnyum turbinatum* (Epicardium).

Distribution : British Isles—north-east Ireland. Western Europe—west coasts of Norway and Sweden ; Channel coasts of France.

Reference : Sars, 1921 (under *Cryptopodus*).

Haplostoma eruca (Norman).

Host : *Ciona intestinalis* (Intestine).

Distribution : British Isles—Shetlands ; Firth of Forth ; north-east Ireland. Western Europe—south coast of Norway.

Reference : Sars, 1921 (under *Cryptopodus*) and see Gotto, 1959.

Haplostoma banyulensis Brément.

Hosts : *Didemnum maculosum*; *Trididemnum tenerum*.

Distribution : British Isles—north-east Ireland. Western Europe—French Mediterranean coast.

Reference : Brément, 1909.

Haplostomides scotti Chatton and Harant.

Host : *Polyclinum aurantium*.

Distribution : British Isles—north-east Ireland. Western Europe—French Atlantic coast.

Reference : Chatton and Harant, 1924 d.

Haplostomides hibernicus. (T. and A. Scott.)

Host : *Polyclinum aurantium*.

Distribution : British Isles—north-east and south-west Ireland. Western Europe—French Atlantic coast.

Reference : Chatton and Brément, 1910 (under *Aplostoma*).

Lichomolgus albens Thorell.

Hosts : *Ascidia mentula*; *A. virginea*; *Ascidiella aspersa*; *A. patula*; *A. opalina*; *Corella parallelogramma*; *Ciona intestinalis*; *Perophora listeri*; *Molgula manhattensis*; *Pyura lurida* (Pharynx).

Distribution : British Isles—south-west Scotland ; west Ireland. Western Europe—coasts of Sweden and south and west Norway ; Channel coast of France ; Mediterranean.

Reference : Sars, 1918.

Lichomolgus forficula Thorell.

Hosts : *Ascidia mentula*; *Phallusia mammillata*; *Ciona intestinalis* (Pharynx ; and also found free).

Distribution : British Isles—Shetland Isles ; north Scotland ; north-west and north-east Ireland ; Isle of Man ; Plymouth. Western Europe—Coasts of Sweden and south and west Norway ; Mediterranean.

Reference : Sars, 1918.

Lichomolgus marginatus Thorell.

Hosts : *Ascidia virginea*; *Ciona intestinalis* (Pharynx).

Distribution : British Isles—north-east Ireland. Western Europe—Norwegian coast ; south-west Sweden.

Reference : Sars, 1918, and see Gotto, 1957 a.

Lichomolgus furcillatus Thorell.

Hosts : *Ciona intestinalis*; *Corella parallelogramma* (Pharynx ; and also found free).

Distribution : British Isles—Shetland Isles ; south-west Scotland ; north and west Ireland ; Isle of Man ; Plymouth. Western Europe—south coast of Norway ; south-west Sweden ; Mediterranean.

Reference : Sars, 1918.

Lichomolgus tenuifurcatus G. O. Sars.

Hosts : *Diplosoma listerianum* (Cloacal cavities ; also found free, and on the skin of the holothurian *Labidoplax digitata* Montagu).

Distribution : British Isles—north-east Ireland. Western Europe—south and west Norwegian coasts.

Reference : Sars, 1918, and see Gotto, 1955.

Lichomolgus didemni Gotto.

Host : *Didemnum maculosum* (Probably cloacal cavities).

Distribution : British Isles and Western Europe—north-east Ireland.

Reference : Gotto, 1956.

Lichomolgides cuanensis Gotto.

Host : *Trididemnum tenerum* (Cloacal cavities).

Distribution : British Isles and Western Europe—north-east Ireland.

Reference : Gotto, 1954 b.

WESTERN EUROPEAN SPECIES NOT SO FAR RECORDED FROM
BRITISH WATERS.

Notodelphys rufescens Thorell.

Hosts : *Ascidia conchilega*; *A. obliqua*; *Ascidiella aspersa*; *A. scabra* (Pharynx).

