

ON THE CLASSIFICATION OF THE ASCARIDAE.

I.—THE SYSTEMATIC VALUE OF CERTAIN CHARACTERS OF THE ALIMENTARY CANAL.

BY H. A. BAYLIS, M.A.

(With 1 Text-figure.)

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INTRODUCTION.

THE great French helminthologist, Dujardin, appears to have been the first to suggest a grouping of the genus "*Ascaris*" according to the structure of the alimentary canal. As is, unhappily, only too well known to modern helminthologists, little attention was paid to internal structures by the earlier workers, whose numerous descriptions and classifications were based almost entirely upon external characters. It is now recognized that a natural system must be based on a survey of the whole structure of the animal, both external and internal, and a re-examination of many of the older species becomes extremely important.

While some families of Nematodes have received considerable attention in recent years, and materials for a natural grouping are gradually accumulating, the Ascarid family seems to have been comparatively neglected, perhaps because of the extremely large number of species, to which every year still more are being added, and which seems to make it an almost hopeless task to reduce them to a natural, orderly and convenient systematic arrangement. Hall (1916), in the course of some introductory remarks to his valuable revision of the Nematodes of Rodents, has mentioned that in the index catalogue of the Zoological Division of the United States Bureau of Animal Industry something like a thousand species are enumerated under the generic name "*Ascaris*." Stossich (1896), in his monograph of the Linnean genus, mentions 218 species. Of course, many of the so-called "species" are no doubt synonyms, misdeterminations, or otherwise inadmissible; but, even allowing for this, the "genus" is intolerably unwieldy, and it is clearly time that effective steps were taken to split it up into smaller groups, if only for the sake of convenience.

The process of splitting-up has been carried on in a desultory manner since Dujardin's day, but has not, up to the present, led to any highly satisfactory results. No uniform system has been adopted by the various workers

who have approached the subject, and the limits and contents of the families and subfamilies that have been created are very ill-defined. The present position, in general, is that the Linnean genus *Ascaris* has risen to the rank of a superfamily, Ascaroidea, with the families Ascaridae, Heterakidae and Oxyuridae. These families, again, have been variously subdivided into subfamilies, while there is a tendency, as always in the progress of systematic zoology, for the subfamilies themselves to be raised to the rank of families.

The System of Dujardin.

We may now return to the consideration of the system outlined by Dujardin (1845). Having separated off as "subgenera" the forms which now compose the families Heterakidae and Oxyuridae from the "true Ascarids," Dujardin places the latter in a "subgenus," *Ascaris*, which he further divides into four sections, taking the structure of the alimentary canal as a basis for the classification. His four sections are as follows (translating as closely as possible the original characterizations):

Section 1. "Ascarids with simple oesophagus with or without ventriculus, but without pyloric appendices."

In this section are placed the whole of the forms known from mammals, the great majority of those from birds, reptiles and fishes, and one from an insect.

Section 2. "True Ascarids in which the oesophagus is followed by a more or less distinct ventriculus and accompanied by a pyloric caecum or appendix springing from the intestine."

This section comprises the following forms:

	Hosts
<i>A. gypina</i> Duj.	Vultures.
<i>A. depressa</i> Rud.	Falco, etc.
<i>A. spiralis</i> (Zeder)	Owls.
<i>A. ensicaudata</i> (Zeder)	<i>Turdus</i> spp.
<i>A. crenata</i> (Zeder) (prob. = <i>ensicaudata</i>)	<i>Sturnus</i> .
<i>A. heteroura</i> Crepl.	<i>Charadrius</i> , etc.
<i>A. semiteres</i> (Zeder)	<i>Vanellus</i> , etc.
<i>A. praelonga</i> Duj.	<i>Colymbus</i> .
<i>A. crassa</i> Deslongchamps	<i>Anas</i> , etc.
<i>A. constricta</i> Rud.	<i>Trachinus</i> .
<i>A. incurva</i> Rud.	<i>Xiphias</i> .
<i>A. ecaudata</i> Duj.	<i>Conger</i> .

