"The Taxonomy and Distribution of the Helminth Parasites of Some Welsh Birds, with Observations on their Dissemination."

A Thesis submitted to the University of London for the Degree of Doctor of Philosophy

by

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PART I Section C.

Phylum ASCHELMINTHES

Class Nematoda.

PHYLUM ASCHELMINTHES Grobben, 1910

Syns.: Nemathelminthes Gegenbaur, 1859 in part; Nematoda ([(Rudolphi, 1808) Diesing, 1861] Lankester, 1877) Potts, 1932; Nemata [(Rudolphi, 1808) Cobb, 1919] Pearse, 1936; Nemerta ([Oersted, 1844] Lankester, 1900) Chitwood, 1950.

Class NEMATODA (Rudolphi, 1808) emend. Diesing, 1861

Syns.: Aphasmidia (Chitwood & Chitwood, 1933) Pearse, 1936; Phasmidia (Chitwood and Chitwood, 1933) Pearse, 1936; Adenophorea (von Linstow, 1905) Chitwood, 1958 (b); Secernentea (von Linstow, 1905) Chitwood, 1958 (b).

Sub-class Adenophoria [(von Linstow, 1905) Chitwood, 1940] nom. emend. Syns.: Aphasmidia Chitwood and Chitwood, 1933; Adenophori (von Linstow, 1905) Chitwood, 1940.

Sub-class Secernentia [(von Linstow, 1905) Chitwood, 1940] nom. emend. Syns.: Phasmidia Chitwood & Chitwood, 1933; Secernentes (von Linstow, 1905) Chitwood, 1940.

While descriptions of new species and genera of free-living and zoo- and phyto- parasitic nematodes continue to be published in increasing numbers, the classification of the group remains an obstacle to all zoological thought. It is precisely because she is able to bring the clear-sight of a zoologist rather than the near-sight of a nematologist that the writer has followed Dr. Hyman (1951) in using Aschelminthes as the phylum name. The phylum Nemathelminthes has been utilised to include the acanthocephalans but there are valid reasons for the exclusion of these animals from a common phylum with the nematodes, not least of which is the fact that much of their internal organization shows a closer affinity to the cestodes, Phylum Platyhelminthes. As understood, the Aschelminthes contain six classes; the Rotifera, Gastrotricha, Echinodera, Priapulida, Nematoda and Nematomorpha with the following definition:- pseudocoelomate with a cuticle and hypo-cuticle secreted by the ectodermal cells and a basically similar ground plan for the excretory system. Steiner (1960) has mentioned that Nemathelminthes should have precedence over Aschelminthes because of priority, but this phylum name, unless specifically emended, must be understood to include the Acanthocephala.

Chitwood (1958 a) withdrew his sub-classes Aphasmidia and Phasmidia, expressing regret that he had not acted on his 1940 acceptance of Adenophori and Secernentes as correct. He left these names open for usage as either sub-class or class, Pearse (1936) having already promoted the classes Phasmidia and Aphasmidia. Dougherty (1958) accepted Phylum Nematoda. Later that year in the discussion that followed Chitwood's contribution to the International Congress for Zoology (1958), Dougherty stated that he considers Aschelminthes to be the valid phylum name and Nematoda a class. This relegation to class rank is well expressed by Steiner (1960): "To consider the Nematoda a phylum would make it necessary to elevate also most, if not all, of the related taxa to phylum rank, a proceeding that would signify a negation of an existing and unquestionable relationship". If the classes Adenophorea and Secernentea are to be reduced to sub-classes it is necessary to emend their terminations to the accepted 'ia'.

The classification of Yamaguti (1961) consists of a reworking of Baylis and Daubney (1926) which, while consistent for zoo- parasitic nematodes, ignores both free-living and phyto-parasitic nematodes. The entire group is so remarkable in its morphological uniformity as opposed to the biological, physiological and ecological adaptations that from a purely zoological point of view a discipline which attempts to embrace this variety is to be preferred. The general dissatisfaction with the presence of absence of phasmids as a criterion and the reluctant acceptance of the Chitwood classification as given in Thorne (1961) p.89, does not negate the necessity for a system which places the nematodes in their broadest context. Only Dr. Chitwood is qualified and has attempted to do so, and so must receive due honour.

In an attempt to determine the classification acceptable to other workers the writer has consulted the last four taxonomic theses submitted from this Department. Khalil (1962) and Wahid (1962) both refer only to families and neither in their introductions state the classifications utilised. Tadros (1965) adheres rigidly to Yamaguti (1961) without reference to Chitwood. This general reluctance to discuss the merits of, or reasons for rejecting, the various systems of higher classification is found also in Rasheed (1964). This last worker, whose knowledge of the class is very sound and who might have been expected to record reasoned views on general classification, makes no attempt to include a classification beyond Super-families - an omission which must have been intentional.

If taxonomic theses are so circumscribed in outlook as to ignore general zoological implications, while adding to the profusion and confusion of generic, specific and sub-specific names, it is only to be expected that taxonomy based on morphology is being ridiculed and the claims of the computer endorsed. The writer accepts the more recent scheme of Chitwood (1959 - quoted Thorne, 1961) at subclass level as zoologically correct.

Order: DORYLAIMIDA Pearse, 1936

Super-family: TRICHUROIDEA Railliet, 1916

Family: Trichuridae Railliet, 1915

Sub-family: Capillăriinae Railliet, 1915

Railliet (1916) recognised two families, Trichinellidae and Trichuridae, the latter possessing Trichurinae, Capillariinae and Trichosomoidinae. Chitwood (1937) and Chitwood and Chitwood (1950) have accepted Railliet's classification. In 1936, Neveu-Lemaire created a separate family for Capillaria and this has been adopted by Skrjabin, Shikhabolova and Orlov (1957).

Genus: Capillaria Zeder, 1800

Syns.: Gordius Goeze, 1782; Trichicephalus Schrank, 1788; Trichosoma Rudolphi, 1819; Trichosomum Creplin, 1829; Liniscus Dujardin, 1845; Thominx Dujardin, 1845; Eucoleus Dujardin, 1845; Calodium Dujardin, 1845; Hepaticola Hall, 1916; Capillostrongyloides Freitas and Lent, 1935; Aonchotheca Lopez-Néyra, 1947; Echinocoleus Lopez-Néyra, 1947.

Goeze (1782) described Gordius from hens and Schrank (1788) described Filaria gallinae and in 1790, Trichicephalus anatis. Gordius and F. gallinae are now considered to be synonyms of C. caudinflata and T. anatis a synonym of C. anatis Madsen, 1951. Zeder (1800) described Capillaria but this name was displaced by Trichosoma of Rudolphi (1819). Dujardin (1845) separated five genera as follows:-

I). Sheath short, equal to twice the diameter of the body, smooth not thickened:- Trichosoma (= Capillaria)

II). Sheath large, ten times the diameter of the body with spines:-

(a) spicule present - Thominx

(b) spicule absent - Eucoleus

III). Sheath very large, no spines but with transverse, oblique striations not thickened, and frequently projecting:- Calodium, Liniscus.

Diesing (1851) recognised only one genera but several sub-genera: Gymnothecae (no spines on spicule sheath) - Calodium, Liniscus; Echinothecae (spined spicule sheath) - Thominx, Eucoleus In his 1861 revision he accepted all genera but Liniscus. Stossich (1890) added a third sub-genus, Athecae for Trichosoma crassicauda which has no sheath. The priority of Zeder's Capillaria was first acknowledged by Travassos (1914) who synonymised all other genera under this name. The following year he created two sub-genera:-

Capillaria (C.) Zeder, 1800 - non-spinose spicule sheath

Capillaria (Thominx) Dujardin, 1845 - spined spicule sheath.

The genus Hepaticola was raised by Hall (1916) for hepatica from the liver of mammals, but Baylis (1931) concluded that most diagnostic characters were of negative value and synonymised all genera with Capillaria Zeder, 1800. His decision has been followed by Cram (1936) and Madsen (1945), the latter's revision of certain avian species being extensive. Skrjabin (1939) re-established Thominx Dujardin, 1845, with the spines on the sheath rating generic importance and in addition to accepting this work, Skarbilovitsch (1946) proposed Skrjabinocapillaria for species in bats.

Lopez-Néyra (1947) based a new classification on the ratios of oesophagus length to that of the body and the presence or absence of spines on the spicule sheath, but Madsen (1951) showed that this scheme is unreliable and reverted to Baylis' classification. Gagarin (1951) studied avian species and conceded three genera with the hitherto unconsidered feature of position in the host utilised as well as morphological characteristics, viz., Eucoleus - mucosa of oesophagus, Capillaria - lumen of small intestine, Thominx - within the caecum. Skrjabinocapillaria was added to this classification by Chetkova (1952) and Hepaticola was considered valid by Pavlov (1955) because of the unusual site in the host and the unique life-cycle.

The next major classification was contributed by Skrjabin, Shikhabolova and Orlov in 1957, which may be summarised as follows:

1)	Spicule present	2
	Spicule absent	4
2)	Spicule sheath with spines	Thominx
	Spicule sheath without spines	3
3)	Eggs laid by female emerge from the host ..	Capillaria
	Eggs laid by female remain within the host ..	Hepaticola
4)	Spicule sheath without spines	Skrjabinocapillaria
	Spicule sheath with spines	Eucoleus

Capillostrongyloides Freitas and Lent, 1935 and Aonchotheca Lopez-Néyra, 1947, are placed under Capillaria, and Echinocoleus Lopez-Néyra, 1947, under Thominx. A curious feature of this extensive revision is the nomination of C. obsignata Madsen, 1945 as genotype instead of C. columbae (Rud., 1819). Neither columbae not obsignata can justifiably replace anatis (Schrank, 1790) as the genotype accepted by nearly all other workers. Even workers who follow this classification express doubts similar to those of Baylis (1931), for example T. Bonner Stewart (1963) in a note on Thominx phasianina (Kótlan, 1940) states "because of the lack of cuticularization of the spicule of certain capillarids, the presence or absence of a spicule is not easily determined". One suspects that a character which may or may not be present in a species should not rank at a generic level. From within the Soviet Union comes the criticism of Gagarin (1959) that the division of Capillaria into genera has been done without a thorough study and redescription of species from all groups of hosts.

Freitas (1959) added four new genera, Gessvella, Pterothominx, Pseudocapillaria and Ritaklossia, using the criteria - nature of the cephalic end, relative lengths of anterior and posterior regions, nature of the mature eggs and of the male caudal region. Freitas and Mendonca (1960) created Pearsonema for some mammalian species and Freitas and Silva (1960) Orthothominx for various avian species. Yamaguti (1961) has created a new Order Trichuridea (syn. Trichinelloidea, Hall, 1916), while the Chitwoods (1950) place the family in Dorylaimida Pearse, 1936. Yamaguti rejects Skrjabin et al., (1957) and synonymises all species in Capillaria with the exception of Skrjabinocapillaria which he separates with a footnote to the effect that the poorly chitinised spicule may have been overlooked.

In this study all specimens are considered as belonging to Capillaria in agreement with Baylis (1931), Cram (1936), Madsen (1945, 1951, 1952), Read (1949) and the Chitwoods (1950).

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1). Capillaria caudinflata (Molin, 1858) Wavilova, 1926

Syns.: Gordius gallinae Goeze, 1782; Filaria gallinae Schrank, 1788; Capillaria semiteres Zeder, 1803; Trichosoma columbae Rudolphi, 1819; Trichosoma longicolle Rudolphi, 1819; Calodium tenue Dujardin, 1845; Trichosoma gallinum Kowalewski, 1894; C. longicollis Madsen, 1945; C. gallinae Lopez-Néyra, 1947; Thominx wavilovi Skrjabin et al., 1957 and many others.

The first accurate and recognisable description of this species is that of Molin (1858) as Calodium caudinflata from the Quail (Coturnix coturnix (L.)) and Madsen (1951) conceded that his longicollis of 1945 is a synonym as a result of the work of Orosz (1931) and Moorehouse (1944). Molin (1859) did not mention the presence of spines on the spicule sheath and despite their presence in Madsen's redescription (1945), Skrjabin et al. (1957) separated longicollis from caudinflata on the presence of spines and used it for their new species Thominx wavilova. Freitas (1960) used the presence of spines and lateral caudal alae to

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Capillaria caudinflata (Molin, 1858) Wavilova, 1926

Figure 135 Male Tail. Bursa lateral view. H.P. x 10
Figure 136 Male Tail. Bursa ventral view. H.P. x 10
Figure 137 Female. Vulva appendage. H.P. x 10.
Figure 138 Egg. Oil immersion.

Capillaria contorta (Creplin, 1839) Travassos, 1914

Figure 139 Female. Vulva ventral view. H.P. x 10.
Figure 140 Female. Vulva lateral view. H.P. x 10.
Figure 141 Egg. Oil immersion.

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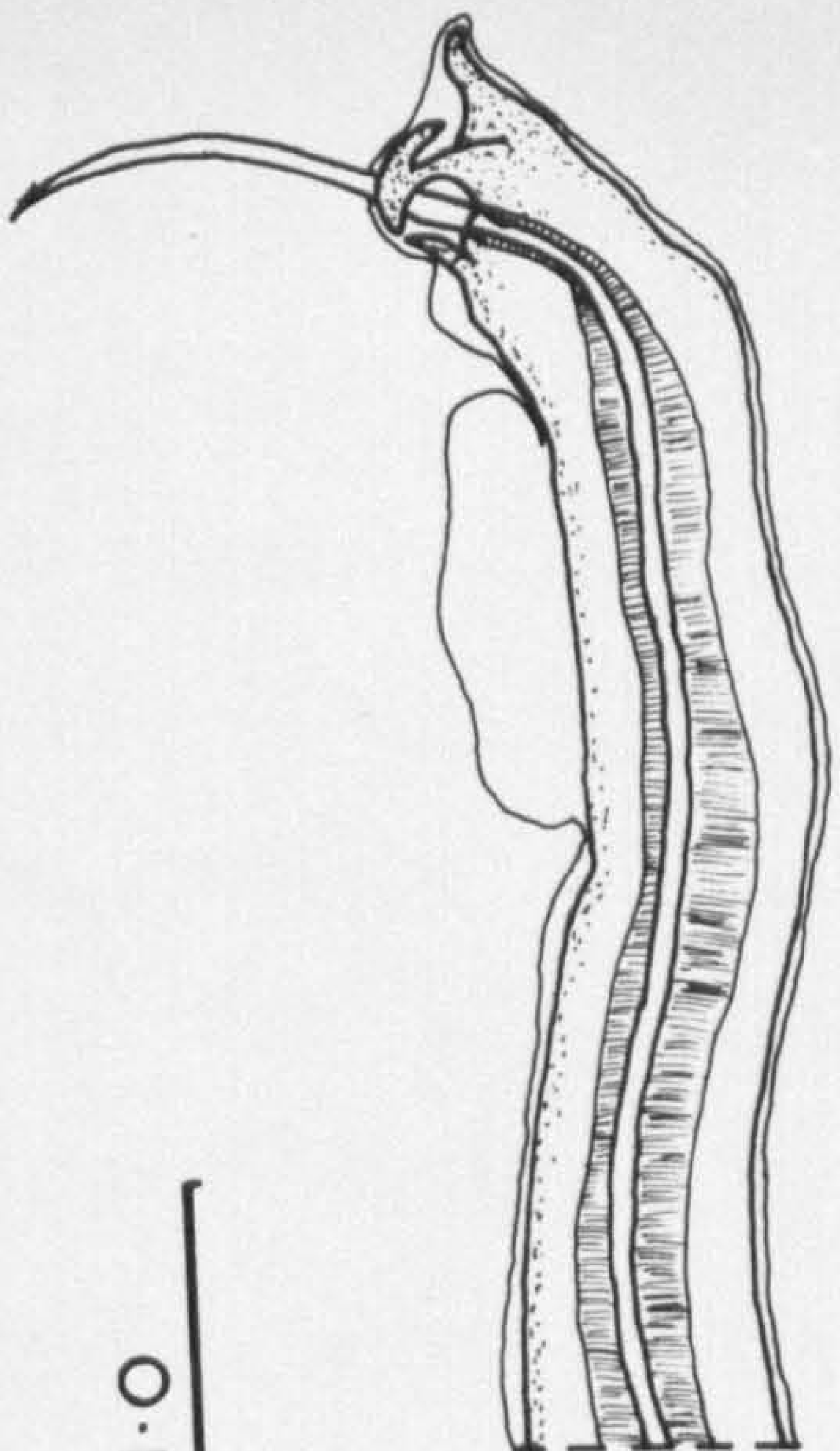

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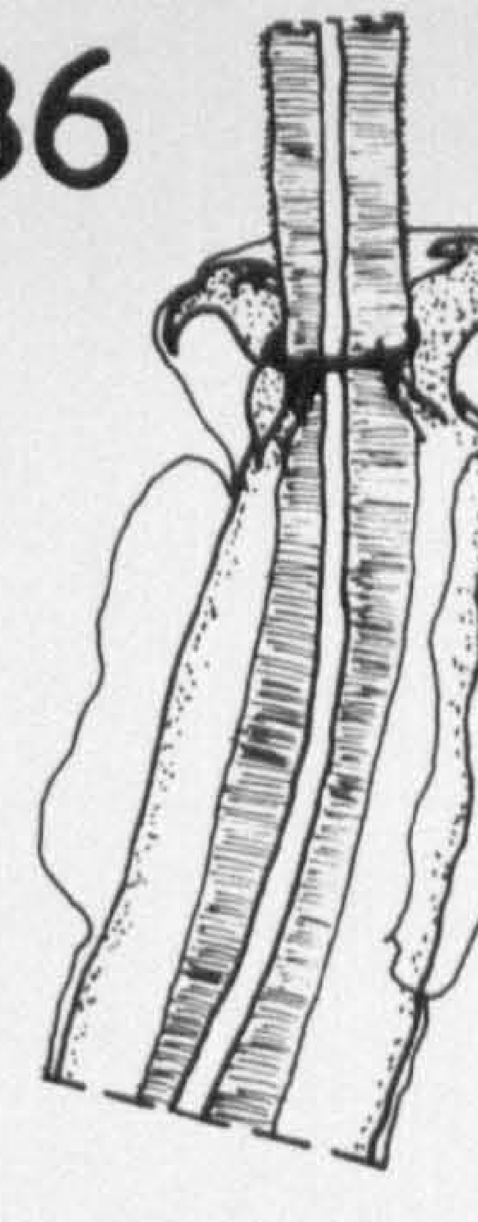

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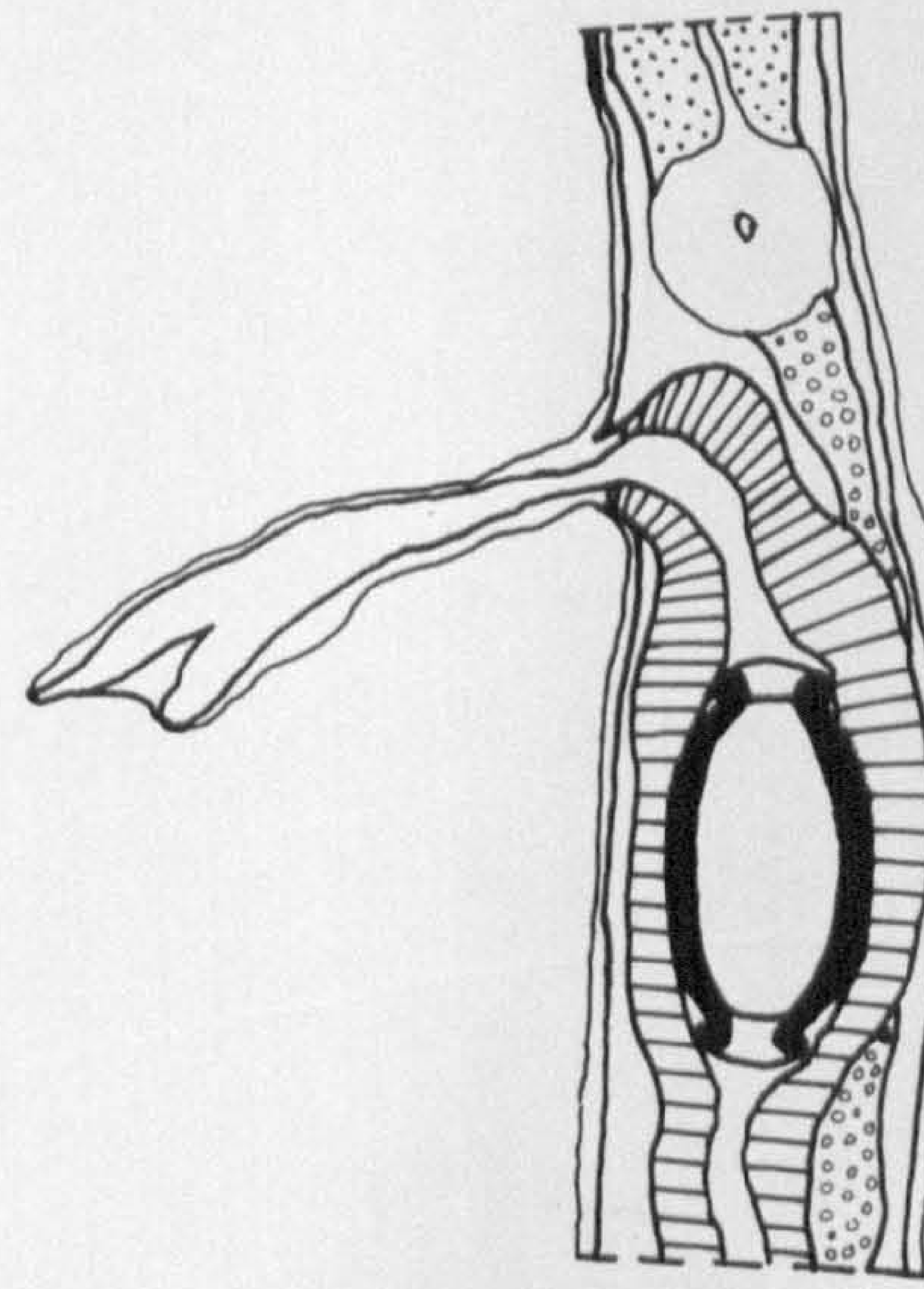