Distribution : Norway and Sweden to Mediterranean.

Reference : Sars, 1921.

Notodelphys tenera Thorell.

Hosts : *Ascidia mentula*; *A. obliqua*; *Phallusia mammillata*; *Ciona intestinalis* (Pharynx).

Distribution : Norway and Sweden to Mediterranean.

Reference : Sars, 1921.

Agnathaner minutus Canu. (Male only known.)Host : *Sidnyum turbinatum*.

Distribution : Northern coast of France.

Reference : Canu, 1892.

Doropygella thorelli (Aurivillius).Hosts : *Ascidia mentula*; *A. obliqua* (Pharynx).

Distribution : Sweden ; south and west Norwegian coasts.

Reference : Sars, 1921.

Doropygopsis longicauda (Aurivillius).Hosts : *Ascidia mentula* ; *A. obliqua* ; *A. prunum* (Pharynx)

Distribution : Sweden ; south and west Norwegian coasts.

Reference : Sars, 1921.

Notopterophorus micropterus G. O. Sars.Host : *Ascidia mentula* (Pharynx).

Distribution : West coast of Norway.

Reference : Sars, 1921.

Notopterophorus elongatus Buchholz.Hosts : *Ascidia mentula*; *A. gelatinosa*; *Ascidiella aspersa*; *Phallusia mammillata*; *Clavelina lepadiformis* (Pharynx).

Distribution : Sweden to Mediterranean.

Reference : Kerschner, 1879.

Bonnierilla longipes (Kerschner).Hosts : *Clavelina lepadiformis*; *Pyura lurida* (Pharynx).

Distribution : Atlantic coast of France ; Mediterranean.

Reference : Canu, 1892.

Bonnierilla arcuata Brément.Host : *Diplosoma listerianum* (Pharynx).

Distribution : French Mediterranean coast.

Reference : Brément, 1909.

Scolecimorpha joubini (Chatton).Host : *Microcosmus sulcatus* (= *M. sabatieri*) (Cysts in the tunic).

Distribution : French Mediterranean coast.

Reference : Chatton, 1909 (under *Ophioseides*).*Scolecimorpha insignis* G. O. Sars.Host : *Polycarpa pomaria* (Between mantle and pharynx).

Distribution : West coast of Norway.

Reference : Sars, 1926 (This species may well be synonymous with *S. joubini*).

Prophioseides abdominalis (Chatton and Brément).

Host : *Aplidium* (*Amaroucium*) *densum* (Post-abdomen).

Distribution : French Mediterranean coast.

Reference : Chatton and Brément, 1911 (under *Ophioseides*).

Bremenia balneolensis Chatton and Brément.

Host : *Didemnum fulgens* (= *Leptoclinum commune*) (Probably cloacal cavities).

Distribution : French Mediterranean coast.

Reference : Chatton and Brément, 1915 a.

Ooneides amela Chatton and Brément.

Host : *Didemnum dentatum* (= *Leptoclinum dentatum*) (Cloacal cavities).

Distribution : French Mediterranean coast.

Reference : Chatton and Brément, 1915 b.

Buprorus lovéni Thorell.

Hosts : *Ascidia mentula*; *A. obliqua*; *Ascidiella aspersa* (Pharynx).

Distribution : Swedish and Norwegian coasts.

Reference : Sars, 1921.

Buprorus nordgaardi G. O. Sars.

Host : *Amaroucium* sp.

Distribution : West coast of Norway.

Reference : Sars, 1921.

Botryllophilus norvegicus Schellenberg.

Host : *Pelonaia corrugata* (Pharynx).

Distribution : West coast of Norway.

Reference : Schellenberg, 1921.

Pteropygus vestitus G. O. Sars.

Host : *Ascidia obliqua* (Pharynx).

Distribution : South coast of Norway.

Reference : Sars, 1921.

Schizoproctus inflatus Aurivillius.

Host : *Ascidia obliqua* (Pharynx).

Distribution : North coast of Norway.