Section 3. "True Ascarids in which the oesophagus is prolonged by a pyloric caecum or appendix alongside of the intestine, and itself accompanied by another caecum springing from the intestine and forwardly directed."

Here are placed the following species:

	Hosts
<i>A. spiculigera</i> Rud.	Cormorant, Pelican.
<i>A. pedum</i> Deslongchamps	<i>Scomber</i> .
<i>A. obtusocaudata</i> (Zeder)	<i>Salmo</i> , etc.
<i>A. adunca</i> Rud.	<i>Clupea</i> .
<i>A. clavata</i> Rud.	<i>Gadus</i> , etc.

Section 4. "True Ascarids having a single pyloric caecum or appendix springing from the oesophagus, posteriorly, alongside of the intestine."

A single species,

A. acus Bloch.

Host
The Pike (*Esox*).

This résumé of Dujardin's system has been given because it seems to have been generally either forgotten or ignored by more recent workers, some of whom have actually created new genera for forms having exactly the characters given by Dujardin for one or another of his Sections 2, 3 and 4, without mentioning the fact that Dujardin had already noticed them, and without comparing the new forms with those included in Dujardin's groups.

During recent years an attempt has been made by Railliet and Henry (1912) to group together all the Ascarids in which oesophageal or intestinal diverticula occur. They thus created the subfamily Heterocheilinae, which they have subsequently (1915) shown a desire to elevate to the rank of a family, Heterocheilidae. More recently still, Gedoelst (1916) has given a dichotomous table of forms referred by him to the Heterocheilinae (apparently not accepting the group as of family rank) to which he has added a new genus, *Dujardinia*, for the reception of *Ascaris helicina* Molin. The table is based on the following features, which are here given in the supposed order of importance:

- (1) Presence or absence of intestinal and oesophageal caeca.
- (2) Presence or absence of interlabia.
- (3) Presence or absence of dentigerous ridges.

In the course of the following remarks it will be necessary to inquire whether this subfamily (or family) can be regarded as a natural group, and to see, if possible, to what extent the presence or absence of caeca connected with the alimentary canal provides a sound basis for classification.

Data derived from a re-examination of species.

With the idea of obtaining some more definite knowledge of the occurrence of these modifications of structure in the alimentary canal, and of the relationships, if any, between the forms in which they are found, a number of species of Ascarids available in the British Museum have been re-examined expressly from this point of view, note being also taken of the presence or absence of interlabia and dentigerous ridges—points usually assumed to be of systematic value. The list of species so examined at present is very limited, but the results already appear to the writer to indicate that the occurrence of such structures is more widespread among the Ascaridae than has hitherto been realised, and that it may have a very important bearing upon the ultimate systematic grouping of these forms.

The species¹ of which specimens have been re-examined at present are the following:

	HOSTS OF ACTUAL MATERIAL
<i>Ascaris aucta</i> Rud.	<i>Blennius viviparus</i> , <i>Rhombus punctatus</i> .
„ <i>decipiens</i> Krabbe	<i>Otaria jubata</i> .
„ <i>depressa</i> (Zed.)	<i>Gyps fulvus</i> , <i>Accipiter nisus</i> , "eagle."
„ <i>colura</i> Baylis	<i>Lophoaëtus occipitalis</i> .
„ <i>ensicaudata</i> (Zed.)	<i>Turdus merula</i> , <i>T. musicus</i> , <i>Sturnus vulgaris</i> .
„ <i>halichoris</i> Owen	<i>Dugong</i> , sp.
„ <i>holoptera</i> Rud.	<i>Testudo graeca</i> , <i>T. mauretunica</i> , <i>T. geometrica</i> , <i>T.</i> sp.
„ <i>microcephala</i> Rud.	<i>Ardea cinerea</i> .
„ <i>rosmari</i> Baylis (= <i>A. bicolor</i> Baird)	<i>Odoboaenus rosmarus</i> .
„ <i>semiteres</i> (Zed.)	<i>Vanellus cristatus</i> .
„ <i>serpentulus</i> Rud. (? = <i>A. ardeae</i> Froel.)	<i>Ardea cinerea</i> .
„ <i>similis</i> Baird	A seal (Antarctic).
<i>Contracaecum spiculigerum</i> (Rud.)	<i>Phalacrocorax verrucosus</i> , <i>P. campbelli</i> , <i>P.</i> sp.
<i>Dujardinia helicina</i> (Molin)	<i>Crocodilus niloticus</i> .
<i>Kathleena osculata</i> (Rud.)	<i>Hydrurga leptonyx</i> .
„ <i>radiata</i> (v. Linst.)	<i>Leptonychotes weddelli</i> .
„ <i>rodhaini</i> Gedoelst	<i>Plotus rufus</i> .
„ <i>tricuspis</i> Gedoelst	<i>Phalacrocorax africana</i> .
<i>Porrocaecum crassum</i> (Deslongchamps)	<i>Anas boscas dom.</i>
<i>Terranova antarctica</i> Leiper and Atkinson	<i>Mustelus antarcticus</i> .