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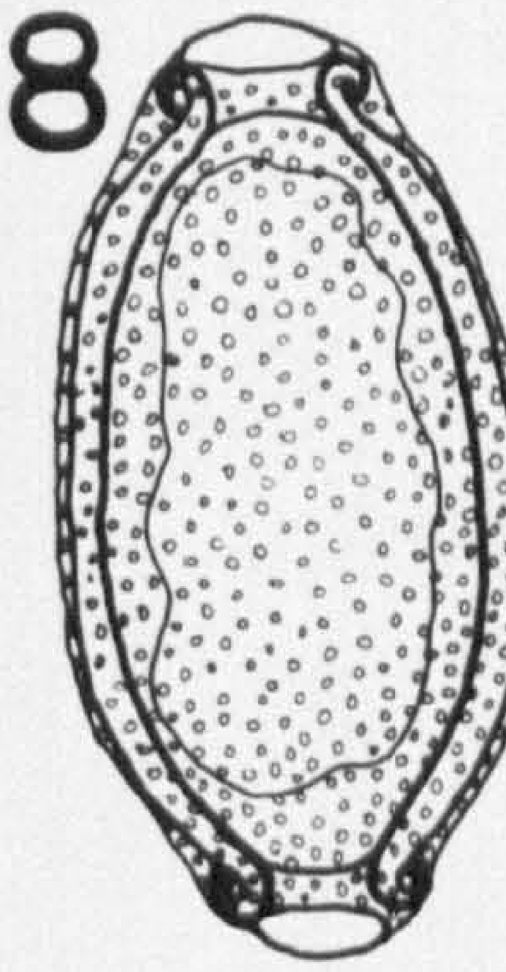

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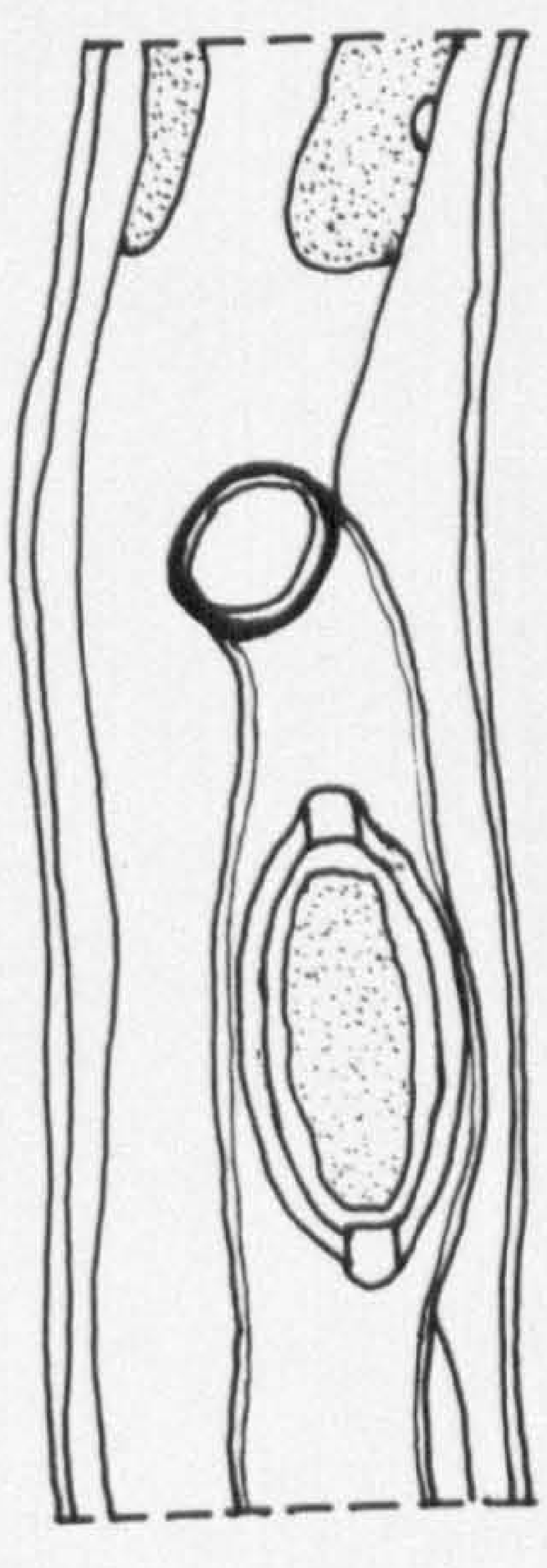

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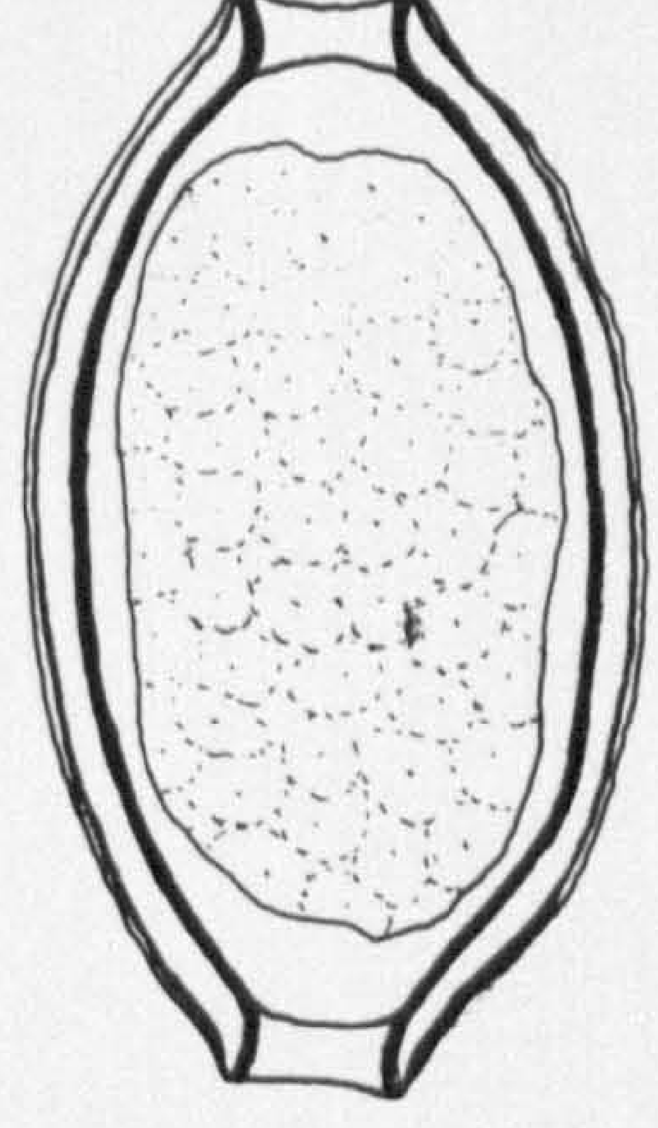

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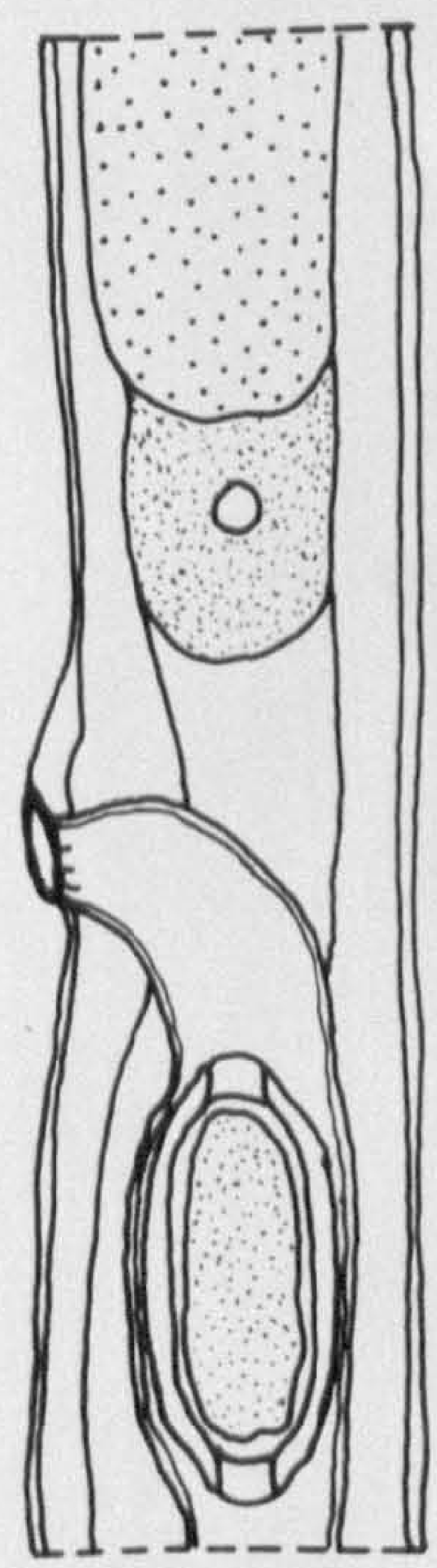

place the species in his new genus Pterothominx. Wakelin (1963, unpubl.) suggested that C. alpina Bach and Forstner (1959) is also a synonym.

First records in British birds are the Black Grouse (Lyrurus tetrix (L.)), the Red Grouse (Lagopus scoticus (Latham)) and the Capercaillie (Tetrao urogallus L.) from Shipley (1909 a, b). Subsequently Clapham (1935) found the nematode in the Partridge (Perdix perdix (L.)) and the Pheasant (Phasianus colchicus L.) and in 1938 she added the Redlegged Partridge (Alectoris rufa L.), the Chukar (Alectoris graeca L.) and the Domestic Pigeon (Columba livia dom. L.). Walker (1937) obtained it from the Domestic Hen (Gallus gallus L.), Baylis (1939) listed the Eastern Little Bustard (Otis tetrax (L.)) and Owen (1951) the Domestic Turkey (Meleagris gallo-pavo dom. L.). Mettrick redescribed the species from the Woodpigeon (Columba palumbus L.). The writer's specimens were obtained from the Woodpigeon during spring and summer months. In the Blackbird (Turdus merula L.) only females were discovered, (5(1) - 11/62).

Description

Male: The length is variable between 9 mm. and 23 mm. (average 13.3 mm.), and the breadth is typically 0.036 mm. across the oesophagus. The ratio anterior to posterior part of the body is therefore 1 : 1 - 1.6. The spicule length is also variable, 1.1 mm. to 1.682 mm., and it is slender and drawn to a fine point, (Figure 135). For most of its length it is circular in cross-section with a diameter of 0.004 mm. to 0.007 mm. Proximally it is more triangular and broadens to 0.009 - 0.012 mm. It may be spatulate or less often irregular in outline. The spicule sheath is 1.8 mm. long, that is larger than the spicule. It has fine transverse striations and also rows of tiny conical spines. The caudal end supports a characteristic bursa, 0.05 mm. in diameter, (Figure 136). It is supported by a pair of T-shaped lateral rays, 0.018 mm. long, postero-laterally to the cloaca (Figures 135 & 136). There are also a pair of pre-anal papillae. Anteriorly to the bursa are a pair of lateral alae, 0.052 mm. long. The shape of the bursa was constant throughout a range of over fifteen specimens.

Female: The length is even more variable than in the male, 11mm. to 43 mm. (average 17 - 18 mm.). The width across the vulva is 0.045 mm. regardless of length. The vulva divides the body in the ratio 1 : 2 and is 0.103 mm. from the oesophagus. Most distinctive is the vulval appendage which is tubular and vase-shaped, 0.068 - 0.085 mm. long, (Figure 137). It leads into a muscular vagina 0.25 mm. long. The tail end is blunt and round. The eggs are rather elongated, 0.05 - 0.055 mm. by 0.022 - 0.023 mm. with a fine reticulate outer shell. The inner shell is reflexed (Figure 138).

Discussion

No variation in egg length comparable with the length of the body and spicule is seen. Table 33 gives the measurements from the descriptions of Madsen (1945) and Mettrick (1959) for longicollis. With regard to the male the spicule range is not

TABLE 33: Capillaria caudinflata (Molin, 1858)

Characters	Madsen, 1945	Mettrick, 1959	Author
Male			
Length	7.0 -20.4	8.4 — 14.7	9.0 - 23.0
Breadth	0.025 - 0.03	0.068	0.036
Oesoph : Body	-	1 : 1.3	1.1 - 1 : 1.6
Spicule length	0.67 - 1.89	0.96 - 1.02	1.1 - 1.682
" diameter	0.005		
Cross-section	-	0	0
Spicule tip	fine point	fine point	fine point
" proximal end	broad, frayed	-	spatulate
" sheath	transverse striations & fine spines	transverse striations & minute spines	transverse striations & fine spines
Bursa	-	-	2 pre-anal papillae and
	-	-	2 T-shaped papillae
Alae	0.055 - 0.095	0.075 - 0.077	0.052
Female			
Length	9.3 - 36.3	8.9 - 17.6	11.0 - 43.0
Breadth	0.03 - 0.07	0.073	0.045
Vulva : Body	-	1:2	1:2
Vulval appendage	0.05 - 0.1	more than 0.042	0.068 - 0.085
Eggs	0.043 - 0.057 X 0.022 - 0.027	0.049 - 0.042 X 0.022 - 0.024	0.05 - 0.055 X 0.022 - 0.023
Outer shell	-	finely punctate	reticulate
Inner shell	-	reflexed	reflexed

as great as that of Madsen, but the average size is bigger (1.302 mm. while Madsen states 0.975 mm.). The bursa is fully and accurately described, for the first time above. The maximum length attained by the female is greater than previously recorded and the egg size more constant. A difference in terminology arises over the markings of the shell. Madsen ignores this point while Mettrick describes "fine punctations". In the writer's material the shell has a reticulate pattern, or at the very least coarse punctations.

The only previous record from Wales came from 110 fowls and the domestic turkey, (Owen, 1951). This is the first record from wild birds, and the Blackbird (*Turdus merula* L.) is a new host record.

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2). *Capillaria contorta* (Creplin, 1839) Travassos, 1915

Syns.: *Trichosomum obtusum* Mehlis, 1831; *Trichosoma contortum* Creplin, 1839; *Trichosomum contortum* Dujardin, 1845; *Trichosoma annulatum* Molin, 1858; *T. strumosum* Reibisch, 1893; *T. delicatissimum* Perroneito & Tomiolo, 1900; *Capillaria perforans* Kotlán & Orosz, 1931; *C. lophortygis* Baylis, 1934; *C. vanelli* Yamaguti, 1935; *Eucoleus raillieti* Lopez-Néyra, 1947.

This universally distributed species has been recorded from the crop and oesophagus of domestic birds, Galliformes, Anseriformes, Charadriiformes and Passeriformes. Madsen (1952) noted the curious fact that there are no records from game or domestic birds in Britain, and this was still true in 1962 when Keymer et al. published their results. There are several records from wild birds however, Nicoll and McIntosh (1927) in the Little Auk (Alle alle (L.)); Baylis (1928) in the Carrion Crow (Corvus corone corone L.); Mettrick (1959) in Crow and the Rook (Corvus frugilegus L.); Pemberton (1960) in the Crow and the Songthrush (Turdus philomelos clarkii Hartert) and Pemberton (1963) in the Herring Gull (Larus argentatus Pont.), the Common Gull (Larus canus L.) and the Blackheaded Gull (Larus ridibundus L.). There are no Welsh records.

In this survey specimens have been recovered from the Mallard (Anas platyrhynchos L.) - (3(1) - 12/62); the Curlew (Numenius arquatus (L.)) - (2(1) - 12/62); the Fieldfare (Turdus pilaris L.) - (5(1) - 3/63); the Robin (Erithacus rubecula melophilos Hartert) - (2(1) - 3/62); the Meadow Pipit (Anthus pratensis (L.)) - (1(1) - 7/62); the Rock Pipit (Anthus spinoletta (L.)) - (1(1) - 11/62) and the Skylark (Alauda arvensis L.) - (1(1) - 7/63). The specimen from the Skylark was an immature female.

Description

Male: The length varied between 6 mm. in the Robin to 23 mm. in the Mallard. The average measurement is 12.3 mm. and across the base of the oesophagus is 0.06 mm. No males were present in the Meadow Pipit, the Rock Pipit and the Skylark. The cuticle is thin with fine transverse striations. The oesophagus varies from 2 mm. to 7 mm. in length and divides the body in the ratio 1: 2.5. The tail end is attenuated and bears a pair of meagrely developed lateral projections. The spicule could only be satisfactorily observed in a single specimen where it projected 0.23 mm. beyond the spicule sheath. The diameter is 0.003 mm. Its proximal termination could not be followed owing to lack of chitinization. It is circular in cross-section. Conversely the spicule sheath is quite distinct, 0.76 mm. to 1.9 mm. long with spines in oblique rows. Proximally the sheath swells slightly to a diameter of 0.027 mm. (for most of its length it is 0.018 - 0.02 mm. wide). In this region the spines are uniformly more coarse.

Female: The length is 14 mm. in the Robin and 30 mm. in the Mallard. The maximum width was 0.11 mm. The vulva is 2.6 - 6.0 mm. from the anterior end and 0.084 mm. from the oesophagus. It has a circular aperture which has a distinct chitinous lip, (Figures 139 & 140). The tail is elongate and slender but ends bluntly. The eggs (Figure 141) are 0.054 mm. to 0.059 mm. by 0.027 mm. to 0.03 mm. The outer shell is smooth and the inner shell is not reflexed.

Discussion

The spicule approximates to Madsen's description (1945) except that the proximal fraying could not be found. The eggs all resemble Madsen's Figure 14d, and are without polar prolongations. The Mallard, Curlew and Robin are all first records in Britain. The Fieldfare (Turdus pilaris L.), the Meadow Pipit

(Anthus pratensis (L.)) and the Skylark (Alauda arvensis (L.)) are all new host records. Williams (1962) recorded Capillaria spp. from the oesophagus of the Rock Pipit, but this is the first established record for contorta in this host.

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3). Capillaria obsignata Madsen, 1945

Syns: Trichocephalus tenuissimus Rudolphi, 1803; Trichosomum tenuissimum Diesing, 1851; Capillaria dujardini Travassos, 1915.

Rudolphi (1819) described T. colombae from the large intestine of Pigeons (Columba livia dom. L.). The material was redescribed by Dujardin (1845) as Calodium tenue and particular reference was made to the projecting membraneous appendage. The latter was not present in Madsen's material (1945) from the small intestine and he chose to name species found in this locality, without an appendage, C. dujardini Travassos, 1915. Travassos (1914) however had specifically proposed dujardini for Calodium tenue and Read (1949) pointed out that as a result 'dujardini' must relate to species from the large intestine with a vulval appendage. Madsen (1945) differentiated C. columbae of Graybill (1924) as obsignata on the basis of a reflexed collar on the inner shell of the egg and a differing proximal end to the spicule. Read reassessed Graybill's material and stated that there are two capillarids in the pigeon intestine:-

a). large intestine - C. columbae (Rud., 1819); syns., Cal. tenue Dujardin, 1845, Tricho. tenuissimum Diesing, 1851, C. dujardini Travassos, 1914.

b). small intestine - C. obsignata Madsen, 1945.

In 1951, Madsen acknowledged that Read was correct and emphasized that C. columbae of general usage is in fact C. obsignata. Specimens with a membraneous vulval appendage (i.e. Trichosoma columbae Rud., 1819, Calodium tenue Dujardin, 1845, and C. dujardini Travassos, 1914) he synonymised with C. caudinflata (Molin, 1858). Skrjabin et al. (1957) nominated C. obsignata as genotype but retained C. columbae as a distinct species. A redescription by Mettrick (1959) was based on Madsen's original definition of the species which was differentiated from columbae of general usage, i.e. without a vulval appendage, and he continued to synonymise dujardini Travassos, 1915 with columbae on the basis that the presence or absence of an appendage is unreliable. The most authoritative account, conversant with Madsen's redefinition (1951), is that of Wakelin (1963).

Owen (1951) records the species in the Goose (Anser anser dom. L.) and Mettrick (1959) redescribed the species from the Domestic Pigeon. Pemberton (1960) found the species in the Feral Pigeon (Columba livia livia Gmelin). Keymer et al. (1962) recorded specimens in the Wood Pigeon (Columba palumbus L.), the Stock Dove (Columba oenas L.), the Partridge (Perdix perdix (L.)) and the Pheasant (Phasianus colchicus L.). Wakelin's

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Capillaria obsignata Madsen, 1945

Figure I42 Male. Bursa and Spicule Tip. H.P. x IO

Figure I43 Male. Spicule - proximal expansion. H.P. x IO

Figure I44 Female. Vulva. H.P. X IO.

Figure I45 Egg. Oil immersion.

Capillaria ovopunctata (von Linstow, I873)

Figure I46 Male tail. H.P. x IO.

Figure I47 Male. Spicule tip. Oil immersion.

Figure I48 Spácule - proximal end. Oil immersion.

Figure I49 Spicule sheath. H.P. x I5.

Figure I50 Female. Vulva with appendage. H.P. x IO

Figure I5I Egg. H.P. x I5.