Reference : Sars, 1921.

Enterocola bilamellata G. O. Sars.

Host : (Found in bottom sample, about 75 m.).

Distribution : South coast of Norway.

Reference : Sars, 1921.

Enterocola mammifera Chatton & Harant.

Host : *Aplidium aspersum* (Stomach).
 Distribution : French Mediterranean coast.
 Reference : Chatton and Harant, 1922 a.

Enterocola clavelinae Chatton & Harant.

Host : *Clavelina nana* (= ? *Pycnoclavella aurilucens*).
 Distribution : Channel coast of France.
 Reference : Chatton and Harant, 1924 b.

Enterocola hessei Chatton & Harant.

Hosts : Unspecified colonial ascidians.
 Distribution : Channel coast of France.
 Reference : Chatton and Harant, 1924 b.

Enterocola sydnii Chatton & Harant.

Host : *Sidnyum turbinatum*.
 Distribution : Côtes-du-Nord.
 Reference : Chatton and Harant, 1924 b.

Enterocolides ecaudatus Chatton & Harant.

Host : *Didemnopis inarmata* (Possibly deep in the colonial matrix).
 Distribution : French Mediterranean coast.
 Reference : Chatton and Harant, 1922 c.

Lequerrea perezii Chatton & Harant.

Host : ? *Polycarpa* sp. (Intestine).
 Distribution : French Atlantic coast.
 Reference : Chatton and Harant, 1924 a.

Enteropsis pilosus Canu.

Host : *Diazona violacea* (Pharynx).
 Distribution : French Atlantic coast.
 Reference : Canu, 1886.

Enteropsis roscoffensis Chatton & Brément.

Hosts : *Pyura microcosmus*; *Dendrodoa (Styelopsis) grossularia* (Pharynx).
 Distribution : French Mediterranean and Atlantic coasts.
 Reference : Chatton and Brément, 1909 a.

Enteropsis sphinx (Aurivillius, emended Chatton & Brément).

Host : *Halocynthia papillosa* (Pharynx).
 Distribution : French Mediterranean coast.
 Reference : Chatton and Harant, 1922 b.

Haplostoma canui Chatton & Harant.

Host : *Polyclinum aurantium*.

Distribution : French Atlantic coast.

Reference : Chatton and Harant, 1924 e.

Haplostomides brementi Chatton & Harant.

Host : ? *Aplidium caeruleum* (In colonial matrix).

Distribution : French Mediterranean coast.

Reference : Chatton and Harant, 1924 d.

Haplostomella tuberculata Chatton & Harant.

Host : *Sidnyum elegans*.

Distribution : French Mediterranean coast.

Reference : Chatton and Harant, 1924 c.

Haplostomella malacocerca Chatton & Harant.

Host : "An aplidian".

Distribution : French Mediterranean coast.

Reference : Chatton and Harant, 1924 c.

Haplosaccus sacculus Chatton & Brément.

Host : *Diplosoma listerianum* (In colonial matrix).

Distribution : French Mediterranean coast.

Reference : Chatton and Brément, 1910 (under *Aplostoma*).

Lichomolgus canui G. O. Sars.

Hosts : *Ciona intestinalis*; ? *Pyura lurida*; *Molgula manhattensis*.

Distribution : Norwegian coast ; Channel coast of France.

Reference : Sars, 1918.

Lichomolgus poucheti Canu.

Hosts : On surface of colonies of *Morchellium argus* and *Sidnyum elegans*; and also free (Sars).

Distribution : South and west Norwegian coasts : Channel coast of France.

Reference : Sars, 1918.

Ascomyzon lilljeborgi Thorell

Host : *Corella parallelogramma* (Pharynx)

Distribution : Coasts of Norway and Sweden.

Reference : Sars, 1918.

REFERENCES.

A very comprehensive list of references (up to 1952) relating to the family Notodelphyidae has been compiled by Illg (1958), whose paper is included in the subjoined list.