Among the forms just enumerated, the hosts of which include mammals, birds, reptiles and fishes, no example of the typical, simple, Ascarid structure of the alimentary canal was met with. In every case some modification of the oesophagus was present, or some caecum or appendage either of the oesophagus or of the intestine, or both.

Five main types of structure were encountered:

I. Oesophagus muscular throughout, opening directly into the intestine, without posterior ventriculus or distinct bulb. A forwardly-directed caecum springs from the intestine. No oesophageal appendix. Examples: *Ascaris holoptera*, *A. colura*.

II. Oesophagus slender, with a more or less distinct globular bulb at the base. The intestine is produced forwards as a long caecum. No oesophageal appendix. Examples: *Ascaris halichoris*, *Dujardinia helicina*.

III. Oesophagus with a posterior glandular portion, or ventriculus, of elongate or oblong shape and often bent in a sigmoid manner. No oesophageal or intestinal caeca. Examples: *Ascaris rosmari*, *A. similis*.

¹ The determination cannot in all cases be vouched for with certainty, though no undue suspicion attaches to any of the specimens. Those of *Ascaris colura*, *A. rosmari*, *A. similis* and *Terranova antarctica* are the type-specimens of the species in question. Those of *Kathleena osculata* and *K. radiata* were determined by Leiper and Atkinson, being part of the "Terra Nova" collection. The examples of *A. decipiens* had been misdetermined by von Linstow as "*A. simplex* Rud.," and the present determination is the writer's. Two out of the three sets of *C. spiculigerum* (*Ascaris spiculigera* Rud.), belonging to the "Challenger" and "Discovery" collections respectively, were determined by von Linstow. Named specimens of *Porrocaecum crassum* were kindly supplied by Prof. Railliet.

IV. Oesophagus with a posterior glandular portion, or ventriculus, often bent so as to open into the intestine laterally. An intestinal caecum present. No oesophageal appendix. Examples: *Ascaris decipiens*, *A. depressa*, *A. ensicaudata*, *Porrocaecum crassum*, *Terranova antarctica*, probably *Ascaris semiteres*, *A. serpentulus*¹.

V. Oesophagus with a reduced posterior ventriculus, giving off a backwardly-directed glandular appendix. An intestinal caecum also present. Examples: *Ascaris aucta*, *A. microcephala*, *Contraecum spiculigerum*, *Kathleena osculata*, *K. radiata*, *K. rodhaini*, *K. tricuspis*.

The subfamily Heterocheilinae, Railliet and Henry.

We may next consider the classification outlined by Railliet and Henry (1912), to which reference has already been made. These authors divided the family Ascaridae into the following subfamilies:

(1) ASCARINAE, to include *Ascaris* L. and other genera with a simple alimentary canal.

(2) ANISAKINAE, to include *Anisakis* Duj., 1845 (= *Peritrachelius* Dies., 1851; = *Conocephalus* Dies., 1861) and perhaps *Crossocephalus* Railliet, 1909 (= *Pterocephalus* v. Linst., 1899).