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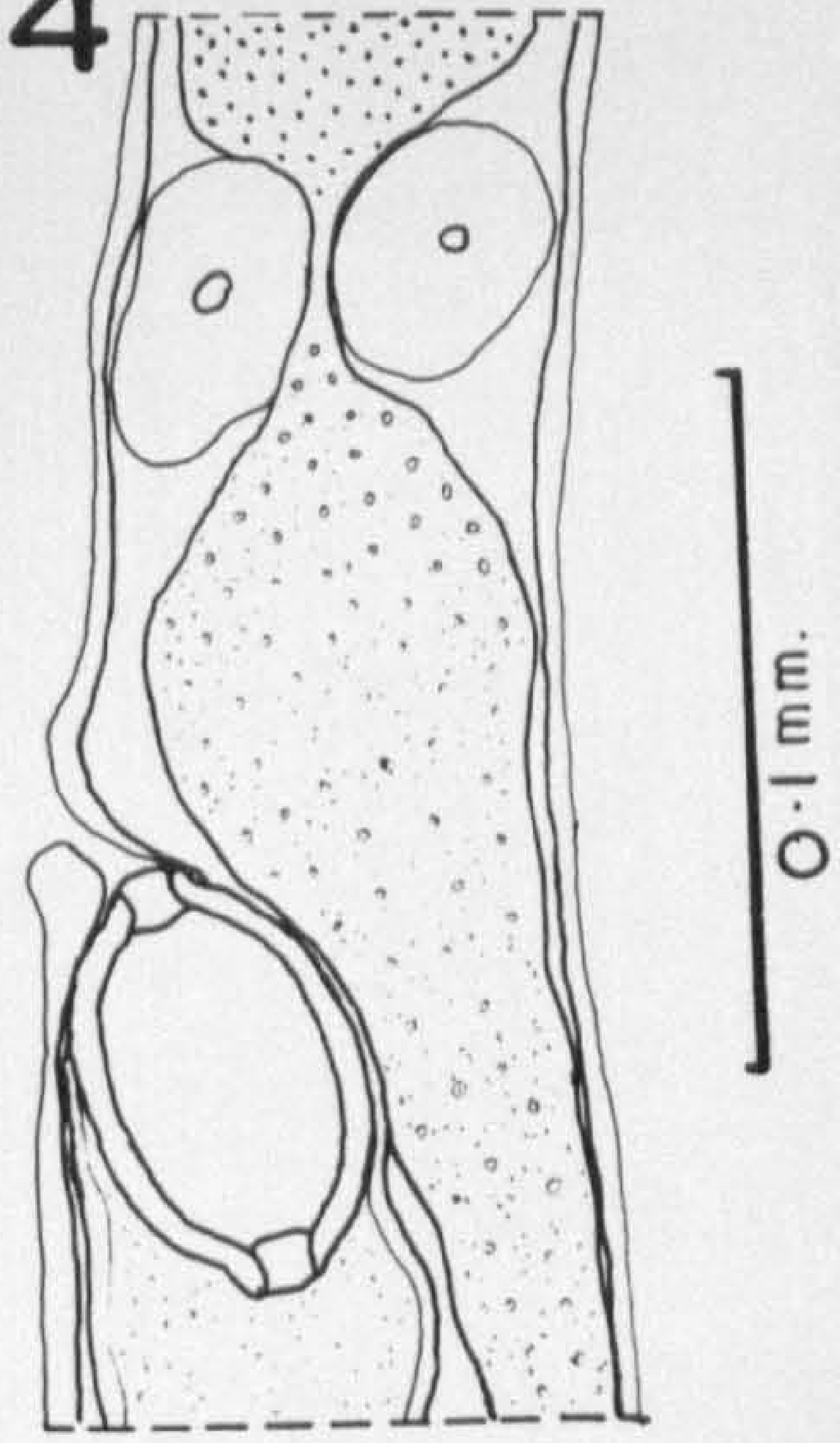

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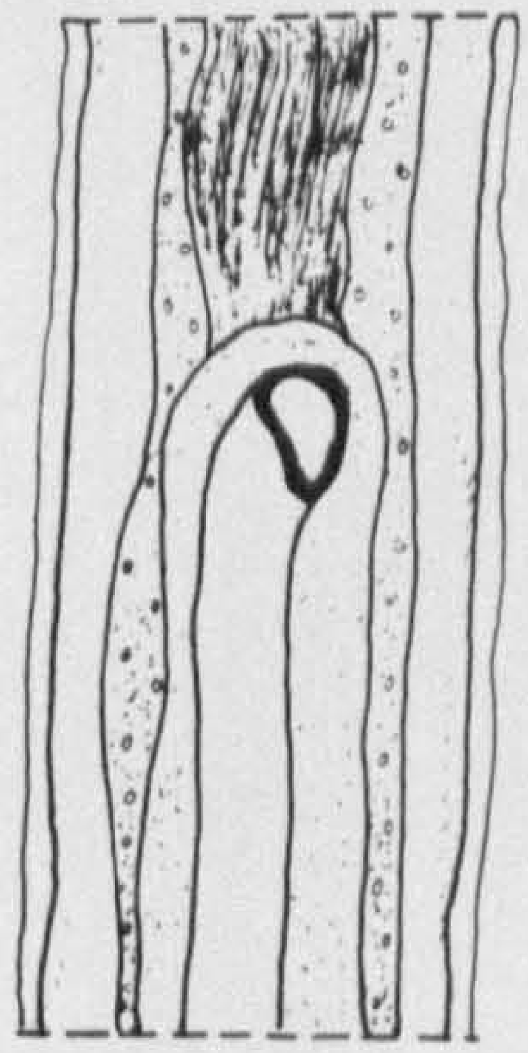

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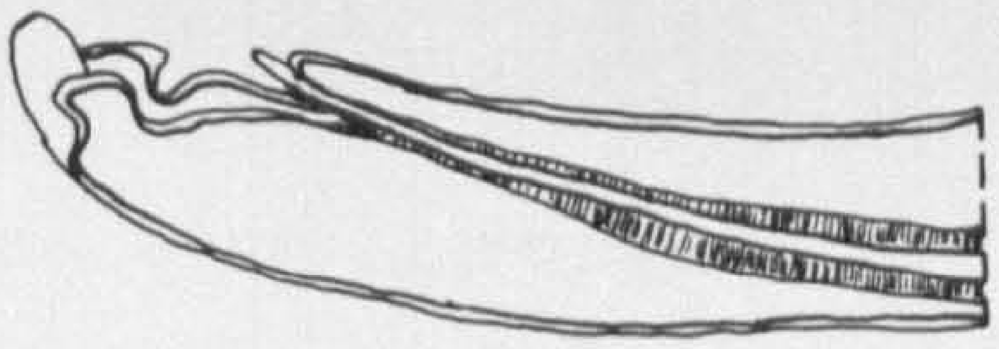

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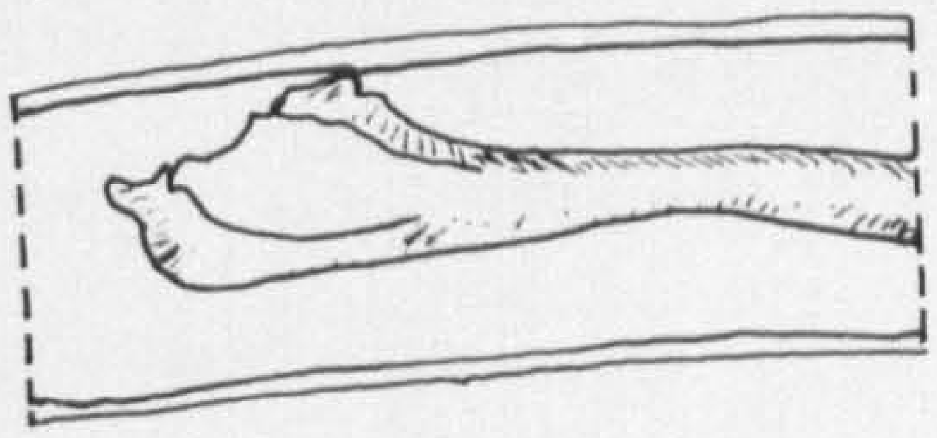

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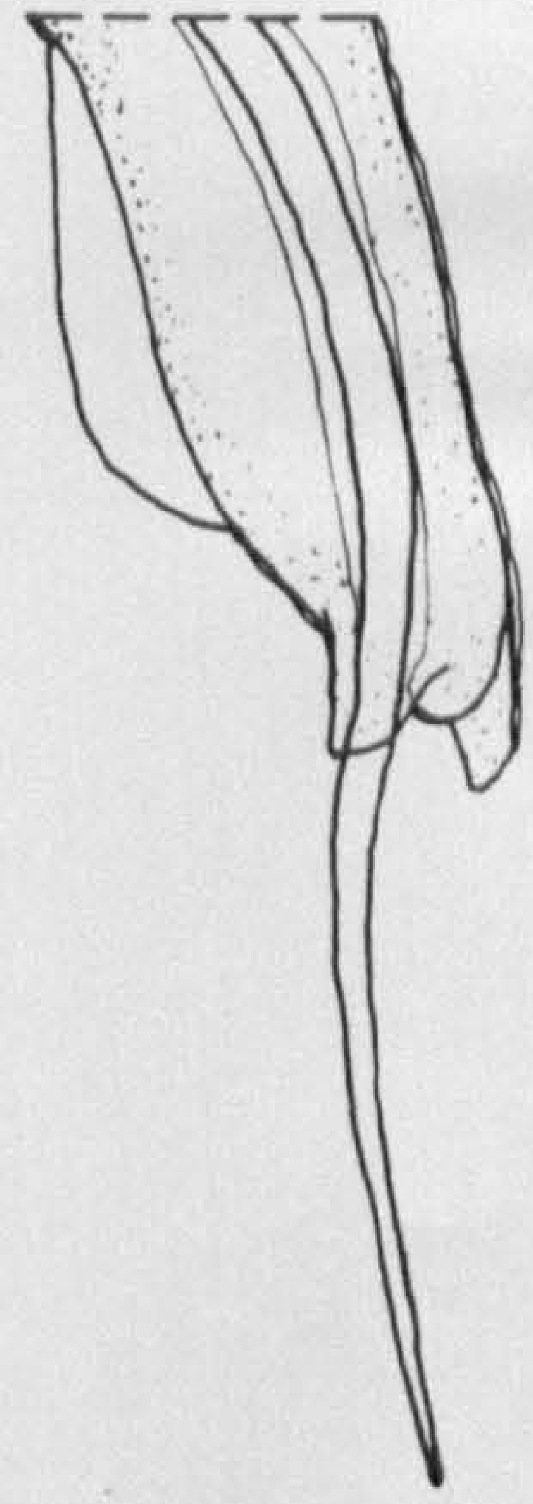

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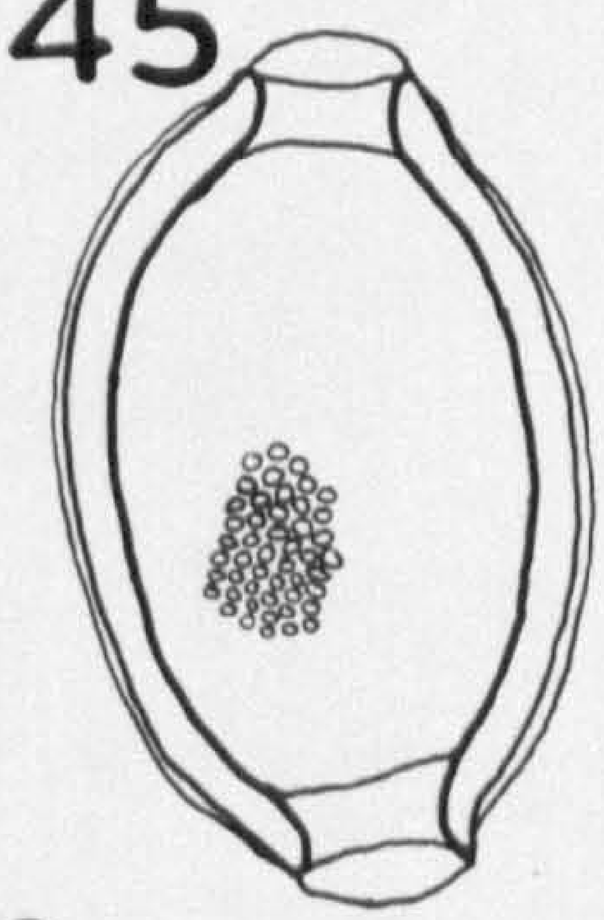

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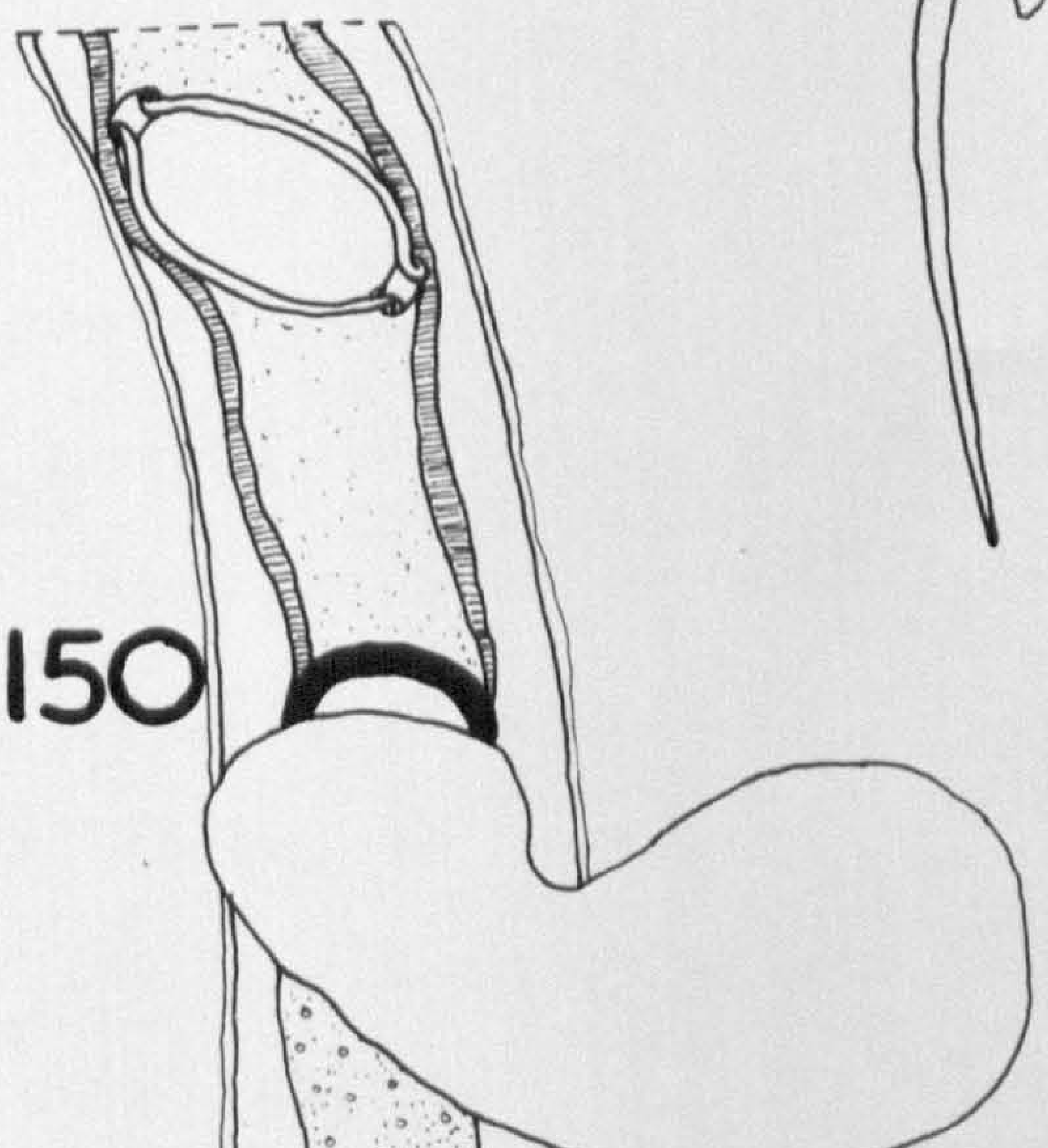

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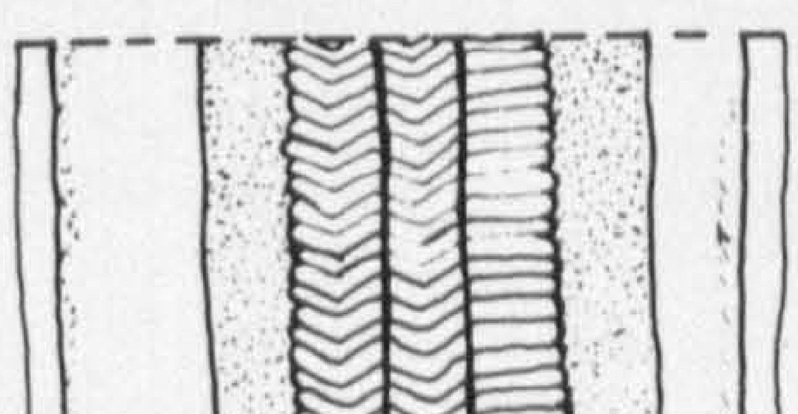

redescription (1963) included measurements from the Black Swan (Cygnus atratus Latham) and the Hen (Gallus gallus dom. L.) and in his thesis (unpubl.) he records the Greenfinch (Chloris chloris (L.)) and the Ashy-headed Goose (Chloephaga poliocephala Gray). In this survey the species has been found in two new hosts, the Blackbird (Turdus merula L.) - (8(1) - 5/63) and the Starling (Sturnus vulgaris L.) - (3(1) - 1/63).

Description

Male: There were six males collected measuring 9.5 - 13 mm. long and up to 0.039 mm. across the base of the oesophagus. The oesophagus divides the body in the ratio of 1 : 1. The spicule is 1.386 mm. to 1.688 mm. long and it is round in cross-section, 0.009 mm. wide. Proximally it is expanded in a trumpet-like manner and curves ventrally, (Figure 143). In this region it may be 0.025 mm. in diameter. The distal tip is blunt. The spicule sheath, which in four of the specimens is everted, has fine striations but no spines. The cloaca is surrounded by a rounded cuticular bursa which is supported laterally by a pair of rays, (Figure 142). There are no associated lobes or alae.

Female: About twenty specimens were recovered, of which eleven were examined in detail. The length is 17 - 19 mm. with an average width of 0.055 mm. The vulva, 0.165 mm. behind the oesophagus, has slight lips, (Figure 144). It divides the body in a ratio 1 : 2.3. The vagina is rather short, 0.18 mm. long: the caudal end is rounded. The eggs are 0.05 mm. by 0.025 mm. wide with finely reticulate outer shell. The inner shell is not reflexed but forms a distinct collar round the plugs, (Figure 145).

Discussion

Table 34 shows Madsen's measurements (1945) and those of Wakelin (1963). This new description from two new hosts falls clearly within the range of variation already attributed to the species. The only previous record in a Passerine host is Wakelin's for the Greenfinch. This has interest since the Finches are predominantly seed-eaters. The new Passerine hosts recorded herein, the Blackbird and Starling, are of greater significance since the Starling particularly is a winter visitor. Recent work (Norton, 1964) has emphasized the considerable increase (up to 49.5 %) in infestation of fowls with <u>obsignata</u> in correlation with utilization of deep-litter techniques in the poultry industry. If the Starling is a natural reservoir host - experimental infections of the Starling with <u>obsignata</u> are dealt with in Part 4 of this thesis - then the prevention of access of these migratory birds to the poultry houses in rural areas is of greater importance than has hitherto been assumed.

TABLE 34: Capillaria obsignata (Madsen, 1945)

Characters	Madsen, 1945	Wakelin, 1963	Author
Male			
Length	6.9 - 12.96	9.88 - 14.79	9.5 - 13.0
Breadth	0.042 - 0.051	0.046 - 0.049	0.039
Oesoph : Body	-	-	1:1
Spicule length	1.09 - 1.53	1.43 - 1.78	1.386 - 1.686
" diameter	0.006 - 0.011	0.004 - 0.009	0.009
Cross-section	0	0	0
Spicule tip	blunt	blunt	blunt
" proximal end	Funnel-shape	Funnel-shape	Funnel-shape
" sheath	transverse striations	transverse striations	transverse striations
Bursa	lateral rays	lateral papillae	lateral rays
Female			
Length	8.28 - 17.28	13.05 - 20.5	17.0 - 19.0
Breadth	0.049 - 0.067	0.053 - 0.064	0.055
Vulva : Body	-	-	1 : 2.3
Vulval appendage	none	none	slight lip
Tail end	-	round, obtuse	rounded
Eggs	0.044 - 0.056 X 0.022 - 0.029	0.042 - 0.056 X 0.022 - 0.029	0.05 x 0.025
Outer shell	reticulate	-	reticulate
Inner shell	not reflexed	not reflexed	not reflexed

4). _Capillaria ovopunctata_ (von Linstow, 1873) Travassos, 1915

Syn.: _Trichosoma ovopunctatum_ von Linstow, 1873

This species has been recorded in the Blackbird (_Turdus merula_ L.) and the Starling (_Sturnus vulgaris_ L.) throughout most of the Northern Hemisphere. In Britain it has been found in the Starling - Baylis (1928), Evans (1938 - unpubl.), Mettrick (1959); and the Blackbird - Baylis (1939). Clapham (1940) found the species in Rook nestlings. The writer's material occurred in small numbers in the above hosts.

Description

Male: Two from the Blackbird (November, 1962) and one from a Starling (December, 1963). The average length of these worms is 7.3 mm. and the width 0.054 mm. at the base of the oesophagus. The bursa is characteristic (Figure 146), with a pair of lateral lobes and a cuticular dorsal projection. 0.012 mm. in front are a pair of lateral alae, 0.036 mm. long and 0.008 mm. wide. The spicule is 0.95 mm. long and tapers to a sharp point. A hitherto unmentioned feature of the spicule is the occurrence of regular annulations at the tip (Figure 147). The proximal end is slightly dilated (Figure 148) with a slight bias to the ventral side. The spicule sheath has marked transverse striations with a distinct pattern (Figure 149). It is 0.01 - 0.014 mm. in diameter. Spines if present could not be detected.