- BOCQUET, C. & STOCK, J. H. 1960. Copépodes parasites d'invertébrés des côtes de France. XI. Le genre *Notodelphys*, de la famille des Notodelphyidae. *Koninkl. Nederl. Akad. van Wetenschappen Amsterdam*. (C) **63**, 123-136.
- BRADY, G. S. 1878. *A monograph of the free and semi-parasitic Copepoda of the British Islands*, 1. Ray. Soc. Lond.
- BRÉMENT, E. 1909. Contribution à l'étude des copépodes ascidicoles du Golfe du Lion. *Arch. Zool. expér. gén. Notes et Rev.* **1**, 61-89.
- . 1911. Sur la situation que peut affecter, chez quelques ascidies mérosomes, le genre de copépode *Enterocola*. *Bull. Mus. d'hist. nat. Paris*, **2**, 69-75.
- CANU, E. 1886. Description de deux copépodes nouveaux parasites des synascidies. *Bull. Sci. Fr. Belg.* (2), **17**, 309-320.
- . 1892. Les copépodes du Boulonnais : morphologie, embryologie, taxonomie. *Trav. Lab. Zool. mar. Wimereux* **6**, 1-354.
- CHATTON, E. 1909. Sur le genre *Ophioseides* Hesse et sur l'*Ophioseides joubini* n.sp., copépode parasite de *Microcosmus sabatieri* Roule. *Bull. Soc. Zool. France*, **34**, 11-19.
- & BRÉMENT, E. 1909 a. *Enteropsis roscoffensis* n.sp. copépode parasite de *Styelopsis grossularia* P. J. van Beneden. *Bull. Soc. Zool. France* **34**, 196-203.
- . 1909 b. Sur un nouveau copépode ascidicole *Enterocola pterophora* n.sp., et sur le genre *Enterocola* P. J. van Beneden. *Bull. Soc. Zool. France*, **34**, 223-229.
- . 1910. Sur trois ascidicoles du genre *Aplostoma* Canu : *Aplostoma magellanica* n.sp., *A. hibernica* (T. & A. Scott), *A. sacculus* n.sp. *Bull. Soc. Zool. France*, **35**, 80-92.
- . 1911. Sur un ascidicole nouveau du genre *Ophioseides* Hesse, *Ophioseides abdominalis*, parasite des Aplidiens. *Bull. Soc. Zool. France*, **36**, 29-33.
- . 1915 a. Notes sur les copépodes ascidicoles. VIII. *Bremetia balneolensis* n.g., n.sp., nouveau copépode ascidicole incubateur, parasite des *Leptoclinum*. *Bull. Soc. Zool. France*, **40**, 129-134.
- . 1915 b. Notes sur les copépodes ascidicoles. IX. Sur un nouveau copépode ascidicole incubateur *Ooneides amela* n.g., n.sp., parasite des *Leptoclinum*. *Bull. Soc. Zool. France*, **40**, 135-143.
- & HARANT, H. 1922 a. Notes sur les copépodes ascidicoles. XI. *Enterocola betencourti* Canu, *E. pterophora* Chatton & Brément, *E. mamnifera*, n.sp. *Bull. Soc. Zool. France* **47**, 147-156.
- . 1922 b. Notes sur les copépodes ascidicoles. XII. *L'Enteropsis sphinx* Aurivillius et *L'Enteropsis teres* (Aurivillius). *Bull. Soc. Zool. France*, **47**, 157-163.
- . 1922 c. Notes sur les copépodes ascidicoles. XIII. *Enterocolides ecaudatus*, n.g., n.sp., et l'évolution des périopodes. *Bull. Soc. Zool. France*, **47**, 245-252.
- CHATTON, E. & HARANT, H. 1924 a. Notes sur les copépodes ascidicoles. XIV. *Lequerrea perezii* n.g., n.sp., enterocolien parasite d'une ascidie simple. *Bull. Soc. Zool. France* **49**, 347-354.
- . 1924 b. Notes sur les copépodes ascidicoles. XV. Sur trois formes nouvelles du genre *Enterocola* P. J. van Beneden. État actuel de la systematique des *Enterocolinae* n. subf. *Bull. Soc. Zool. France* **49**, 354-364.
- . 1924 c. Notes sur les copépodes ascidicoles. XVI. Le nouveau genre *Haplostomella*. Deux espèces de ce genre. Remarques sur les oostégites et la 5^e paire de périopodes. *Bull. Soc. Zool. France* **49**, 398-406.
- . 1924 d. Notes sur les copépodes ascidicoles. XVII. Le nouveau genre *Haplostomides* et deux espèces nouvelles de ce genre : *Haplostomides scotti* et *Haplostomides brementi*. *Bull. Soc. Zool. France* **49**, 406-412.
- . 1924 e. Notes sur les copépodes ascidicoles. XVIII. *Haplostoma canui*, n.sp. État actuel de la systématique des *Haplostominae* n. subf. Le nouveau genre *Haplosaccus*. *Bull. Soc. Zool. France* **49**, 413-422.
- GOTTO, R. V. 1954 a. On *Mycophilus roseus* Hesse, and other notodelphyoid copepods from Strangford Lough, Co. Down. *Proc. Zool. Soc. Lond.* **124**, 659-668.
- . 1954 b. *Lichomolgides cuanensis* n.g., n.sp., an ascidicolous copepod occurring in *Trididemnum tenerum* (Verrill). *Parasitol.* **44**, 379-386.
- . 1955. A note on the ecology of the genus *Lichomolgus* (Copepoda : Cyclopoida). *Ann. Mag. Nat. Hist.* (12) **8**, 390-392.