(3) HETEROCHEILINAE, to include provisionally all the forms with oesophageal or intestinal caeca. *Heterocheilus* Dies., 1839; *Typhlophorus* v. Linst., 1906; *Porrocaecum* Railliet and Henry, 1912; *Crossophorus* Hempr. and Ehbr., 1828; *Lecanocephalus* Dies., 1839; *Contraecum* Railliet and Henry, 1912. To these were subsequently added (1915) the genera *Terranova* and *Kathleena* of Leiper and Atkinson, 1914, and *Raphidascaris* Railliet and Henry, 1915.

With the first subfamily it is not intended to deal at present. Of the forms included in the last two subfamilies, it is important to note the following features.

Anisakis (type-species (?) "*Ascaris simplex* Rud." of Dujardin—type-specimens renamed *A. dussumieri* by van Beneden, 1870—? synonym, *Peritrachelius* [*Conocephalus*] *typicus* (Dies., 1860); Host, *Delphinus*). The main character upon which Dujardin's subgenus *Anisakis* was based was the presence of two spicules of unequal length in the male. The descriptions of *A. dussumieri* and of *Ascaris* [*Peritrachelius*] *typica* show, however, that the oesophagus possesses a posterior ventriculus of different histological appearance from the anterior, muscular portion, and that oesophageal and intestinal caeca are absent. (See Stiles and Hassall (1899), where the anatomy and the complicated synonymy are fully dealt with.)

Crossocephalus, as more recent researches (Gedoelst (1916); Baylis (1919, a))

¹ The material available for the study of the last two forms did not permit of satisfactory examination.

have shown, has no close relationship with any of the *Ascaridae*, and probably belongs to the *Oxyuridae*.

Heterocheilus (type-species, *H. tunicatus* Dies., 1839, from *Manatus exunguis*) has a very peculiar cuticular swelling behind the lips, consisting of a series of longitudinal ribs; while the lips themselves, from Diesing's figures, seem to be of an unusual type. The oesophagus has a bulb at the base, and there is an intestinal caecum running forwards.

Typhlophorus (type-species, *T. lamellaris* v. Linst., 1906, from *Gaviais gangeticus*). From the brief description of this form, and from the figures, it appears to be closely related to *Heterocheilus*. There is a very similar longitudinally-ribbed cuticular swelling behind the lips. A long intestinal caecum is present, but the structure of the oesophagus is not described.

Porrocaecum (type-species, *P. [Ascaris] crassum* (Deslongchamps), from ducks). In the structure of the alimentary canal this genus corresponds to Dujardin's Section 2, which includes the type-species, and also to what has just now been described as "type IV."

Crossophorus is a genus of so highly specialised a type that it seems to have little or nothing in common with the other genera. It certainly possesses two long intestinal caeca, but in several features (see Baylis (1919, *b*)) it appears to be quite isolated.

Lecanocephalus. The correct generic name, as Railliet and Henry (1915) have pointed out, is *Goezia* Zeder, 1800 (type-species, *G. ascaroides* (Goeze, 1782), from *Silurus glanis*). This genus is characterised by having the cuticle armed with numerous transverse rings of spines, and by the peculiar, flattened shape of the lips, which are unlike those of any other known *Ascarid*. For these reasons it may be doubted whether it bears any close relationship to most of the genera among which it has been placed. Its claim to this position is based on its possession of a long glandular oesophageal appendix and a short intestinal caecum, in which respects it resembles *Contraecum*.

Contraecum (type-species, *C. [Ascaris] spiculigerum* (Rud., 1809), from the cormorant, etc.) corresponds, in the structure of the alimentary canal, to Dujardin's Section 3, and to "type V" in the list given above.

Terranova (type-species, *T. antarctica* Leiper and Atkinson, 1914, from a shark, *Mustelus antarcticus*). The characters upon which this genus was based were "three large simple lips. No interlabia. Oesophagus simple. Gut with anterior caecal prolongation. No oesophageal appendage." A re-examination of the type-specimen, however, shows that the statement that the oesophagus is simple was erroneous, and that, on the contrary, it has a specialised ventricular portion, 1.4 mm. long, and therefore the structure is of the same type as in *Porrocaecum*.