Female: Five specimens from the Blackbird and seven from the Starling. The body is whitish and up to 15.7 mm. long (from Starling). The diameter is approximately 0.066 mm. in the region of the vulva when the uterus is distended with eggs. The vulva is 0.01 mm. from the oesophagus and has an appendage which may be absent or take several different forms. Most frequently it is rather sausage-shaped (Figure 150), but it may be more squat or mushroom-like. The largest appendage was 0.13 mm. by 0.059mm. The eggs have a very protruding plug and the lips are bent laterally. The outer shell has deep striations (Figure 151), and together with the plugs the eggs measure 0.056 mm. by 0.026 mm.

Discussion

Mettrick's description (1959) is one of the first since von Linstow's original. The details of the male are similar to the above text with the exception that Mettrick did not observe the annulations at the spicule tip. With regard to the female, the writer is unable to offer corroborative evidence that the presence or absence and shape of the vulval appendage is related to the age. This may be true. The eggs are indisputably striated in this collection. In his full text Mettrick describes them as finely punctate and in his key on page 82, he includes them with a raised lattice-like pattern. This contradiction with his text is of no significance since neither description is valid. The eggs are distinctly striated.

This is the first record of the worm in the Blackbird from Wales.

5). Capillaria resecta (Dujardin, 1843) Travassos, 1915

Syn.: Trichosomum resectum Dujardin, 1842; Trichosoma resecta Baird, 1853; Trichosoma resecta von Linstow, 1877 (b).

This species has been recorded from members of the family Corvidae throughout the Northern Hemisphere. The British records are:- the Jackdaw (Corvus monedula L.) Baylis (1928), Evans (1938, unpubl.), Mettrick (1959), Pemberton (1960); the Rook (Corvus frugilegus L.) Baylis (1928), Mettrick (1959), Pemberton (1960); the Jay (Garrulus glandarius (L.)) Baylis (1939); Carrion Crow (Corvus corone corone L.) Baylis (1939); and the Magpie (Pica pica (L.)) Pemberton (1960). The writer has collected specimens extensively from Crows, Rooks and Jackdaws at most seasons of the year but especially during summer and early autumn.

Description

Male: The description is based on twenty-one readings. The specimens are opaque, 10.1 - 12.3 mm. long and 0.052 mm. across the base of the oesophagus. The caudal region is rounded with a cuticular bursa, 0.033 - 0.036 mm. in diameter, while laterally there are a pair of lobes, the rays of which are 0.012 mm. long (Figure 152). The spicule is 1.05 - 1.148 mm. long in the Rook and in the Jackdaw it reaches 1.265 mm. in length. The measurements for the Crows approximate to those of the Rook. It is triangular in cross-section and 0.007 - 0.011 mm. across, but distally it is rounded with a blunt point (Figure 152). Proximally it expands to 0.018 mm. and when seen laterally it is funnel-like (Figure 153). A ventral view shows a spatulate

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plate 44

Capillaria resecta (Dujardin, 1843)

Figure 152 Male tail. Lateral view. H.P. x 10.

Figure 153 Spicule, proximal end - lateral view. H.P. x 10.

Figure 154 Spicule. proximal end - ventral view H.P. x 10.

Figure 155 Female. vulva lateral view. H.P. x 10.

Figure 156 Egg. Oil immersion.

Capillaria vanelli (Rudolphi, 1819)

Figure 157 Male. Spicule sheath. H.P. x 6.

Figure 158 Male. Spicule sheath (a) proximal spines (b) Distal spines

Figure 159 Female. Vulva appendage 'plaque'. H.P. x 10

Figure 160 Egg. Oil immersion.

plate 44

Capillaria resecta (Dujardin, 1843)

Figure 152 Male tail. Lateral view. H.P. x 10.
Figure 153 Spicule, proximal end - lateral view. H.P. x 10.
Figure 154 Spicule. proximal end - ventral view H.P. x 10.
Figure 155 Female. Vulva lateral view. H.P. x 10.
Figure 156 Egg. Oil immersion.

Capillaria vanelli (Rudolphi, 1819)

Figure 157 Male. Spicule sheath. H.P. x 6.
Figure 158 Male. Spicule sheath (a) proximal spines (b) Distal spines
Figure 159 Female. Vulva appendage 'plaque'. H.P. x 10
Figure 160 Egg. Oil immersion.

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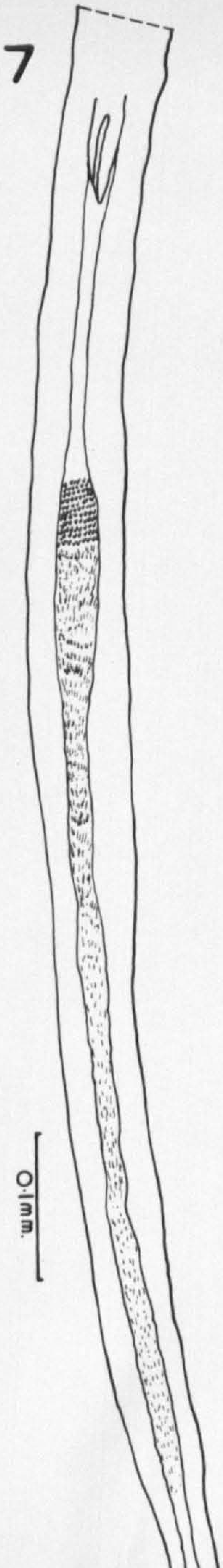

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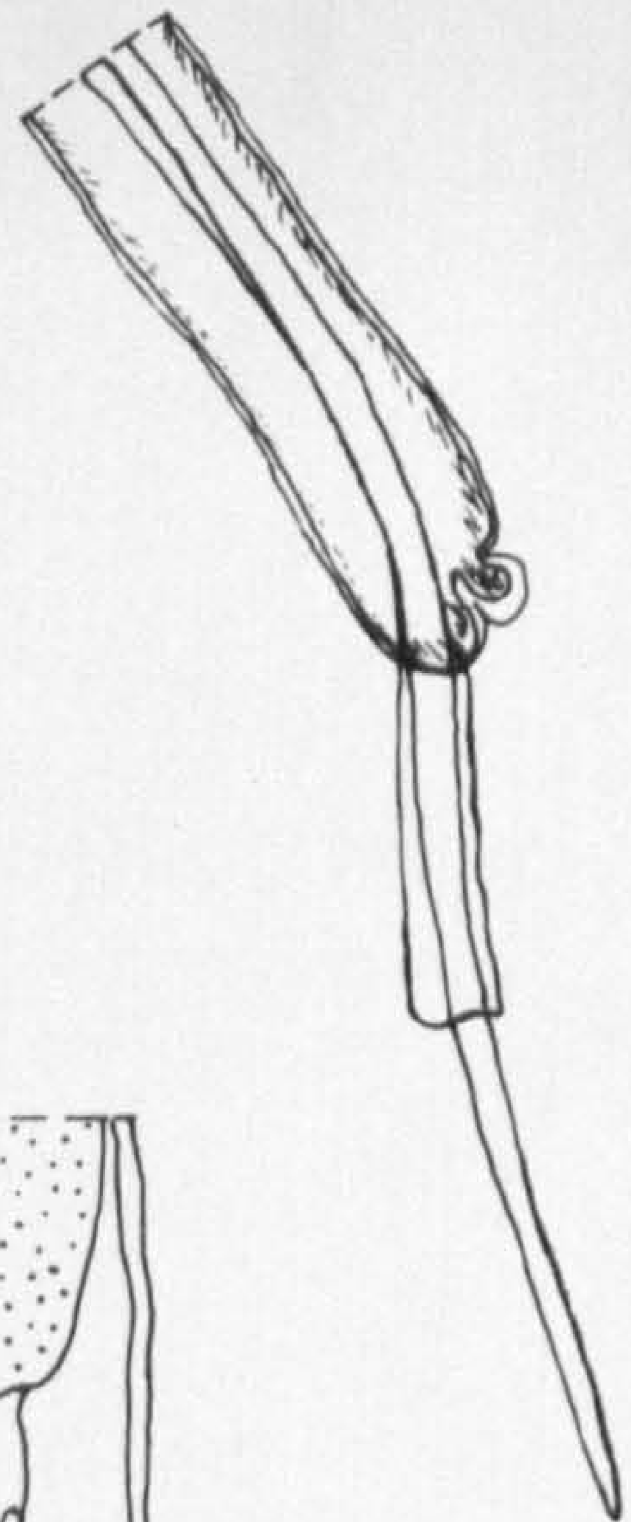

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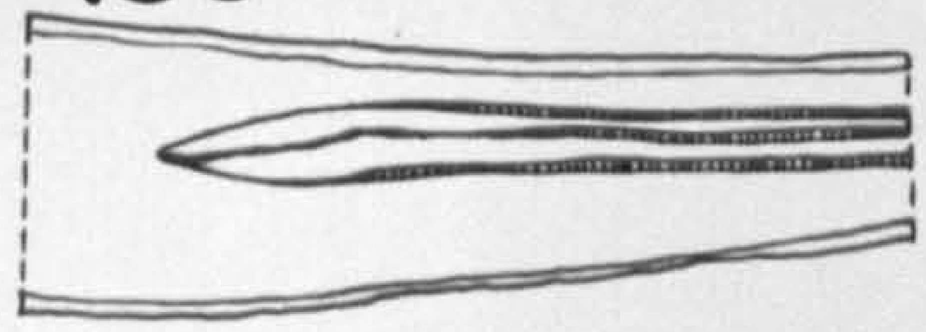

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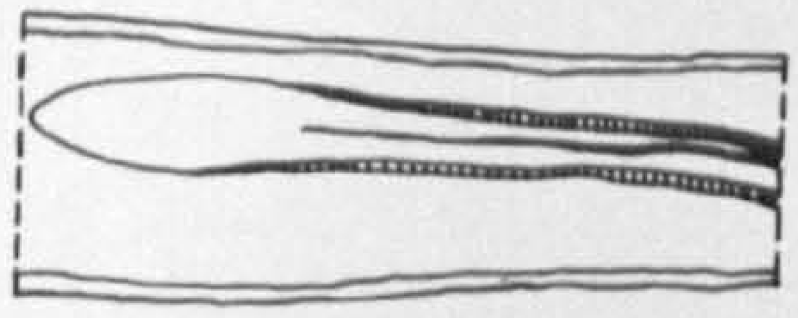

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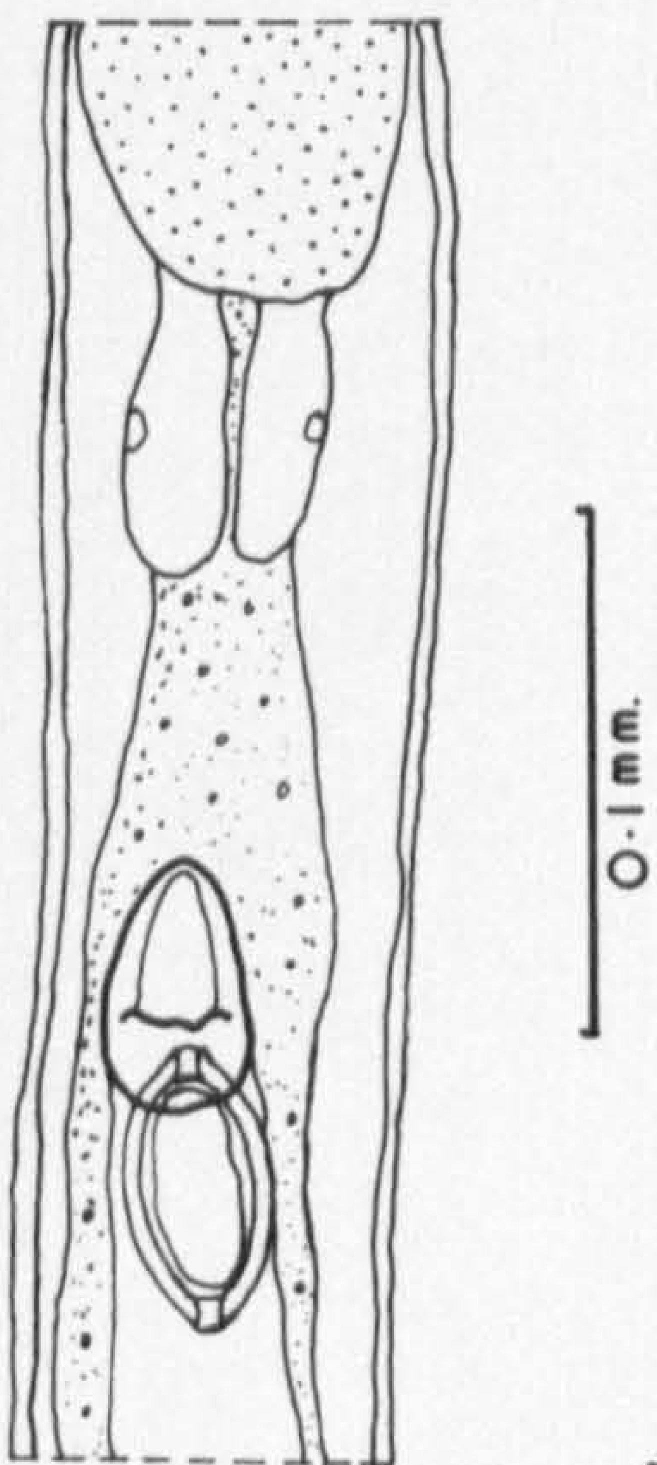

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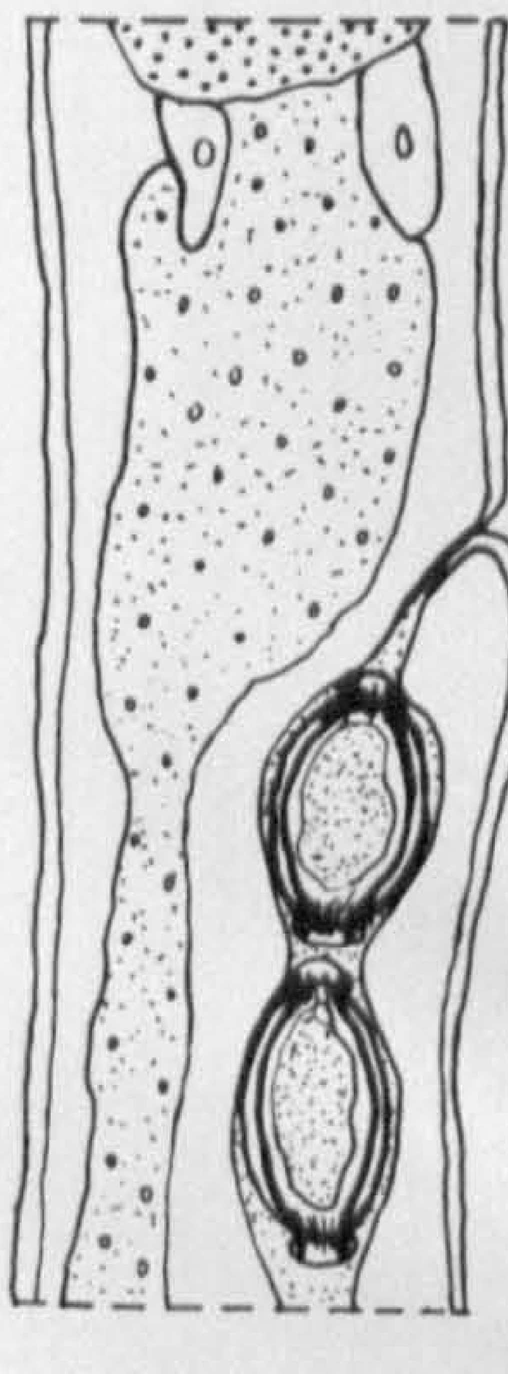

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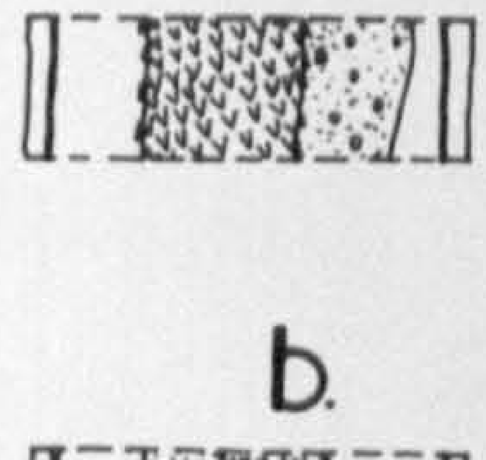

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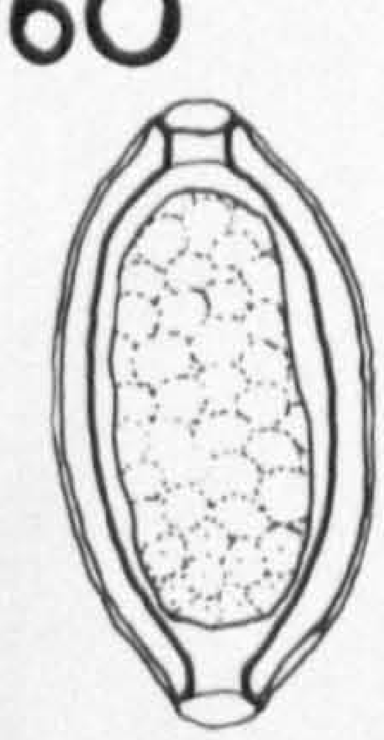

shape with a rounded margin (Figure 154). The sheath is rather longer than the spicule and is 0.013 - 0.015 mm. across. It is smooth along the entire length.

Female: Forty-six readings. The length varies from 11 mm. - 14.25 mm. in the Rooks and Crows and 17.7 mm. in the Jackdaws. Across the vulva the diameter is 0.073 mm. and the oesophagus is 5.25 - 7.25 mm. long. The distance between oesophagus and vulva is 0.141 mm. The vulva (Figure 155) is a transverse slit, without appendages. The vagina is muscular and up to 0.432 mm. long. The tail is rounded. The eggs (57 measurements) are 0.051 mm. - 0.058 mm. by 0.031 mm. with an outer shell which has longitudinal striations (Figure 156). The inner shell is reflexed although this is not always to be discerned with ease.

Discussion

Mettrick (1959) has described a membraneous appendage in the vulva region. This is absent in all female specimens including those in the School collection (Bottles - Rook:2695, Crow:3627 and Jackdaw:3704). One must therefore query this aspect in Mettrick's redescription. Otherwise the text above agrees well with both Madsen and Mettrick. Madsen (1952) considered that resecta is a synonym of anatis (Schrank, 1790). This has not met with acceptance from other workers since the egg shell pattern is quite distinct in resecta, (Wakelin - personal communication). In the ~~second~~ Fourth part of this thesis experimental evidence on the inability to infect ducks with resecta from Rooks will be given.

The species has not been found in the Rook or Carrion Crow in Wales.

6). Capillaria vanelli (Rud., 1819) Chabaud, 1952

Syns.: Trichosoma vanelli Rudolphi, 1819; Trichosomum protractum Diesing, 1851; Trichosoma triloba von Linstow, 1875.

Capillaria vanelli was for many years considered to be nomen nudum but Chabaud (1952) published a description of a nematode which is found under the horny lining of the gizzard of the Lapwing (Vanellus vanellus (L.)). He has utilized the name vanelli for specimens occurring at this location. Von Linstow (1875) described Trichosoma triloba from the same host and location This species Chabaud considers to be a synonym.

The first British record is by Baylis (1939) in the Lapwing. Mettrick (1959) published a redescription (as triloba) of this material from the British Museum together with some from a new host, the Oystercatcher (Haematopus ostralegus L.). The material for this new description was taken from the Lapwing (18 (4) - 12/60, 1/61, 1/62, 12/62), the Oystercatcher (25 (6) - 7/60, 12/62, 1/63 (2), 2/63, 7/63), and the Curlew (Numenius arquatus (L.)) (14 (3) - 1/61, 11/62, 12/62). All were shot in the Saundersfoot area.

Description

Male: (9 readings). The worms are white and greatly coiled. They can only be removed with difficulty since the serpentine convolutions and tendency for the head or tail to be buried in the gizzard lining makes damage very easy. The average length is 12.0 mm. and width 0.037 mm. The oesophagus is 3.228 mm. long (ratio 1 : 3). In the posterior part of the body the width may be 0.05 mm. Striations in the cuticle occur every 0.003 mm. The tail has two lateral lobes, each with its own papilla, and stretching between the lobes on the dorsal side is a transparent membrane. The bursa diameter is 0.028 mm. The sheath is 0.85 mm. long and bears fine spines (Figure 157). Proximally, it is expanded slightly and this swelling bears two types of spines. Figure 158 (a) shows the strong triangular spines which occupy the proximal third and Figure 158 (b) the finely pointed spines which occupy the distal two thirds. The spicule projects beyond this swelling, which terminates in a spine-free membrane. The spicule is 0.37 mm. long and 0.006 mm. wide, and it is round in cross-section. Proximally the spicule is slightly swollen to a diameter of 0.009 mm. Distally it ends in a fine point.

Female: The females are 26 - 31 mm. in length and 0.069 mm. wide across the vulva. The vulva is 4.5 mm. from the front, giving a ratio to body length of 1 : 6.88. The distance between the oesophagus and the vulva is 0.345 mm. The vulva is unique in that an acorn-shaped 'plaque' surrounds the aperture (Figure 159). This cuticular swelling is seen best in untreated specimens. The vagina is 0.85 mm. long. The tail end is rounded with a terminal anus. The eggs are 0.059 - 0.063 mm. by 0.026 - 0.029 mm. and have a smooth outer shell, while the inner shell is not reflexed as a collar (Figure 160).