- 1956. A new ascidicolous copepod : *Lichomolgus didemni* sp. nov. *Journ. Linn. Soc.* **42**, 600-602.
- 1957 a. A cyclopoid copepod new to British waters, with a note on its structure. *Irish Nat. Journ.* **12** (6), 138.
- 1957 b. The biology of a commensal copepod, *Ascidicola rosea* Thorell, in the ascidian *Corella parallelogramma* (Müller). *J. mar. biol. Ass. U.K.* **36**, 281-290.
- 1959. The rediscovery in British waters of two little-known copepods. *Irish Nat. Journ.* **13** (1), 9-11.
- GRAY, P. 1933. *Mycophilus rosovula* n.sp., a notodelphoid copepod parasitic within *B. (Botrylloides) leachii* Sav., with a description of the nauplius and notes on the habits. *J. mar. biol. Ass. U.K.* **18**, 523-528.
- ILLG, P. L. 1958. North American copepods of the family Notodelphyidae. *Proc. U.S. Nat. Mus.* **107**, 463-649.
- LANG, K. 1948. Copepoda "Notodelphyoida" from the Swedish west-coast with an outline on the systematics of the copepods. *Ark. Zool.* Bd. **40A** (14), 1-36.
- LEIGH-SHARPE, W. H. 1935. A list of British invertebrates with their characteristic parasitic and commensal Copepoda. *J. mar. biol. Ass. U.K.* **20**, 47-48.
- SARS, G. O. 1918. *An Account of the Crustacea of Norway.* 6. Copepoda, Cyclopoida. Bergen.
- 1921. *An Account of the Crustacea of Norway.* 8. Copepoda, Monstrilloida and Notodelphyoida. Bergen.
- 1926. Description of *Scolecimorpha insignis* G. O. Sars, a remarkable new ascidicole parasite. *Kgl. Norske Vidensk. Selsk. Skrifter*, 1925, **2**, 1-12.
- SHELLENBERG, A. 1921. Neue norwegische Notodelphyiden. *Kgl. Norske Vidensk. Selsk. Skrifter*, 1921, **3**, 3-11.
- 1922. Neue Notodelphyiden des Berliner und Hamburger Museums mit ein Übersicht der ascidienbewohnenden Gattungen und Arten. *Mitt. zool. Mus. Berl.* **10**, 219-298.