Kathleena (type-species, *K. osculata* (Rud., 1802), from seals). On comparing examples of the two type-species, the characters of this genus appear to be identical with those of *Contraecum*.

Raphidascaris (type-species, *R. acus* (Bloch, 1779), from the pike) is

characterised by the possession of an oesophageal appendix, but no intestinal caecum.

From this survey it appears doubtful whether the subfamily Heterocheilinae, as it stands, can be regarded as a satisfactory or natural group. We have seen that *Crossophorus* probably ought to be removed to a position by itself. The genera *Heterocheilus*, *Typhlophorus* and *Goezia* (= *Lecanocephalus*) also seem to be clearly marked off from the rest of the forms by peculiarities of external features—all the remainder being of typical "Ascarid" appearance externally.

There can be little question that *Terranova* is generically identical with *Porrocaecum*, and *Kathleena* with *Contracaecum*. Hence, according to the law of priority, the names *Terranova* and *Kathleena* fall into synonymy.

Setting aside all the aberrant forms mentioned above, the only genera among the original Heterocheilinae with which we are immediately concerned are *Porrocaecum*, *Contracaecum* and *Raphidascaris*. These genera, together with *Anisakis*, and with the addition of certain other forms to be mentioned, seem to compose a more natural group, united by possessing the general outward appearance of an "Ascaris," but with certain modifications of the alimentary canal which mark them off from the Ascarinae.

Proposed new arrangement.

The new group which it is proposed to set up comprises the type-genus of the former subfamily Anisakinae and part of the former subfamily Heterocheilinae. The forms which are to be included in it may be divided into two sections, according to the presence or absence of a specialised "ventriculus," forming a posterior division of the oesophagus. This structure, for which Dujardin's term may conveniently be used, has been neglected since his time as a feature of systematic value. It seems to the writer, however, that it deserves the consideration which Dujardin was disposed to give to it, and that it is probably of greater phylogenetic importance than the presence or absence of caecal appendages. Although no special attention has as yet been devoted to the ventriculus of Ascarids from the histological or physiological standpoints, it is interesting to observe that in a nematode of another family, *Camallanus*, in which a very similar organ exists, a recent writer (Magath (1919)) has suggested that it is concerned in the excretory processes. In the species dealt with it seems to have some structural connection with the excretory apparatus. Now in some of the Ascarids in which a ventriculus occurs we find it associated with a peculiar type of excretory apparatus, terminating in a long, unpaired, unicellular "gland," opening close to the lips. This is the case, at all events, with a number of the forms included here under the names *Anisakis*, *Porrocaecum* and *Contracaecum*, and will very possibly be found to be characteristic of all the forms in which there is a ventriculus. Pending fuller investigation, therefore, it is suggested that all

the forms with a true ventriculus should be placed together. It may prove that the forms without a true ventriculus ought to be entirely separated from those possessing it, and that their inclusion in the same subfamily is too artificial. Certain forms of this type may, however, be placed here at present provisionally. The true relationships of all the genera and species can, of course, only be estimated after a much fuller inquiry into their entire anatomy.

The following arrangement is suggested:

ANISAKINAE Railliet and Henry, 1912, *emend.* Baylis, 1920.

Ascaridae having the general external appearance of an *Ascaris*, *i.e.* with a smooth cuticle, transversely striated but without cuticular spines or other raised structures. The oesophagus may or may not be divided into an anterior muscular portion and a posterior ventriculus of different histological structure. When the latter is absent (and frequently when it is present) there is an anterior caecum, springing from the intestine and lying alongside of the oesophagus. A posterior caecum or solid glandular appendix may also be developed in connection with the ventricular portion of the oesophagus. Interlabia may be present or absent, and when present show various degrees of development. Dentigerous ridges on the lips may also be present or absent. The species are parasitic in the alimentary canal of mammals, birds, reptiles and fishes, and the majority are found in aquatic or at least fish-eating hosts. There is reason to believe that in some cases, and perhaps in all, an intermediate host is required for their development, and that, in the case of species inhabiting fish-eating animals when adult, the intermediate host is a fish.