Discussion

Chabaud's measurements are shown with those of the writer and Mettrick's *triloba* in Table 35. Noteworthy differences

TABLE 35: Capillaria vanelli (Rudolphi, 1819)

Characters	Chabaud, 1952	Mettrick, 1959	Author
Male			
Length	9.6	10.0	12.0
Breadth	0.045	-	0.037
Spicule length	0.39	0.72 - 0.81	0.37
" diameter	0.006 - 0.008	0.006	0.006
Cross-section	-	-	0
Spicule tip	-	blunt	fine point
" proximal end	-	inflated	swollen 0.009
" sheath	0.515 x 0.018	0.43 x 0.15	0.85
Spination	distal 2/3 fine spines	many spines	fine spines
Bursa	bilobed	bilobed	bilobed
Female			
Length	31.7	24.0 - 28.0	26.0 - 31.0
Breadth	-	0.12	0.069
Vulva : Body	1 : 6.8	1 : 5	1 : 6.88
Vulva - Oesophagus	0.2	0.2	0.345
Vulval appendage	'plaque' 0.06 x 0.028	small circular	'plaque' 0.05 x 0.025
Vagina	0.9	-	0.85
Eggs	0.065 - 0.075 X 0.025 - 0.028	0.064 - 0.067 X 0.033 - 0.035	0.059 - 0.063 X 0.026 - 0.029
Outer shell	smooth	smooth	smooth
Inner shell	not reflexed	not reflexed	not reflexed
Tail end	rounded	rounded	rounded

between Chabaud's and this text is the smaller spicule length combined with the greater length of the spicule sheath. Also there are smaller eggs obtaining in the present account. The smaller spicule length may be accounted by Chabaud's statement that the distal portion of the spicule is unsclerotised. Chabaud clearly differentiates his species from contorta but queries his male specimen which was not found under the gizzard lining but in the oesophagus lumen. The close agreement of this text in which all specimens were removed from the gizzard lining indicates that his single male specimen may have penetrated the horny layer and escaped into the gut. The characters of the male of the species is confirmed herein.

Mettrick's description does not show such close agreement. He records a blunt tip to the spicule and failed to observe the differences in the spines on the proximal swelling of the sheath. Most astonishing is his failure to mention the peculiar vulval appendage which he describes as a small circular protruberance. This 'plaque' is difficult to determine until the eye is trained but can be demonstrated in untreated specimens. Some triloba specimens from the British Museum, which may well have been those redescribed by Mettrick, were examined and the 'plaque' was present.

The nematode has not been recorded from Wales and the Curlew (Numenius arquatus (L.)) is a new host record.

7). Capillaria sp.

In the small intestine of a Skylark (Alauda arvensis L.) three females of a capillarid species were discovered. Two were immature, 9.5 mm. (oesophagus 4.3 mm.) and 11.5 mm. (oesophagus 5.5 mm.), while the third was mature, 10.5 mm. (oesophagus 5 mm.). The ratio of the oesophagus to the body is 1 : 2. The body width across the vulva is 0.056 mm. The vulva is a transverse slit which has a slight cuticular swelling around the aperture, (Figure 161). The distance from the oesophagus is 0.028 mm. The vagina is 1.203 mm. long. The tail end is rounded and the anus is terminal. The eggs are 0.052 mm. by 0.029 mm. and have a striated outer shell. The inner shell is not reflexed, (Figure 162).

Discussion

Capillaria alaudae (Rud., 1819) from the large intestine of the Skylark has not been fully descibed. Most characters recorded relate to the male and the only details for the female are:- length 17 mm., vulva without appendage, eggs 0.052 mm. long and the lateral bands occupy a third of the body width. Although the mature specimen is shorter than the above measurement, the egg length is compatible, as is the absence of a vulval appendage. The lateral bands occupy rather more than a third of the body width. In the absence of a male this species can only be tentatively identified as C. alaudae (Rud., 1819), but is the first British record of a capillarid worm in this location in a Skylark. There are no British records for alaudae. The bird was dissected in August, 1962.

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Plate 45

Capillaria spp. (Skylark)

Figure 161 Female. Vulva lateral view. H.P. x 10.
Figure 162 Egg. Oil immersion.

Capillaria spp. (Twite)

Figure 163 Male. Bursa and distal end of spicule. H.P. x 10.
Figure 164 Male. Spicule. Proximal end. H.P. x 10.

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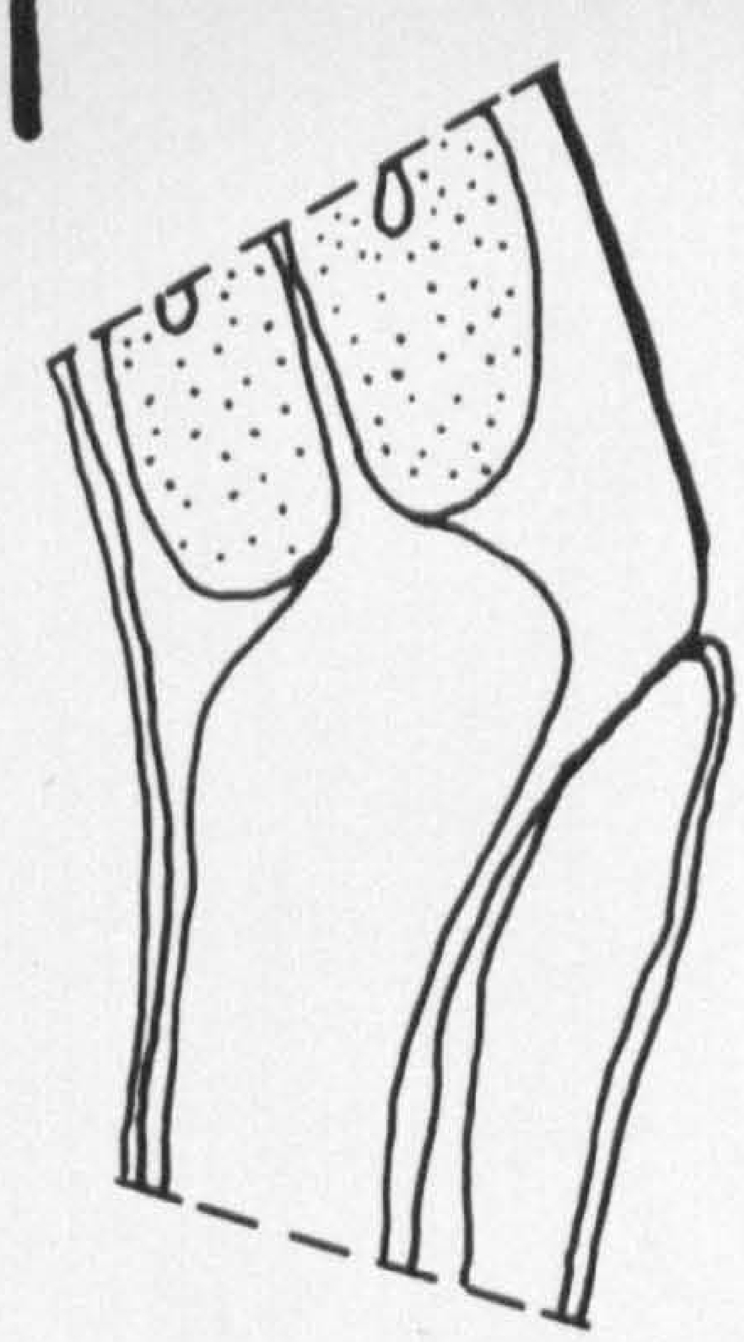

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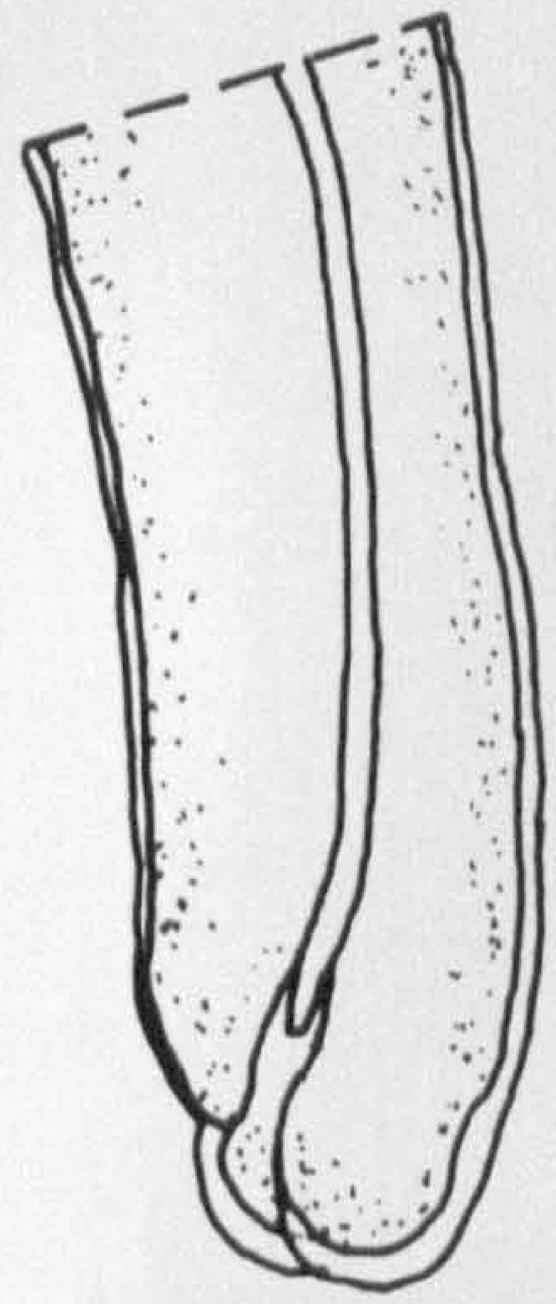

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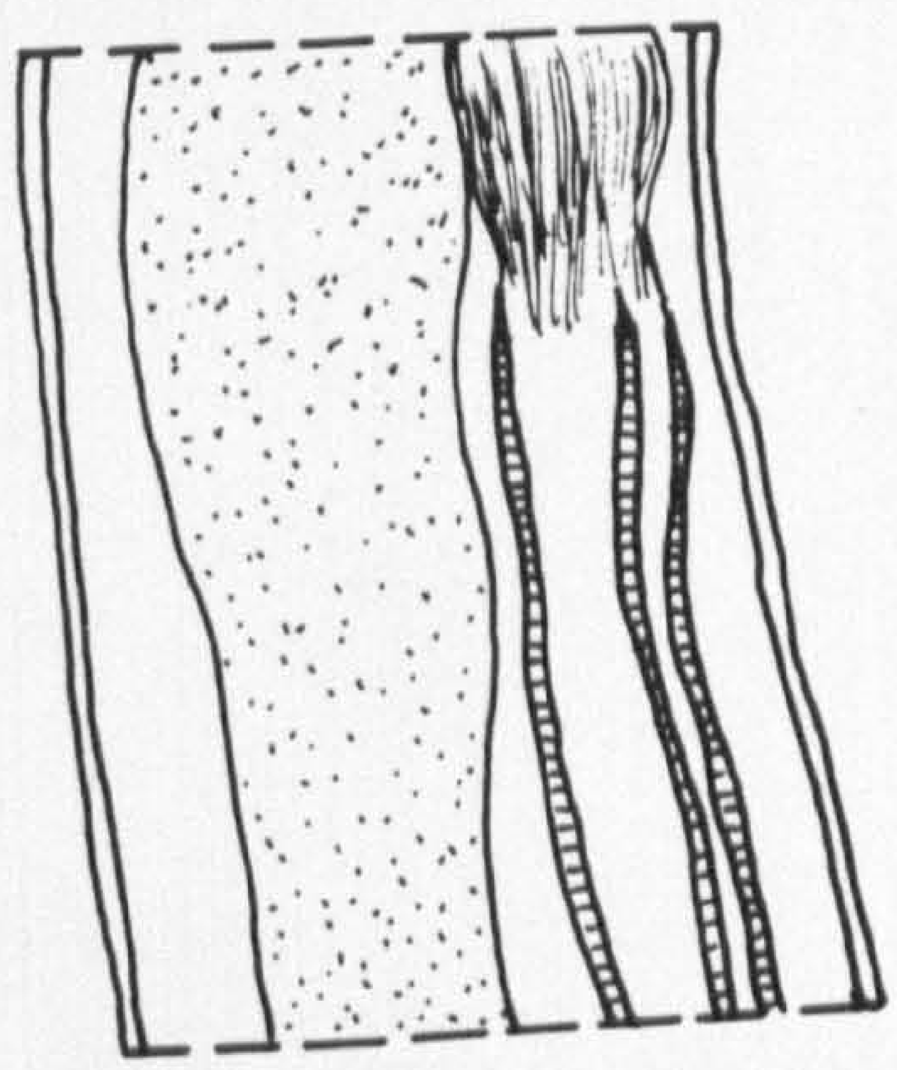

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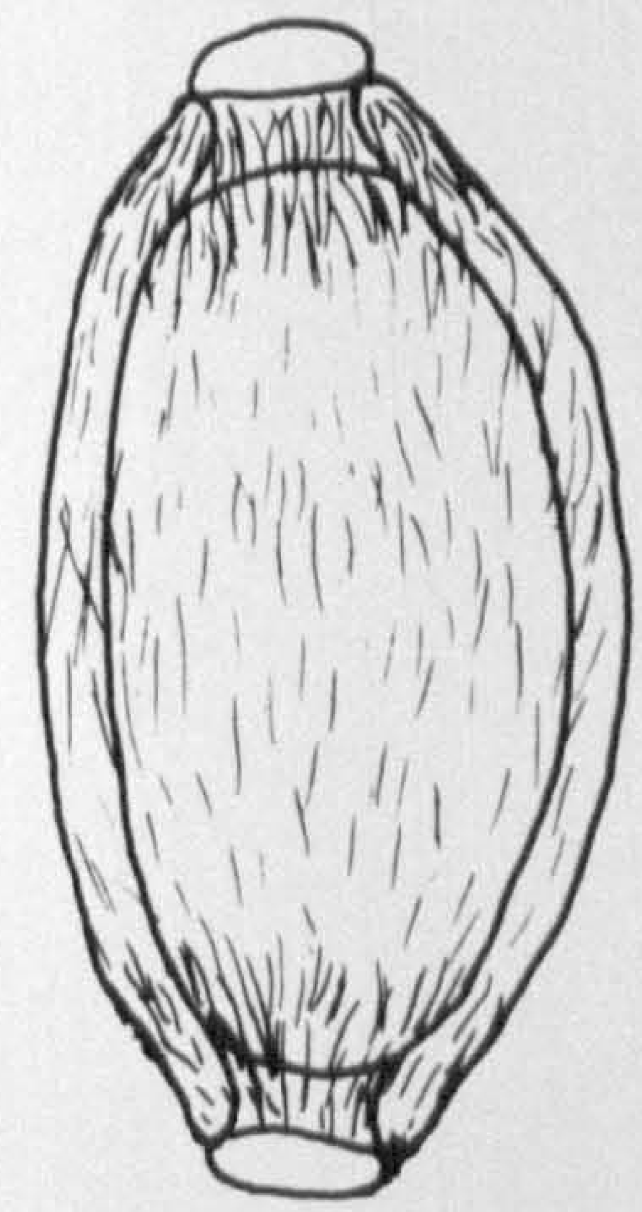

8). Capillaria sp.

A Twite (Carduelis flavirostris L.) was dissected and an incomplete male specimen was recovered, (1 (1) - 8/63). The length is 2.378 mm. and a spicule is 0.965 mm. The distal point is rounded (Figure 163) and the cross-section triangular, 0.024 mm. in diameter. The proximal end is an irregular frayed funnel, (Figure 164). The bursa has a pair of lateral lobes, (Figure 163). The spicule sheath is thin and membraneous and devoid of both striations and spines.

Discussion

The Twite is a new host for a capillarid worm. No description of any species from a Passerine bird approximates to that above. C. resecta is as close as any but has a longer spicule.

Subclass: Secernentia (von Linstow, 1905) Chitwood, 1940

Syn.: Subclass Phasmidia Chitwood & Chitwood, 1933

Class Secernentea (von Linstow, 1905) Dougherty, 1958

Order: STRONGYLIDA

Super-family: STRONGYLOIDEA (Weinland, 1858) Hall, 1916

Family: Syngamidae Leiper, 1912

Genus: *Syngamus* Siebold, 1836

Syn.: *Cyathostoma* Blanchard, 1849

9). *Syngamus trachea* (Montagu, 1811) Leiper, 1912

Syns.: *Fasciola trachea* Montagu, 1811; *Syngamus trachealis* Siebold, 1836; *Strongylus pictus* Creplin, 1849; *Syngamus bifurcatus* Theobold, 1896; *Syngamus mucronatus* Schlotthauber, 1860; *Syngamus primitivus* Molin, 1861; *Syngamus sclerostum* Molin, 1861.

Half a dozen pairs *in copula* were recovered from the trachea of a young Rook (*Corvus frugilegus* L.) in July, 1962. This species has had numerous records from Wales both in poultry and in wild birds. It would appear to be unimportant in Pembrokeshire however, and it was not recovered from any of the migrant birds such as the flocks of starlings, in winter, which might be thought to be introducing a parasite of economic importance to local stock. The species is too well-known to warrant yet another redescription.

Order: ASCARIDIDA

Super-family: Ascaridoidea

Family: Heterocheilidae Railliet et Henry, 1912

Subfamily: Filocapsulariinae Yamaguti, 1961

Yamaguti (1961) nominated the subfamily Filocapsulariinae in place of Anisakinae Railliet et Henry, 1912, because Anisakis has been proven a synonym of Filocapsularia Deslongchamps, 1824.

Genus: Contracaecum Railliet et Henry, 1912

Syns.: Kathleena Leiper and Atkinson, 1914; Cerascaris Cobb, 192?

The two genera from the Ascaridoidea in the present collection are easily distinguished by the presence of an oesophageal appendix. Osche (1959) has given a comparative account of the morphogenesis of the lips of Contracaecum and Porrocaecum.

10). Contracaecum spiculigerum (Rudolphi, 1809)

Railliet et Henry, 1912

Syn.: Ascaris spiculigerum Rudolphi, 1809

British records for this universally dispersed species are:- the Cormorant (Phalacrocorax carbo (L.)) - Lewis, 1927; Baylis, 1928; Davies, 1937 (unpubl.); Baylis, 1939; Williams, 1961: the Shag (Phalacrocorax aristotelis (L.)) - McIntosh & Nicoll, 1927; Baylis, 1928; 1939; Williams, 1961; the Green Cormorant (?) - Davies, 1937 (unpubl.): the Black-headed Gull (Larus ridibundus L.) - McIntosh & Nicoll, 1927; Jennings & Soulsby, 1958: the Guillemot (Uria aalge (Pont.)) - McIntosh & Nicoll, 1927. The writer's specimens were recovered from the

Shag - (8 (1) - 11/63); the Razorbill (Alca torda L.) - (1 (1) - 7/62); the Guillemot - (3 (1) - 7/62); the Lesser Black-backed Gull (Larus fuscus L.) - (2 (1) - 7/62) and the Manx Shearwater (Puffinus puffinus (Brünnich)) - (1 (1) - 7/62). There were three males in the Shag and one in the Guillemot. The remaining specimens are female and both those from the Manx Shearwater and Razorbill were immature. Measurements derived from various sources are stated in brackets after the writer's own.

Description

Male: The specimens were 19.6 mm., 23.0 mm., and 24.5 mm. long respectively. The average breadth was 0.85 mm. (20.0 - 45.0 mm. by 0.014 - 1.001 mm.). The head is quite distinctive (Figure 165); three large lips with conspicuous interlabia of nearly equal length and an overall diameter of 0.24 mm. are followed by a deeply folded cervical expansion, 0.289 mm. across. Immediately posterior to this is a deep transverse furrow, after which the body thickens to 0.365 mm. The cuticle is 0.019 mm. thick and the striations are 0.005 mm. apart. The lips are 0.115 mm. across and 0.112 mm. long (0.075 - 0.139 mm. by 0.085 - 0.117 mm.) and the papillae are conspicuous, 0.013 mm. in diameter. A dentigerous ridge is absent but anteriorly from each lip a blunt 'horn' protrudes for 0.026 mm. The interlabia are 0.082 mm. long, (0.061 - 0.112 mm. by 0.036 - 0.074 mm.). The nerve ring is 0.458 mm. from the anterior end (0.52 - 0.65 mm.). The oesophagus is 2.24 - 3.06 mm. long (3.0 - 5.2 mm.) and the width is approximately 0.172 mm. The ventriculus is not very distinct, 0.248 mm. by 0.226 mm. (0.226 - 0.375 mm. by 0.2 - 0.32 mm.) and from it arises a ventricular appendix, 0.89 mm. by 0.152 mm. (0.714 - 1.3 mm. by 0.096 - 0.25 mm.). The intestinal caecum is 2.24 mm. by 0.21 mm. (2.03 - 3.3 mm. by 0.192 mm.).

The tail (Figure 166) is conical and ventrally curved with the cloaca 0.212 mm. from the posterior tip. The spicules are extremely long, almost half the body length (Figure 167), equal and alate. The exact length of those figured is 11.763 mm. (6.2 - 9.1 mm.). The shaft is 0.019 mm. across and with the alae the total width is 0.047 mm. The end is pointed. The number of pre-anal papillae is difficult to estimate but there are not fewer than thirty pairs. The seven post-anal pairs are arranged as shown in Figure 166, namely three lateral pairs of which the middle pair is the smallest, and four subventral pairs, two of which are closer to the cloaca, with one pair median to the others, and the rear two pairs adjacent to the first and second lateral pairs.

Female: (Five readings). The body is 52.0 mm. long and 1.05 mm. wide (36.0 - 85.0 mm. by 0.96 - 1.8 mm.) and the head shows a similar organization to that of the male. The lips are 0.119 mm. by 0.11 mm. (0.11 - 0.151 mm. by 0.11 - 0.131 mm.), and the interlabia are 0.085 mm. by 0.07 mm. (0.111 mm. by 0.072 mm.). The head diameter is 0.259 mm. (0.28 - 0.42 mm.) and it is followed by a striated cuticular expansion, 0.328 mm. across. The nerve ring is 0.63 mm. from the anterior end (0.62 - 0.76 mm.).

The oesophagus is 3.751 mm. by 0.28 mm. (3.5 - 5.3 mm. by 0.2 - 0.31 mm.) and leads into a ventriculus 0.32 by 0.318 mm. (Figure 168). The ventricular appendix is 1.128 mm. by 0.041 mm. (0.84 - 1.5 mm. by 0.14 - 0.21 mm.) with an intestinal caecum 2.872 mm. by 0.314 mm. (2.4 - 4.4 mm. by 0.203 mm.). The vulva is in the anterior third of the body and divides the body in the ratio of 1 : 2.6. The tail tip is conical and the anus is 0.284 mm. from the posterior end. The lateral papillae mentioned by Yamaguti (1941) could not be discerned. The eggs are subspherical, 0.072 mm. long and 0.061 mm. across. The shell is 0.004 mm. thick and the ovum unsegmented.

Discussion

The specimens fall well within the range of recorded measurements. The only significant differences are the extreme length of the spicules in the male, almost half that of the body, and the apparent absence of the lateral papillae in the female tail. There has been no redescription from material found in Britain. The Razorbill, Lesser Black-backed Gull and Manx Shearwater are all new British host records.

The life-cycle was described in part by Thomas (1937).

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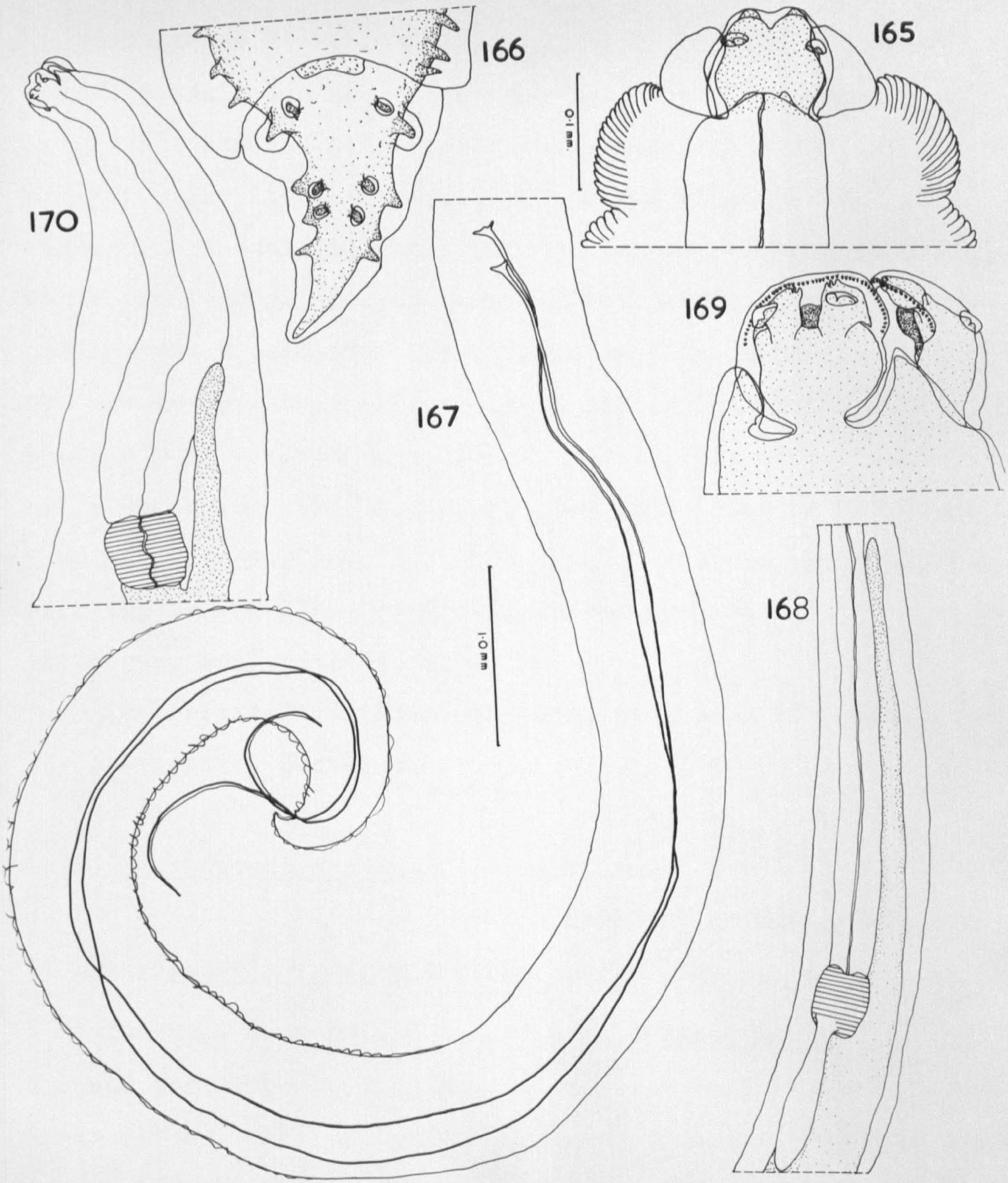
Plate 46

<u>Contracaecum spiculigerum</u> (Rudolphi, 1809)

Figure 165 Dorsal lip. H.P. x 10.
Figure 166 Male tail. H.P. x 10.
Figure 167 Male tail with spicules. L.P. x 6
Figure 168 Female. Oesophagus. L.P. x 6.

<u>Porrocaecum crassum</u> (Deslonchamps, 1824)

Figure 169 Dorsal lip. H.P. x 10.
Figure 170 Head end. L.P. x 6.


166
165
0.1 mm.
170
169
167
1.0 mm
168

Genus: Porrocaecum Railliet et Henry, 1912

Syn.: Terranova Leiper and Atkinson, 1914

The genus is well established in fishes, reptiles, birds, marine mammals and insectivores. Apart from the absence of an intestinal caecum the presence of dentigerous ridges is characteristic. The lips have diagnostic value at a specific level also. The dorsal lip has a pair of sub-dorsal double papillae while the lateral lips each have a fully-developed sub-ventral papilla and a vestigeal sub-lateral papilla. The interlabia are rarely more than extensions of the cuticle but the lips contain body tissues as a 'pulp'. Anteriorly a pair of lobes arise which are variously subdivided into anterior and lateral lobulii, (Figures 169, 171, 176, 181). On the inner side of each lip is the lobus impar, sometimes projecting beyond the lip border and sometimes not.

The species from European birds have been studied and a key provided by Hartwich (1959).

11). Porrocaecum crassum (Deslongchamps, 1824)
Railliet et Henry, 1912

Syn.: Ascaris crassum Deslongchamps, 1824

The type host is the domestic duck (Anas platyrhynchos dom. L.) and the first British record occurred in this same host - Lewis (1926). Baylis (1928) recorded the species in the Mallard (Anas platyrhynchos L.). Subsequent records from the Domestic

Duck are from Wales - Davies (1937 - unpublished) and Evans (1938 - unpublished). Two immature females were taken from the Mallard - (2 (1) - 12/62).

Description

The measurements recorded by previous authors - Dujardin, 1845; Skjabin, 1926; Mosgovoy, 1953 and Hartwich, 1959 - are stated in brackets following those of the writer. The average length of these specimens is 18 mm. (43.0 - 66.0 mm.) and the breadth 0.58 mm. (2.0 - 2.2 mm.). The head diameter is 0.274 mm. (0.334 - 0.584 mm.) and the lips are conspicuous with dentigerous ridges which extend to the respective sub-dorsal or sub-ventral papillae (Figure 169). The lobes of the labial pulp are broad and at the inner edge are three short digitate projections. Laterally the lobe has a small extension - the 'tail piece'. Figure 169 shows the dorsal lip and part of the right sub-ventral lip. The median lobus impar projects only a very short distance beyond the main labial pulp. The interlabia are small and pyramidal, approximately two-fifths of the lip length. Cervical alae are absent.

The oesophagus (Figure 170) is 1.21 mm. long (3.4 - 4.65 mm.) and leads to a small oblong ventriculus, 0.212 mm. by 0.254 mm. (0.4 - 0.462 mm. by 0.653 mm.). The intestinal caecum is 0.69 mm. long (1.414 - 1.9 mm. by 0.354 mm.), that is three to six times the length of the ventriculus. The vulva is in the second third of the body. The tail is slender and the anus is 0.226 mm. from the posterior tip. There were no eggs.

Discussion

The short ventriculus, broader than long, is characteristic of this species, the genotype. Similarly the length of the intestinal caecum is three to five times that of the ventriculus and the lips correspond to Hartwich's redescription (1959). Thus despite the small and immature specimens, it is possible to provide an accurate identification. The lateral papillae which Hartwich describes between the third and last quarter of the tail were not discovered. The Mallard is a new host record for Wales and is the first from a non-domesticated bird. This is also the first redescription from British material. The life-cycle was studied by Mosgovoy in 1952.

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12). *Porrocaecum ensicaudatum* (Zeder, 1800), Baylis, 1920

Syns.: *Fusaria ensicaudatum* Zeder, 1800; *Ascaris ensicaudatum* (Zeder, 1800) Rudolphi, 1809; *Ascaris crenata* (Zeder, 1800), Rudolphi, 1809; *Fusaria lancea* Zeder, 1800; *Ascaris lancea* (Zeder, 1800), Rudolphi, 1809; *Spiroptera turdi* Molin, 1859; *Filaria turdi* von Linstow, 1877.

The type host is the Blackbird (*Turdus merula* L.) and British records from this host are:- Bellingham, 1844; Lewis, 1926, 1927; Baylis, 1928; Davies, (1937 - unpubl.); Baylis, 1939 and Mettrick, 1960. The first British record occurred in the Missel Thrush (*Turdus viscivorus* L.), Bellingham, 1844;

Baylis, 1928; Evans (1938 - unpubl.); and Mettrick, 1960. Other members of the family Turdidae to be hosts in Britain are the Songthrush (<u>Turdus philomelos</u> L.) - Baylis, 1928; Baylis, 1939; Mettrick, 1960; Williams, 1961: the Fieldfare (<u>Turdus pilaris</u> L.) - Mettrick, 1960: the Redwing (<u>Turdus musicus</u> L.) - Baird, 1853; Baylis, 1928 and 1939: and the Icelandic Redwing (<u>Turdus musicus coburni</u> ?) - Scott, 1957.

There are numerous records for Corvid birds - the Rook (<u>Corvus frugilegus</u> L.) - Lewis, 1927; Baylis, 1928; Evans (1938 - unpubl.); Baylis, 1939; Mettrick, 1960; Pemberton, 1960 and Williams, 1961: the Carrion Crow (<u>Corvus corone corone</u> L.) - Baylis, 1939 and Mettrick, 1960; the Jackdaw (<u>Corvus monedula</u> L.) - Mettrick, 1960 and Pemberton, 1960: and the Jay (<u>Garrulus glandarius</u> (L.)) - Mettrick, 1960. Records from the Starling (<u>Sturnus vulgaris</u> L.) - Lewis, 1926, 1927; Baylis, 1928; Walker, 1937; Evans, (1938 - unpubl.); Baylis, 1939 and Mettrick, 1960.

The writer's material was found in the Rook - (25 (11) - 1960, 61, 62, 63), the Carrion Crow (5 (1) - 1/63), the Starling (8 (2) -12/62, 1/63), the Blackbird (9 (3) - 4/61, 1/62, 5/63), the Redwing (3 (1) - 3/63), the Fieldfare (5 (2) - 3/63), the Songthrush (6 (1) - 8/63) and the Black-headed Gull (<u>Larus ridibundus</u> L.) - (2 (1) - 1/63). All were examined in Pembrokeshire.

<u>Description</u>

<u>Male</u>: (Nine readings). The length is 28.0 - 35.0 mm. and the breadth is 0.58 - 0.73 mm. The head diameter is 0.47 mm.,

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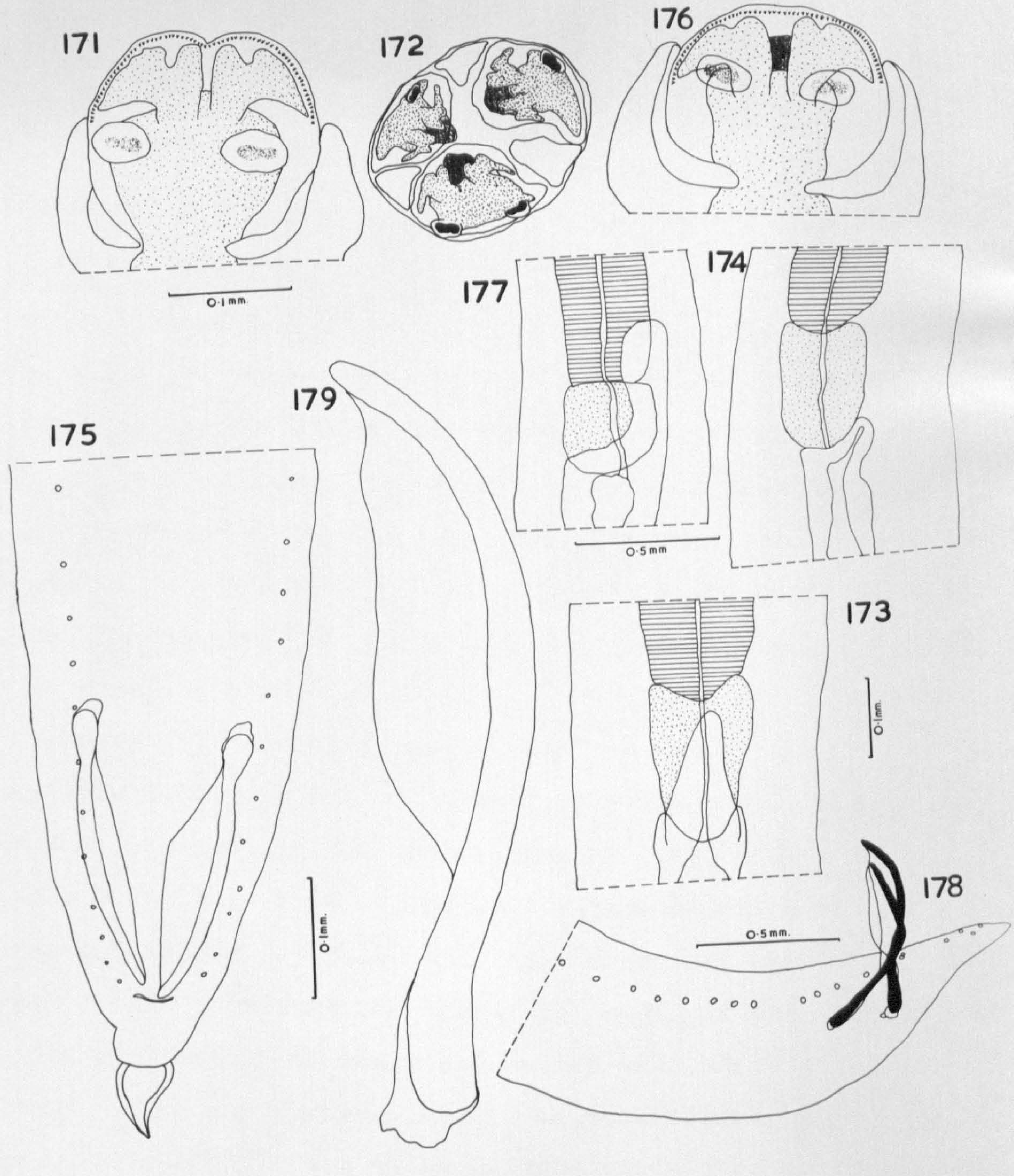
Plate 47

<u>Porrocaecum ensicaudatum</u> (Zeder, 1800)

Figure 171 Dorsal lip. H.P. x 10.
Figure 172 Head. Anterior view. H.P. x 10.
Figure 173 Intestinal caecum. <u>Larus ridibundus</u> H.P. x 6.
Figure 174 Intestinal caecum. <u>Turdus pilaris</u> L.P. x 10.
Figure 175 Male tail. H.P. x 10.

<u>Porrocaecum semiteres</u> (Zeder, 1800)

Figure 176 Dorsal lip. H.P. x 10.
Figure 177 Intestinal caecum. L.P. x 10.
Figure 178 Male tail. L.P. x 10.
Figure 179 Spicule. H.P. x 10.


171
172
176
0·1 mm.
177
174
0·5 mm
179
175
173
0·1 mm.
0·1 mm.
178
0·5 mm.

while those of the ventriculus and tail are 0.616 and 0.21 mm. There are three lips, oval in outline and with a distinct cleft on the anterior edge of the dorsal in each specimen (Figure 171). The length is 0.132 mm. and the central pulp is oblong and solid in outline. The lobus impar on the inner side of each lip does not project beyond the central pulp but may be seen in the anterior view (Figure 172). Each lip bears a pair of frontal lobes which are distinctive to this species and the closely related semiteres. Anteriorly there is a cleft between two lobules, while a distinct lateral lobule extends as a 'tailpiece' almost to the papillae (Figure 171). The dentigerous ridge does not extend to the papillae. The interlabia are conical expansions of the cuticle, half to three-fifths of the lip length. There are no cervical alae.

The cuticle varies in thickness from 0.009 - 0.015 mm. with striations 0.006 - 0.008 mm. apart. The oesophagus length is 2.03 - 2.18 mm. while the ventriculus is 0.428 - 0.49 mm. by 0.132 - 0.284 mm. That of the male in the Black-headed Gull measured 0.175 mm. by 0.132 mm. The intestinal caecum in the male is never more than one third the length of the ventriculus (Figure 174) except in the Black-headed Gull where it is almost as long, 0.169 mm. (Figure 173). The tail narrows to a small cone (Figure 175) with a thick cuticle which does not, however, expand to form a caudal alae, proper. The cloaca is 0.27 mm. from the posterior tip. There are 14-18 pairs of pre-anal papillae and six pairs of post-anal, the first of which is a subventral double pair adjacent to the cloaca and 0.249 mm. from the posterior end. A short gap separates the second, third and fourth pairs which are subventral converging towards the midventral axis. The fifth pair are lateral and the sixth are again subventral, 0.072 mm. from the posterior tip. The spicules are alate, 0.55-0.69 mm. long. In the Black-headed gull they are only 0.48 mm.

Female: (Twelve readings). The longest specimen was 43.0 mm., with a breadth of 1.55 mm. The average diameter of the head is 0.323 mm., across the ventriculus 1.3 mm., and of the tail 0.35mm. The cuticle is very thick, up to 0.31 mm. in the ventricular region. The lips are similar to those of the male, 0.212 mm. long, and the interlabia are 0.119 mm. long. The oesophagus is 2.54 mm. long and the ventriculus is 0.49 mm. by 0.297 mm. The intestinal caecum is 0.332 mm. long and never exceeds the length of the ventriculus. In the longest specimen, the vulva is 22.0 mm. from the anterior end, i.e. just within the anterior half of the worm. The tail is blunt and the anus 0.63 mm. from the posterior end. In the terminal fifth are a pair of lateral papillae. The eggs have an outer shell with a reticulate pattern, 0.099 mm. by 0.063 mm.