Type-genus—*Anisakis* Duj., 1845.

The following genera may be enumerated:

(1) *Anisakis* Duj., 1845 [= *Peritrachelius* Dies., 1851; = *Conocephalus* Dies., 1861].

Oesophagus with anterior muscular portion and posterior ventriculus, the latter being oblong or sigmoid in shape. No oesophageal or intestinal caecum. Interlabia absent. Dentigerous ridges present. Spicules of male sometimes unequal.

Hab.—stomach and intestine of marine mammals.

With the following species:

A. dussumieri van Ben., 1870 (= *A. simplex* Duj., 1845, *nec* Rudolphi, 1809) (genotype) from a dolphin.

A. typica (Dies., 1860) from *Delphinus*, *Phocaena*, *Prodelphinus* (perhaps identical with the preceding).

A. insignis (Dies., 1851) from *Inia geoffroyi* (= *Delphinus amazonicus*).

A. similis (Baird, 1853) from a seal (Antarctic).

A. rosmari (Baylis, 1916) [= *Ascaris bicolor* Baird, 1868] from the Walrus (*Odobenus rosmarus*).

A. simplex (Rud. 1809) from *Balaenoptera*, *Delphinus*, etc.

? *A. kuenikhalii* (Cobb, 1888) from *Delphinapterus* (sp. inq.; perhaps = *A. simplex*).

(2) *Raphidascaris* Railliet and Henry, 1915¹.

Oesophagus with anterior muscular portion and small posterior ventriculus. From the latter springs a small posterior appendix. No intestinal caecum. Interlabia present. Dentigerous ridges absent.

Hab.—intestine and stomach of fishes.

Species:

R. acus (Bloch, 1779) (genotype) from the pike (*Esox*).

(3) *Porrocaecum* Railliet and Henry, 1912. (Syn. *Terranova* Leiper and Atkinson, 1914.)

Oesophagus with anterior muscular portion and posterior ventriculus of oblong shape, the latter short in the genotype, but in other species frequently long and bent at an angle so as to open into the intestine laterally. An intestinal caecum present. No oesophageal appendix. Interlabia present, usually small. Dentigerous ridges present.

Hab.—intestine of birds, marine mammals and fishes.

Species:

P. crassum (Deslongchamps, 1824) (genotype) from ducks.

P. depressum (Zed., 1800) from birds of prey (*Falco*, etc.).

P. ensicaudatum (Zed., 1800)² from *Turdus*, *Sturnus*.

P. decipiens (Krabbe, 1878) from seals.

P. antarcticum (Leiper and Atkinson, 1914) from *Mustelus antarcticus*, and probably also

P. semiteres (Zed., 1800)³ from *Vanellus*, etc.

P. serpentulus (Rud., 1809) from *Ardea* sp.

P. heteroura (Crepl., 1829) from *Charadrius*, etc.

P. spirale (Zed., 1803) from owls.

P. praelongum (Duj., 1845) from *Colymbus*.

Certain species from fishes, with this type of alimentary canal, mentioned by Dujardin, require further investigation.

(4) *Contraecum* Railliet and Henry, 1912. (Syn. *Kathleena* Leiper and Atkinson, 1914.)

Oesophagus with reduced posterior ventriculus, giving off a solid posterior appendix. An intestinal caecum present. Interlabia present, usually very well-developed. Dentigerous ridges absent⁴.

¹ Ward and Magath (1916) have described a new genus, *Hysterothylacium* (type-species *H. brachyurum* Ward and Magath, from the "black bass"), which is stated to belong to the Heterocheilidae and to have the following characters: "Oesophagus long, slender, with terminal spherical bulb. Intestine with short simple cecum, arising from anterior end of intestine, directed posteriorly." The oesophageal bulb is said to contain three teeth. The authors do not make any comparison between this form and *Raphidascaris*, but it appears not unlikely that the two forms are related. It is important to note, however, that the caecum is said to belong to the intestine and not to the oesophagus. Wigdor (1918) has described a second species, *H. cayugensis*, from *Esox* and *Ameiurus*, which, from its description, can hardly be distinguished from *Raphidascaris acus*.