Discussion

The specimens from the Songthrush were all immature, found under the horny layer of the gizzard. They correspond to Molin's Spiroptera turdi (1856), which Mawson (1956) showed to be the 4th. larval stage of ensicaudatum. This has been confirmed by Levin (1957) and Osche (1957). Table 36 gives the author's

TABLE: A36 *Porrocaecum ensicandatrium* (Zoder, 1800)

Characters	Hartwich (1959)	Mettrick (1960)	Author
Male			
Body length	21.5 - 44.5	30.0 - 44.0	28.0 - 35.0
Body Breadth	0.5 - 0.88	1.1 - 1.34	0.73
Head Diameter	-	-	0.21 - 0.24
Ventriculus Diameter	-	-	0.616
Tail Diameter	-	-	0.210
Cuticle	-	thick	0.009 - 0.015
Striations	-	-	0.006 - 0.008
Lips	-	-	0.132
Inter-labia	-	$\frac{2}{3}$ of lips	0.065 - 0.079
Oesophagus	1.66 - 3.04	-	2.03 - 2.184
Ventriculum	0.36 - 0.66	-	0.428 x 0.28
Intestinal caecum	0.07 - 0.32	-	0.169
Cloaca	-	-	0.198 - 0.27
Preanal papillae	-	12-15	14-18
Postanal papillae	-	6 pairs	6
Spicules	0.56 - 0.735	0.54 - 0.57	0.69 - 0.63
Tail	0.22 - 0.36	0.25 - 0.28	-
Female			
Body Length	22.5 - 68.0	52.0 - 58.0	43.0
Body Breadth	0.6 - 1.4	1.4 - 1.8	1.55
Head Diameter	-	0.28 - 0.31	0.323
Ventriculus Diameter	-	-	1.3
Tail Diameter	-	-	0.35
Cuticle	-	-	0.031
Oesophagus	2.15 - 3.4	4.0 - 5.5	2.54
Ventriculum	0.35 - 0.7	0.65 - 0.71	0.49
Intestinal caecum	0.075 - 0.175	-	0.332
Lips	-	-	0.212
Inter-labia	-	-	0.119
Vulva	12.5 - 29.5	4 : 5	-
Tail	0.46 - 0.66	-	-
Anus	-	-	0.63
Eggs	0.105 - 0.107 x 0.073 - 0.077	0.086 x 0.065	0.099 x 0.063

measurements alongside those of Hartwich (1959) and Mettrick (1960). Every measurement falls within those already recorded for the species with the single exception of the intestinal caecum in the male specimens from the Black-headed Gull (*Larus ridibundus* L.); these are unique in being almost the length of the ventriculus (Figure 173). Osche (1959) on page 468 describes *Porrocaecum* larvae in 'Fehlwirten' - false hosts - and in particular the Black-headed, Common and Herring Gulls, and the Woodcock (*Scolopax rusticola* L.). From under the horny layer of the gizzard he has described larvae ('Infective larvae') in the Black-headed Gull, which he is able to compare directly with *ensicaudatum* from the correct intermediate host, the earthworm (*Lumbricus terrestris*). This third stage differs from the adult in lip morphology and other features and in so different a host and a vertebrate one also, there is no reason to suppose that further development would occur. However in the Herring Gull, Osche records *ensicaudatum* larva lV of which seven out of twelve were living. The only previous record which indicates full development in the family Laridae is from Pemberton (1963) who found *Porrocaecum* species in the Herring Gull and the Black-headed Gull as new host records. The Black-headed Gull as a definitive host for *ensicaudatum* is confirmed in this text as a new host record in so far as the specimens can be identified. The small size of the spicules is more suggestive of *ensicaudatum* than of *semiteres* although Lewis (1926) has queried the value of spicule length as a criterion in distinguishing between these two species. Despite the length of the intestinal caecum, because it does not extend beyond the ventriculus the species is more obviously ensicaudatum than semiteres. The writer's main identification with the former species is based on ecology rather than morphology. P. semiteres is found in the family Charadriidae, which are insect-eaters rather than eaters of earthworms. (Based on the writer's own findings in the gizzards and crops of birds dissected during this survey - careful correlation of parasite and gizzard content always being made.) The commoner Laridae are increasingly land-bound and during the winter months eat enormous quantities of earthworms, and a feature to be commented on more fully in the analysis of this survey is the general loss of usual parasites in the winter months when the diet changes from being littoral or fully marine to terrestrial components. However a nematode species which uses the earthworm as an intermediate host could easily establish itself in a non-passerine host during the temporary change of diet. Osche (1959) p.460 in discussing the larval stages of semiteres has found larva III with ensicaudatum larvae in the intestine of mammals - the Water Vole (Neomys fodiens) and the Field Mouse (Apodemus agrarius). He is mistaken in his inference that these hosts and the definitive Charadrid hosts must have obtained semiteres from Oligochaetes (top of page 461) since both the mice and the birds are more specifically insectivores (eating both larval and adult stages) and an insect intermediate host is more certain.

Hartwich (1959) raised a new combination P. picae (Rud., 1819) for Porrocaecum spp. from corvid birds. His main criterion is the intestinal caecum, which is up to, but never more than, one and a half times the length of the ventriculus. He places the ensicaudatum of Baylis (1939) under this species. While there has not been time to examine Baylis' material, none collected from corvid birds during this work possesses so long a caecum and until this particular feature is found, the writer is exercising caution in accepting the new combination.

The Black-headed Gull is a new host record for the species, while the Carrion Crow, the Fieldfare and the Redwing are all first records in Wales.

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13). Porrocaecum semiteres (Zeder, 1800) Baylis, 1920

Syns.: Fusaria semiteres Zeder, 1800; Ascaris semiteres (Zeder, 1800) Rudolphi, 1802; Ascaris heteroura Creplin, 1829; Porrocaecum heteroura (Creplin, 1829) Baylis, 1920; Ascaris retusa Fröhlich, 1802.

The Lapwing (Vanellus vanellus L.) is the type host and the species has been recorded by Baird (1853), McIntosh and Nicoll (1927), Baylis (1928), Davies (1937, unpubl.), Evans (1938, unpubl.) and Baylis (1939). McIntosh and Nicoll (1927) recorded Ascaris heteroura Creplin, 1829, from the Golden Plover

(*Charadrius apricarius* L.).

The writer's material was recovered in the Lapwing - (5 (1) - 1/62) and the Golden Plover - (1 (1) - 1/63). The specimen from the Golden Plover was a male. The measurements of Hartwich (1959) follow those of the writer.

Description

Male: Two readings. The male from the Lapwing was damaged, so the following measurements relate to the male from the Golden Plover. The length is 24.0 mm. and the breadth is 0.854 - 0.934 mm. (22.0 - 40.0 mm. by 0.56 - 1.0 mm.). The head is 0.235 mm. across, the ventriculus 0.66 mm. and the tail 1.15 mm. The cuticle is 0.015 mm. wide and has striations 0.006 mm. apart in the neck region and 0.012 mm. on the body. The cervical alae recorded by several workers were not discerned.

The lips are very similar to those of *ensicaudatum* but are oblong rather than oval and wider than long, 0.149 mm. by 0.198 mm. (Figure 176). The anterior edge of the dorsal lip is without the cleft described in *ensicaudatum* and the *lobus impar* does project slightly beyond the main pulp of the lip, which is rather narrower than in *ensicaudatum*. The lobes and lobuli are identical with *ensicaudatum*. The interlabia are rather more strongly developed, at least two-thirds of the lip length. The oesophagus is 1.63 mm. long (1.76 - 2.05 mm.) and the ventriculus less elongated than that in *ensicaudatum*, 0.346 mm. by 0.306 mm. (0.22 - 0.375 mm.). The intestinal caecum is never less than one and a half times the length of the ventriculus

(Figure 177) and may be double this length, 0.476 mm. being recorded for this material (0.24 - 0.65 mm.). The cloaca is 0.33 mm. from the posterior end and the tail is conical. (Figure 178). Thirteen pairs of pre-anal papillae were counted and six pairs of post-anal. These show virtually the same distribution as those of ensicaudatum, with the first pair immediately post-anal and double, and the fifth pair laterally placed. The spicules are alate in the Golden Plover, 0.645 mm. long and in the Lapwing 0.86 mm. long (Figure 179) (0.605 - 1.24 mm.).

Female: The four specimens were 32.5 mm., 38.0 mm., 47.0 mm. and 55.3 mm. long respectively (21.0 - 58.0 mm.). The breadth is 0.658 mm. (0.625 - 1.45 mm.). The oesophagus was 1.862 mm. by 0.298 mm. (1.5 - 2.98 mm.) and the ventriculus 0.27 - 0.312mm. by 0.332 - 0.346 mm. - wider than long, unlike the males. The caecum is 0.332 mm. to 0.525 mm. long (0.22 - 0.62 mm.). The vulva occurs between the second and third fifths of the body and the sculptured reticulated eggs are 0.085 - 0.109 mm. by 0.063 - 0.066 mm. (0.093 mm. by 0.07 mm.). There is a pair of lateral alae near the tail tip.

Discussion

Baylis (1922) separated semiteres from ensicaudatum. His criteria, despite criticism from Lewis (1927), remain valid, as is demonstrated by a comparison of the above descriptions with regard to lips and caecal length. Lewis (1927) recorded semiteres in Rooks and Starlings. If the caecal lengths of Lewis' material is closer to semiteres than to ensicaudatum, then it is possible that Lewis was describing the species which Hartwich (1959) believes to be P. picae (Rud., 1819). Baylis stated that the two species are really little more than subspecies. Even so the distinctive features of each remains remarkably constant throughout the range if the various European, American and Russian redescriptions are valid.

The Golden Plover is a new host for Wales.

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14). Porrocaecum spirale (Rud., 1795) Baylis, 1920

Syns.: Ascaris spirale Rudolphi, 1795; Ascaris depressum (Zeder, 1800) Rudolphi, 1819; Ascaris bulomus Fröhlich, 1802.

The original material was found by Rudolphi in the Tawny Owl (Strix aluco L.) and this host was recorded by Baylis, 1939. Other British hosts are the Long-eared Owl (Asio otus (L.)) - Bellingham, 1844; the Short-eared Owl (Asio flammeus (Pont.) - Lewis, 1926; the Barn Owl (Tyto alba (Scopolli)) - Baird, 1853; Baylis, 1939; and the Little Owl (Athene noctua mira Witherby) - Lewis, 1927; Baylis, 1928; and Baylis, 1939. The material for this redescription was found in the Little Owl - (3 (1) - 2/61) and the Barn Owl - (1 (1) - 11/63).

Description

Male: One reading. The length is 39.0 mm. and the breadth is 1.1 mm. The head diameter is 0.398 mm., while the ventriculus

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Plate 48

Porrocaecum spirale (Rudolphi, 1795)

Figure 180 Anterior end with caecum. L.P. x 6
Figure 181 Dorsal lip. H.P. x 6
Figure 182 Male tail. L.P. x 10.

Streptocara tridentata (von Linstow, 1873)

Figure 183 Female. Anterior end. H.P. x 10.
Figure 184 Egg. Oil immersion.

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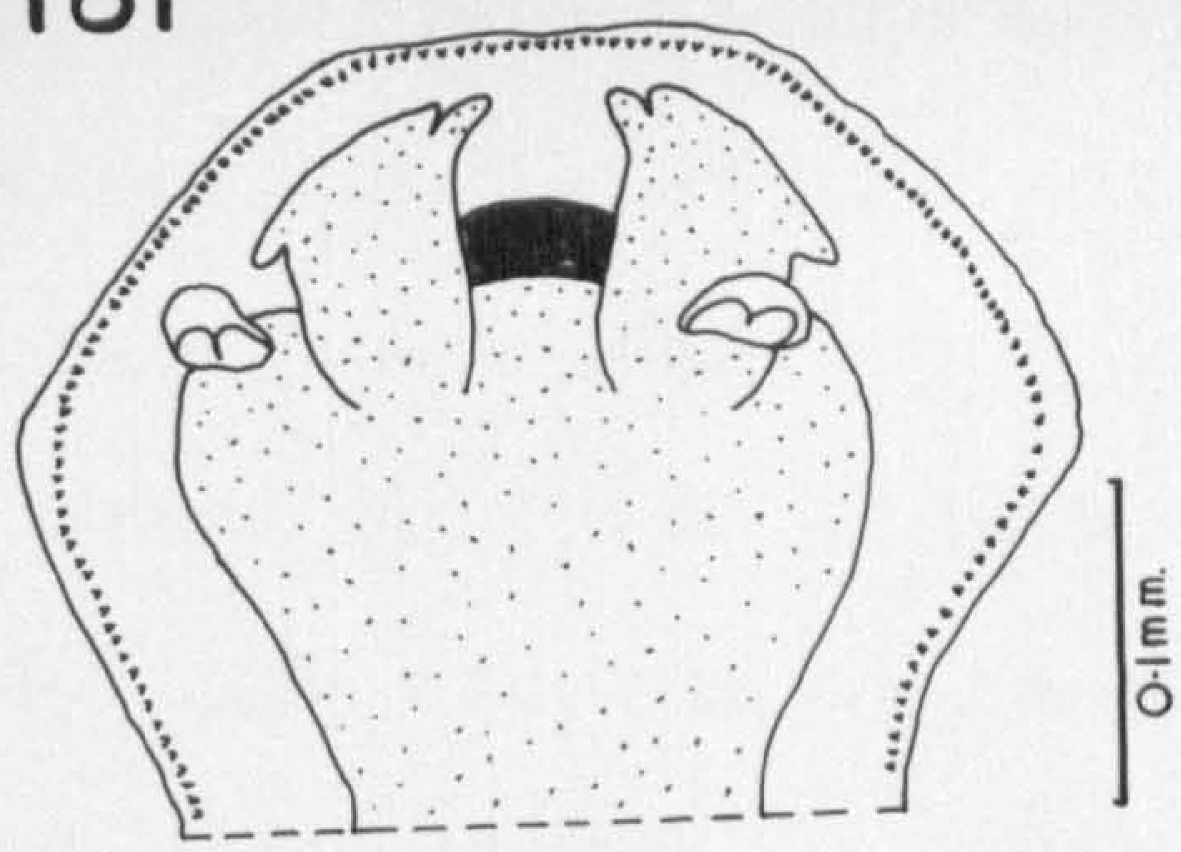

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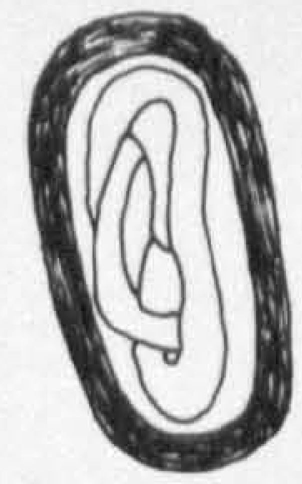

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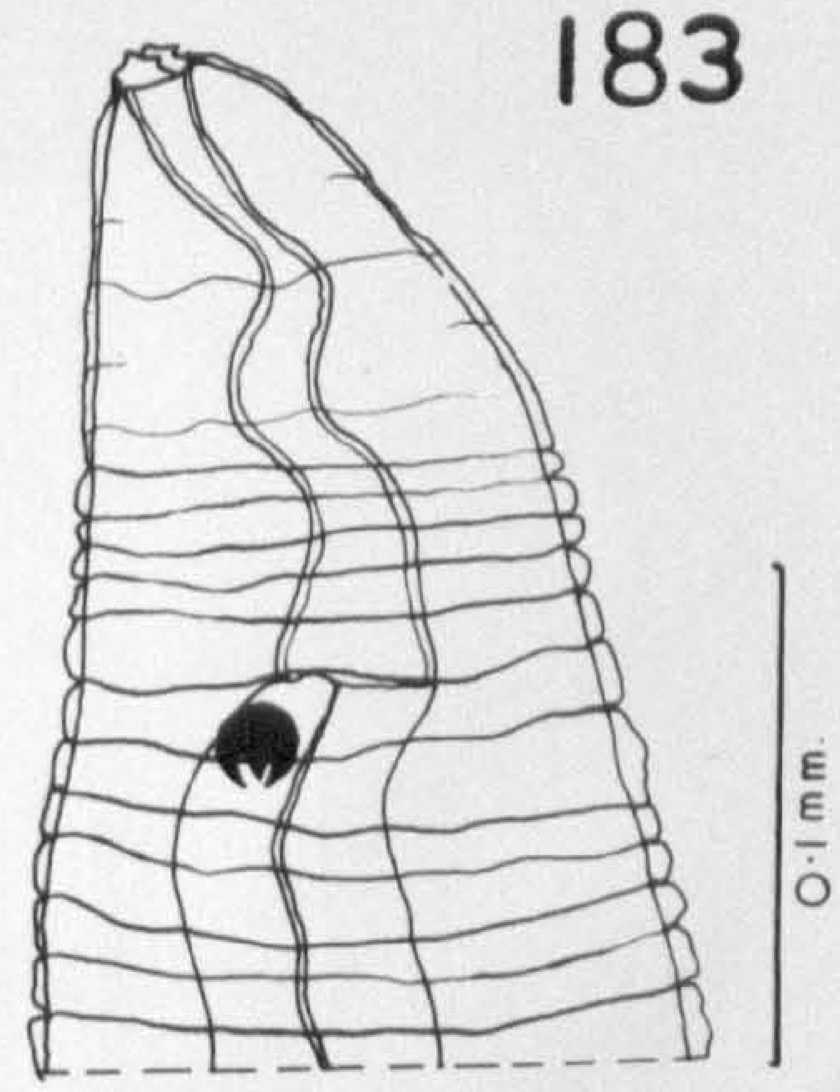

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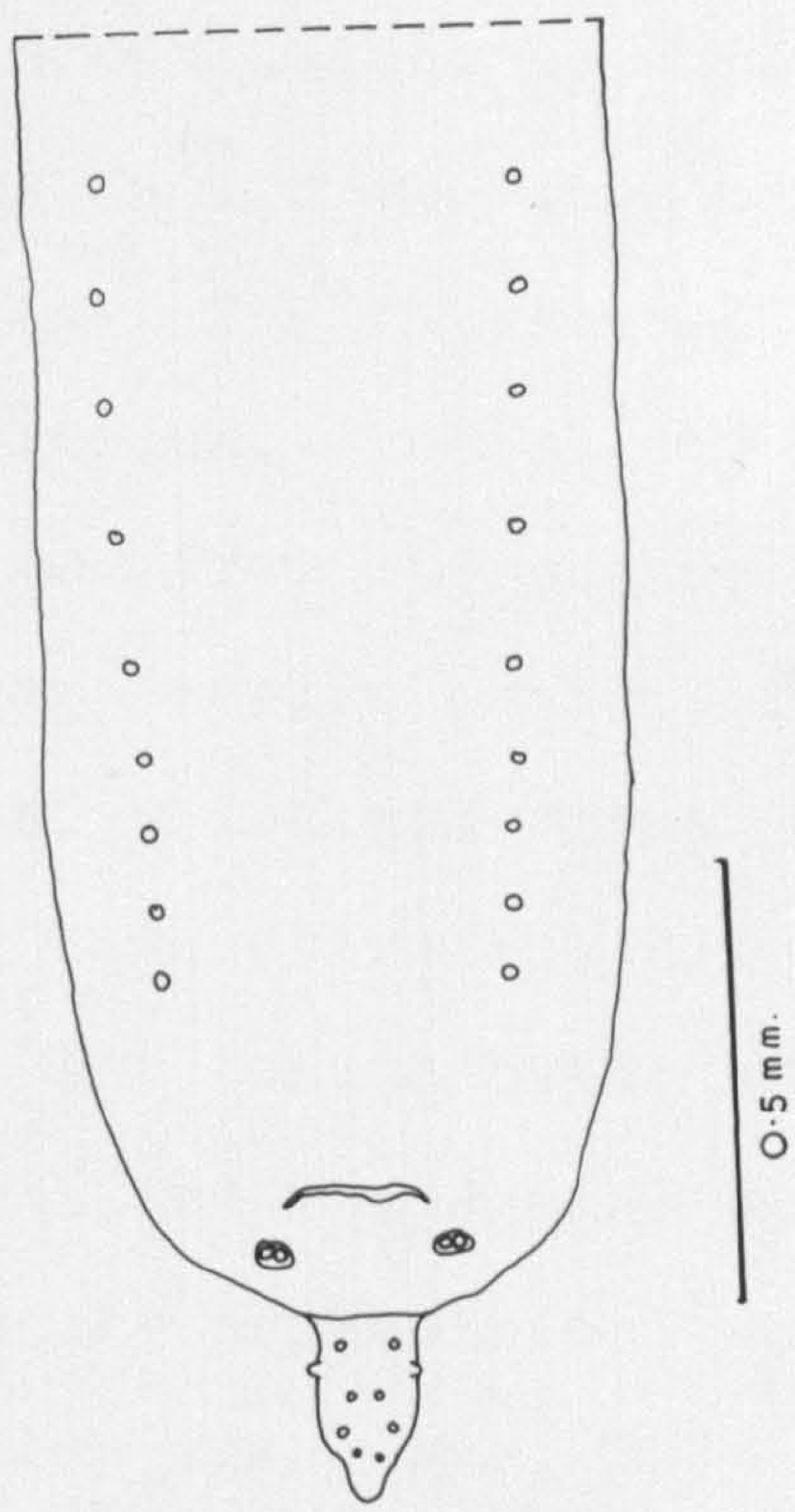

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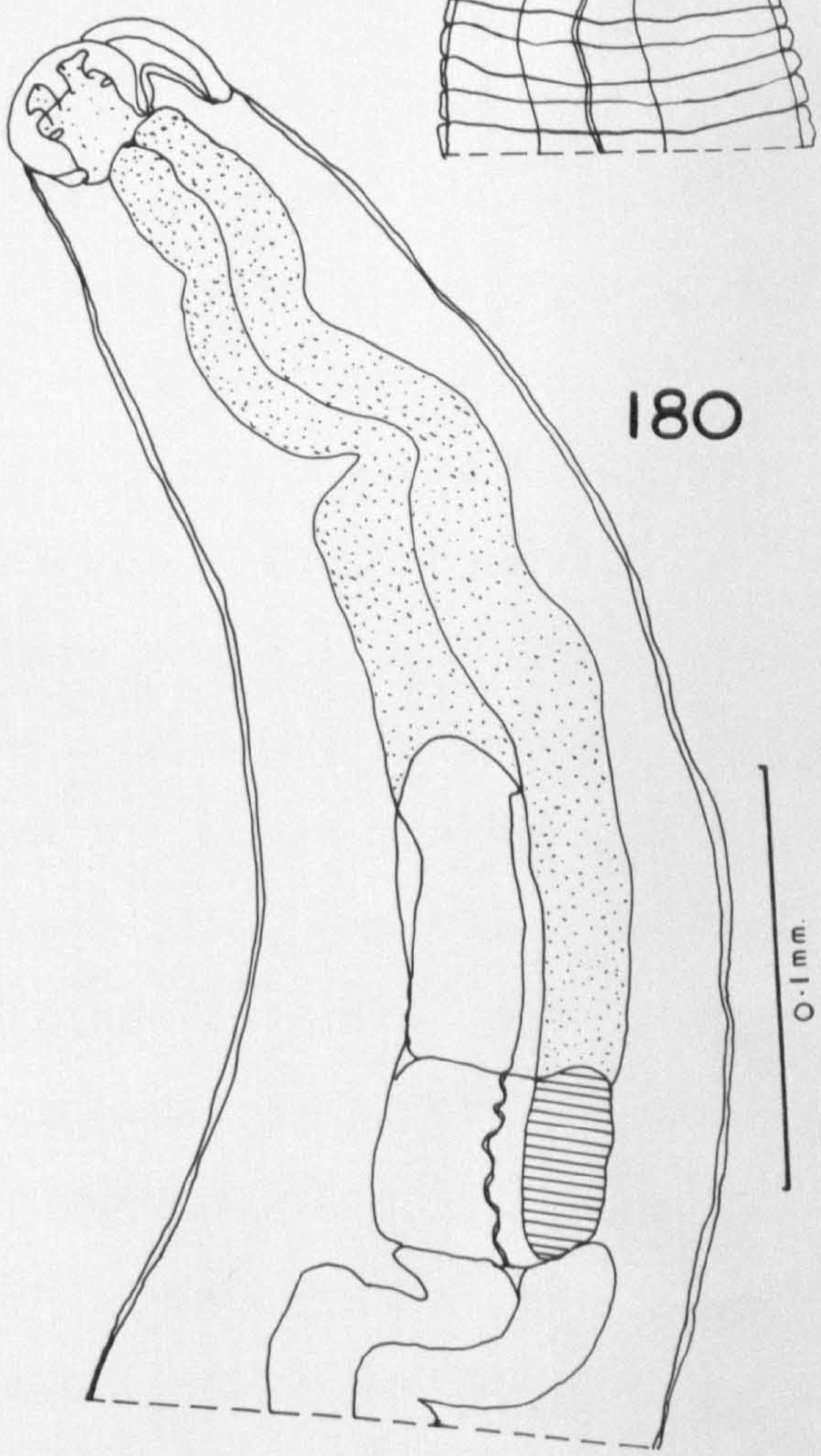

and tail are 0.714 mm. and 0.24 mm. across respectively. The lips are hexagonal and 0.264 mm. long. The pulp is oval with two anterior lobes, cleft into two short lobuli (Figure 181). The lateral lobule or tail-piece is much reduced, not reaching to the papillae. The lobus impar is well-developed, projecting for at least half the length of the anterior lobes. The dentigerous ridge extends to near the stem of the lip and the conical interlabia are 0.098 mm. long - rather more than a third of the lobe length. There are no cervical alae. The cuticle is 0.027mm. thick with striations up to 0.012 mm. apart in mid-body. The oesophagus is 1.6 mm. long and the ventriculus oblong, 0.314 mm. by 0.346 mm. The intestinal caecum is three times as long as the ventriculus, 1.08 mm. by 0.153 mm. (Figure 180). The anus is 0.232 mm. from the posterior end. The pre-anal papillae number about twelve pairs. There are six pairs of post-anal papillae of which the first pair is doubled, (Figure 182). The remaining five pairs are all on the small conical tail-piece, the first and fourth being subventral. The third and fifth pairs are ventral and the second pair are lateral. They were not conspicuously asymmetrical as indicated by Hartwich (1959). The spicules are alate, 0.58 - 0.64 mm. long.