² In *P. ensicaudatum* the caecum is very small and almost rudimentary, at least in the examples seen.

³ The single specimen of *P. semiteres* available for study proved too opaque for the structure to be made out with certainty.

⁴ Gedoelst's (1916) statement that dentigerous ridges are present in *Contraecum* is ap-

Hab.—intestine of fish-eating mammals and birds, and of fishes.

Species:

- C. spiculigerum* (Rud., 1809) (genotype) from cormorants, etc.
- C. osculatum* (Rud., 1802) from seals.
- C. radiatum* (v. Linst., 1906) from seals.
- C. rectangulum* (v. Linst., 1906) from seals.
- C. scotti* (Leiper and Atkinson, 1914) from *Diomedea*.
- C. microcephalum* (Rud., 1809) from *Ardea*, etc.
- C. rodhaini* (Gedoelst, 1916) from *Plotus rufus*.
- C. auctum* (Rud., 1809)¹ from *Blennius*, etc.
- C. clavatum* (Rud., 1819) from various fishes.
- C. aduncum* (Rud., 1809) from *Clupea*.

And probably other species from fishes (see Dujardin (1845), pp. 208–211).

Gedoelst (1916) has compiled a list of species to be referred to *Kathleena*. These should probably all be included here, and we have therefore the following additional species:

- C. lobulatum* (Schneider, 1866) from *Platanista gangetica*.
- C. falcigerum* (Railliet and Henry, 1907) from seals.
- C. multipapillatum* (v. Drasche, 1882) from *Tantalus loculator*.
- C. micropapillatum* (Stossich, 1890) from *Pelecanus* spp.
- C. ovale* (v. Linst., 1907) from *Podiceps cristatus*.
- C. rosarium* (Connal, 1912) from *Nycticorax* sp.
- C. tricuspe* (Gedoelst, 1916) from *Ardea* sp.
- C. punctatum* (Gedoelst, 1916) from ?*Pseudotantalus ibis*.

Kathleena arcuata Gedoelst, 1916, from *Ardea*, sp., appears to the writer to be identical with *C. microcephalum* (Rud.).

(5) *Dujardinia* Gedoelst, 1916.

Oesophagus with a small posterior spherical bulb. An intestinal caecum present. No oesophageal appendix. Interlabia present. Dentigerous ridges absent.

Species:

- D. helicina* (Molin, 1860) (genotype) from *Crocodylus* spp.
- D. halichoris* (Owen, 1833) from *Dugong* spp.

(6) *Angusticaecum*, n.g.

Oesophagus without ventriculus or distinct bulb. A long slender caecum springs from the intestine a little behind its origin. No oesophageal appendix. Interlabia absent. Dentigerous ridges present.

Species:

- A. holopterum* (Rud., 1819) (genotype) from *Testudo* spp.
- A. [Porrocaecum] numidicum* (Seurat, 1917) from *Rana ridibunda*.

(7) *Amplificaecum*, n.g.

Oesophagus without ventriculus or distinct bulb. A wide intestinal caecum

parently an error. They have not been observed in the species examined, and the distinction between *Contraecum* and *Kathleena*, based on this point, does not appear to hold good.

¹ *C. auctum* has the interlabia much reduced.

present. No oesophageal appendix. Small interlabia present. Dentigerous ridges present.

Species:

A. colurum (Baylis, 1919) (genotype) from *Lophoaëtus occipitalis*.

A table may now be given which will serve to distinguish the genera mentioned, and also show to some extent the relationships supposed to exist between them.

A. Oesophagus divided into an anterior muscular portion and a posterior ventriculus, the latter being oblong or sigmoid in shape, or having a posterior appendix.

(a) An intestinal caecum present.

(a) An oesophageal appendix present...*Contraecaecum*.

(β) Oesophageal appendix absent...*Porrocaecum*.

(b) No intestinal caecum.

(a) An oesophageal appendix present...*Raphidascaris*.

(β) Oesophageal appendix absent...*Anisakis*.

B. Oesophagus without ventriculus, with or without a small but distinct posterior bulb. The latter, if present, spherical and without a posterior appendix. An intestinal caecum present.

(a) A distinct spherical oesophageal bulb present...*Dujardinia*.

(b) Distinct oesophageal bulb absent.

(a) Small interlabia present...*Amplicaecum*.

(β) Interlabia absent...*Angusticaecum*.

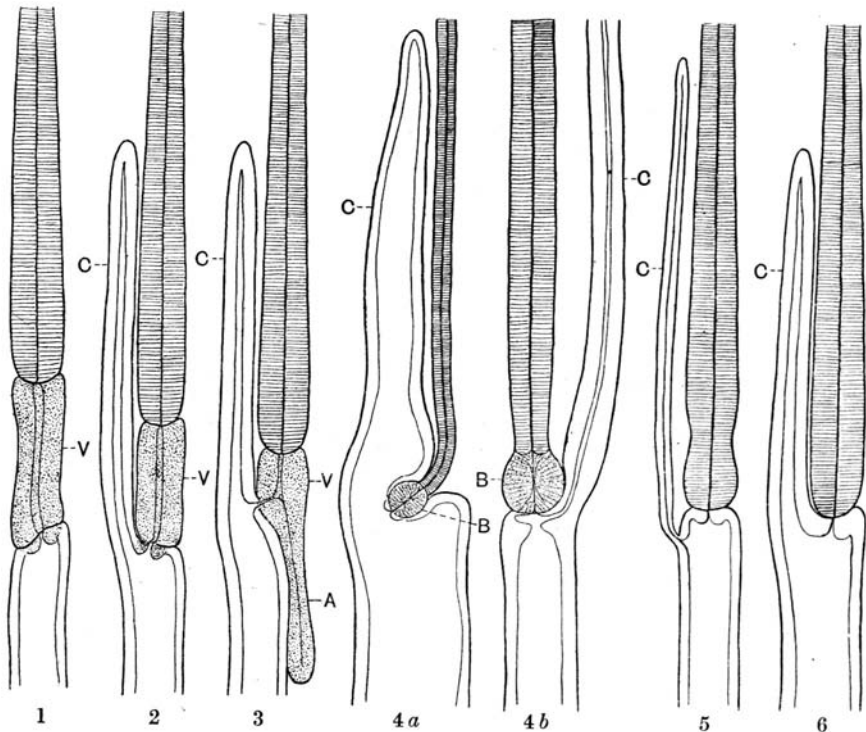
We have now to consider the position of the genera which were removed from the rest of the "Heterocheilinae"—*Heterocheilus*, *Typhlophorus*, *Goezia* and *Crossophorus*. The last-named genus seems so unlike any other Ascarid at present known that it may at once be placed in a subfamily by itself, which may be called CROSSOPHORINAE, n. subfam.

As regards the remaining three genera, it may be well to recall that von Drasche (1884) placed *Lecanocephalus* (= *Goezia*) and *Heterocheilus* in separate categories, which he named Lecanocephalidea and Heterocheilidea respectively. Considering the peculiarities of the genera in question, it seems not unreasonable to retain von Drasche's arrangement, and altering his names in accordance with the plan of modern nomenclature, to place *Heterocheilus* and *Typhlophorus* together in a subfamily HETEROCHEILINAE (or, in other words, to restrict Railliet and Henry's (1912) subfamily to these two genera), and *Goezia* by itself in another subfamily, GOEZIINAE.

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A series of diagrams illustrating certain types of structure met with in the alimentary canal of Ascaridae. The shaded portion represents the hinder part of the oesophagus.

A, oesophageal appendix; B, oesophageal bulb; C, intestinal caecum; V, ventriculus.

1, *Anisakis*; 2, *Porrocaecum*; 3, *Contraecum*; 4, *Dujardinia* (4a, *D. helicina*; 4b, *D. hali-choris*); 5, *Angusticaecum*; 6, *Amplificaecum*.

No specimens of *Raphidascaris* having been available, the structure found in this genus has not been figured. It is presumably like (3), but without the intestinal caecum.