Female: (Three readings.) The length is 59.0 mm. and the breadth 1.4 mm. Most other measurements are slightly larger than those of the male. The vulva is in the posterior half. It has distinct transverse lips and the muscular vagina is 0.43 mm. long. The anus is 0.414 mm. from the posterior tip and the eggs, which have a punctate outer shell, are 0.086 - 0.097 mm. by 0.066 mm.

Discussion

Table 37 compares the measurements of the writer with Hartwich (1959) and a group of other workers - Dujardin, 1845, Yamaguti, 1941, and Mosgovoy, 1953. Yamaguti (1941) states: "Anterior porcesses of pulp, simple not bifid". Figure 181 above shows quite distinctly the finger-like lobuli at the anterior tip of each lobe. Hartwich also describes and figures this condition. Yamaguti also neglected to mention the small lateral lobuli, The spicules are shorter than those of Hartwich but longer than in the older accounts. This feature must therefore be as variable and unreliable as in the crassum-ensicaudatum-semiteres group.

The species has been recorded from a wider range of Strigiforme hosts in Britain than elsewhere but this is the first redescription from British material. The intermediate host is uncertain.

TABLE 37: Porrocaecum spirale (Rud., 1795)

Characters	Dujardin, 1845 Mosgovoy, 1953	Hartwich, 1959	Author
Male			
Body Length	24.0 - 48.8	58.0 - 81.0	39.0
" Breadth	0.3 - 1.5	0.87 - 1.32	1.1
Head Diameter	-	-	0.398
Ventriculus Diameter	-	-	0.714
Tail Diameter	-	-	-
Cuticle	-	-	0.027
Striations	-	-	0.012
Lips	-	-	-
Inter-labia	-	-	0.098
Oesophagus	2.013 - 2.112	2.98 - 3.07	1.6
Ventriculus	0.236 - 0.36	0.45 - 0.47	0.314 x 0.346
Intestinal caecum	0.544 - 0.821	1.07 - 1.48	1.084 x 0.153
Cloaca	-	-	0.212 - 0.232
Preanal papillae	-	-	12 pairs
Postanal papillae	-	-	6 pairs
Spicules	0.47 - 0.532	0.643 - 0.796	0.58 - 0.64
Female			
Body Length	39.0 - 74.0	60.0 - 126.0	59.0
" Breadth	0.75 - 1.7	0.95 - 2.09	1.4
Head Diameter	0.21 - 0.23	-	-
Vulva	30.0	-	8:7
Vagina	-	-	0.43
Anus	-	-	0.414
Eggs	0.08 - 0.11 x 0.057 - 0.075	0.081 - 0.095 x 0.062 - 0.065	0.086 x 0.066

Order: SPIRURIDA

Super-family: Spiruroidea

Syn.: Spiruridea, Diesing, 1861

Family: Physalopteridae Leiper, 1908

Genus: <u>Streptocara</u> Railliet, Henry et Sissoff, 1912

Syn.: <u>Yseria</u> Gedoelst, 1919

15). <u>Streptocara tridentata</u> (von Linstow, 1877) Railliet, Henry et Sissoff, 1912

Syns.: <u>Filaria tridentata</u> Linstow, 1877

<u>Spiroptera tridentata</u> (Linstow, 1877) Newman, 1900

A female specimen was found in the oesophagus of the Great Black-backed Gull (<u>Larus marinus</u> L.) on Skomer Island - July, 1962. The length is 17.2 mm. and the width 0.23 mm. The pair of tricuspid papillae from which the specific name is derived are 0.126 mm. from the small lateral lips (Figure 183). These project for only 0.004 mm. beyond the head and have a lateral papilla on each side. The anterior part of the oesophagus is 0.12 mm. and the posterior part is 1.049 mm. long, giving an overall length of 1.169 mm. The anus is 0.188 mm. from the tip of the conical tail and the vulva is a transverse slit in the middle of the body. The vagina is 0.25 mm. long. The eggs (Figure 184) are embryonated when laid and thick-walled, 0.037 mm. by 0.02 mm.

<u>Discussion</u>

This is the first record of <u>Streptocara tridentata</u> from the Great Black-backed Gull in Britain. Previous records are the Red-throated Diver (<u>Colymbus stellatus</u> Pont.) - Baylis, 1939, and the Herring Gull (Larus argentatus Pont.) - Pemberton, 1963. There has been no redescription from British material.

Family: Acuariidae Seurat, 1913 (a)

Genus: Seuratia Skrjabin, 1916

Syns: Rictularia Fröhlich, 1802 partim; Acuaria Bremser, 1811 partim; Spiroptera Rudolphi, 1819 partim; Gnathostomata Owen, 1836 partim; Pronostemma Gendre, 1921

The genus has shipleyi (Stossich, 1900) as genotype. There are four species.

16). Seuratia puffini Yamaguti, 1941

Yamaguti described the species from the cardiac region of the stomach of the Sooty Shearwater (Puffinus griseus (Gmelin)) in Japan. The species has been found in all specimens of the Manx Shearwater (Puffinus puffinus (Brünnich)) examined at Skomer Island in the summers of 1960, 1961 and 1962. The anterior end is invariably inserted into the gastric pits in the cardiac half with the remainder of the body hanging free. The worms are remarkably viable and living specimens were recovered from an oiled bird which had been dead for three days.

Description

Male: The body is white, 11 - 12.5 mm. long and the tail is invariably rolled up. The maximum width is 0.286 mm. The lateral

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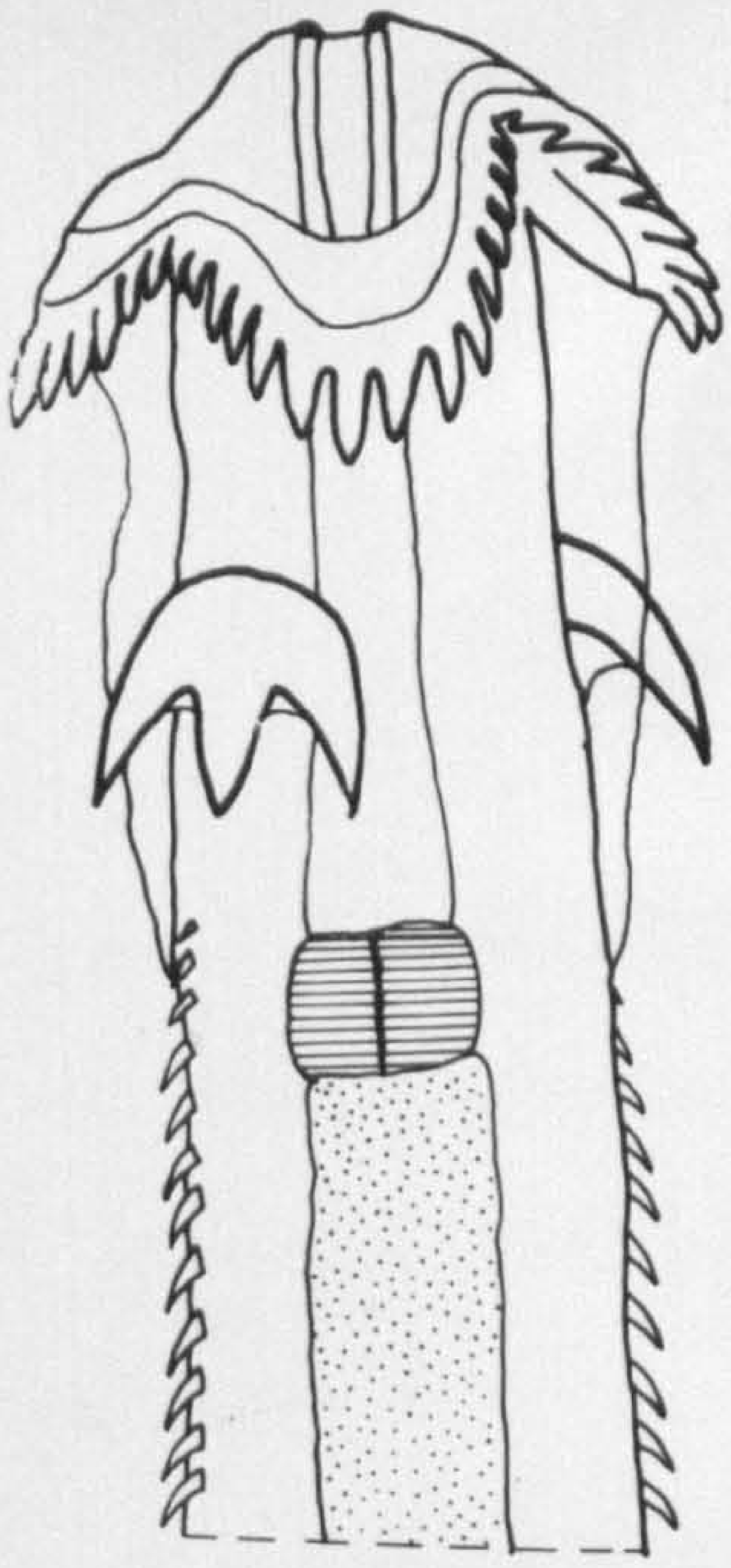
plate 49

Seuratia puffini Yamaguti, 1941

Figure 185   Anterior end. H.P. x 10.
Figure 186   Male tail. Ventral view. H.P. x 6
Figure 187   Male tail. Lateral view. H.P. x 6

185



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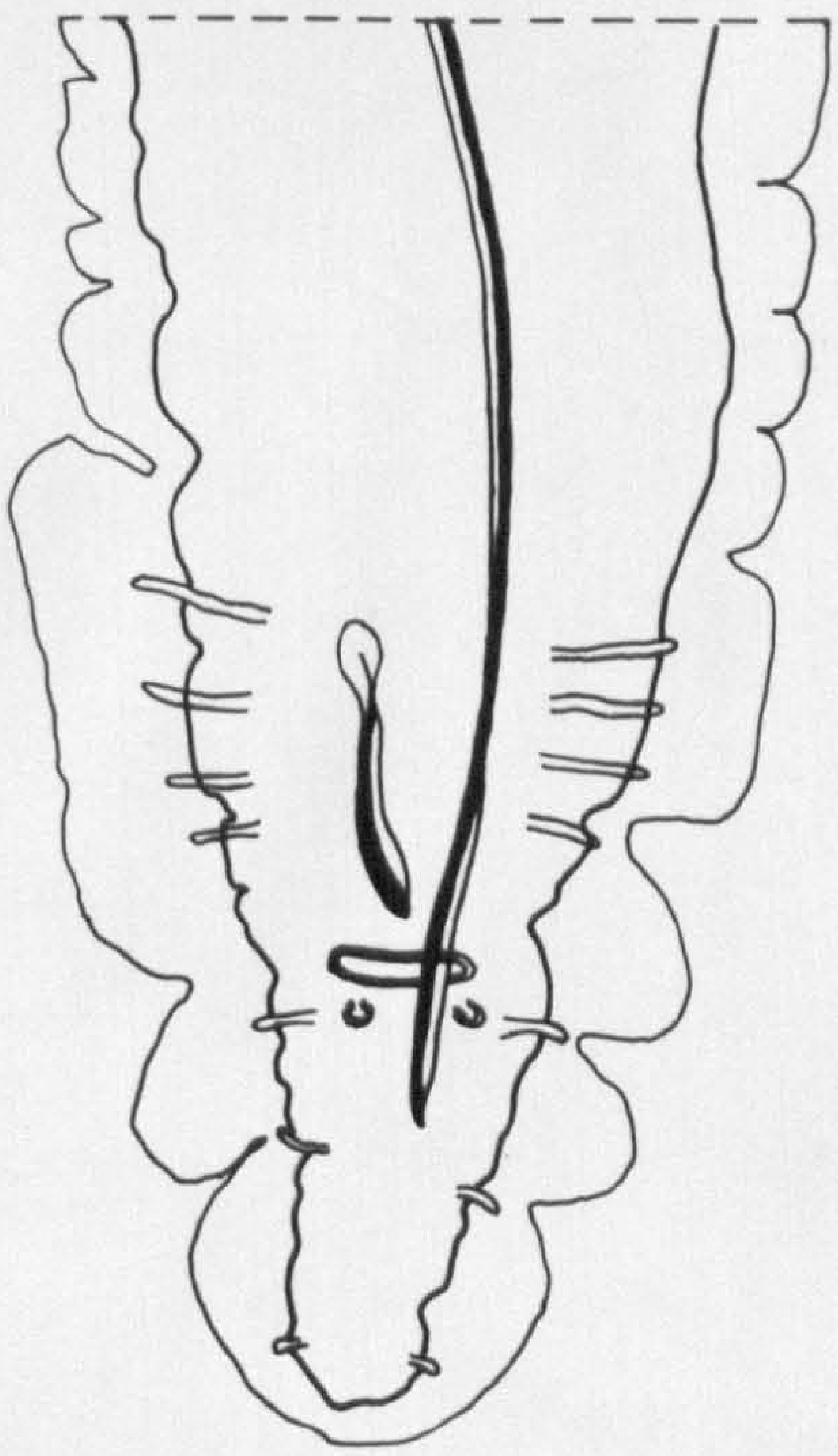

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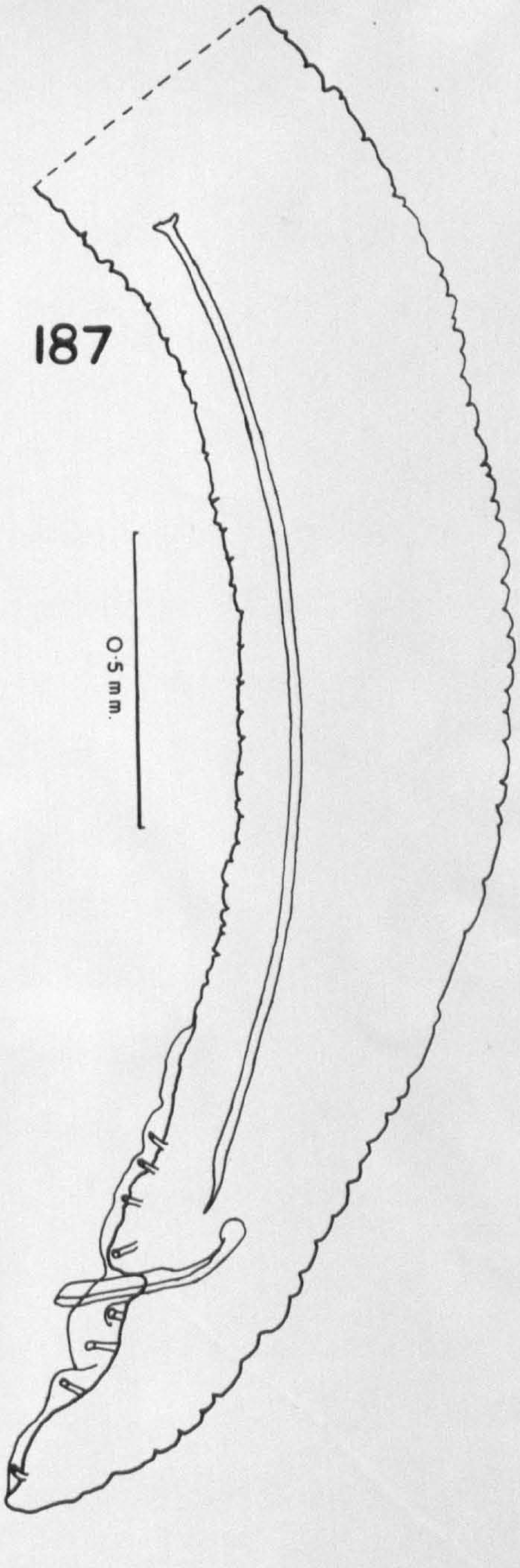

lips are not well developed and at the apex of the lobe is a cuticular projection which has the appearance of a papilla rather than a tooth as described by Yamaguti. There are four cephalic epaulets (Figure 185) which are 0.074 mm. in diameter and bear twenty-eight to thirty-two backwardly projecting spines. These vary between 0.0185 mm. at the free posterior edge and 0.009 mm. at the anterior indenture. On both the dorsal and ventral sides are found large tricuspid teeth. Each is 0.115 mm. from the anterior extremity and is of nearly equal proportions, 0.055 - 0.058 mm. long and 0.056 mm. wide. Roughly 0.19 mm. behind the anterior end arise a double row of lateral spines. These are 0.017 mm. long and persist for two-thirds of the body length. The buccal tube is 0.154 mm. by 0.02 mm. and is distinctive with a thick cuticle and many striations. The anterior part of the oesophagus is 0.685 mm. by 0.049 mm. and the posterior part 4.9 mm. by 0.09 mm. The cloaca is 0.23 mm. from the tip of the blunt tail (Figure 186). There are seven pairs of lateral papillae supporting the caudal alae, four pre-anal and three post-anal. In addition there are a mammiform pair in the mid-region just posterior to the anus. The spicules are unequal (Figure 187) and each has a narrow flange. The right spicule is stubby, 0.215 mm. and the left elongate, 1.09 mm.

Female: Except in the uterine region the body is translucent white and up to 23 mm. long and 0.34 mm. wide. The cephalic epaulets are larger, 0.085 mm. diameter and the marginal teeth are 0.021 mm. long. The tricuspid teeth are 0.148 mm. from the anterior end and the lateral spines 0.218 mm. The buccal tube is similar to the male, 0.162 mm. long. The tail is blunt and the anus is 0.14 mm. from the posterior end. The vulva is in the first third of the body, 7.9 mm. from the head. The vagina runs back for 0.77 mm. before it divides into two uteri, the anterior of which continues for a further 0.61 mm. before turning anteriorly. The eggs are 0.043 mm. by 0.019 mm., oval and thick-shelled.

Discussion

There is no substantial difference between the above text and the original account of Yamaguti. The Manx Shearwater (*Puffinus puffinus* (Brünnich)) is a new host and this is the first record of the nematode from Atlantic waters and from Europe in particular. Yamaguti's original host, the Sooty Shearwater, is an occasional visitor to Britain during the autumn.

Family: Ancyracanthidae Railliet, 1916

S.F.: Schistorophinae Travassos, 1918

Genus: *Viguiera* Seurat, 1913(b)

17). *Viguiera euryoptera* (Rud., 1819) Seurat, 1913(b).

Syns.: *Spiroptera euryoptera* Rudolphi, 1819

Acuaria lanium Molin, 1866

Spiroptera euryoptera was found by Rudolphi (1819) under the horny layer of the gizzard of the Great Grey Shrike (*Lanius excubitor* L.). The first satisfactory redescription was by Seurat (1913b) who used the species as genotype for his new genus *Viguiera*. Other hosts in Southern Europe and North Africa are the Red-backed Shrike (*Lanius collurio* L.), the Lesser Grey Shrike (*Lanius minor* Gmelin) and ? (*Lanius rufo* ?). Recent redescriptions of new hosts are Singh (1949) in the Bay-backed Shrike (*Lanius vittatus* Valenciennes) and the White-bellied Drongo (*Dicrurus coerulescens* (L.) Vielliot) in Hyderabad; Chabaud (1957) in the Woodchat Shrike (*Lanius senator senator* (L.)) in Tunis; and Wahid (1961) in the Indian Tree Pie (*Dendrocitta vagabunda* (Latham)) from Pakistan. The author has three specimens, a male and two females from the gizzard of a Blackbird (*Turdus merula* L.). The worms were recovered in March, 1963.

Description

The worms were slender and each end tapers to a narrow extremity. The head is most difficult to interpret, the most adequate description being that of Chabaud (1957). Because of the limited material end-on views were not attempted but lateral

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Plate 50

Viguiera euryoptera (Rudolphi, 1819)

Figure 188 Head. Oil immersion (a) lateral view
(b) dorso-lateral

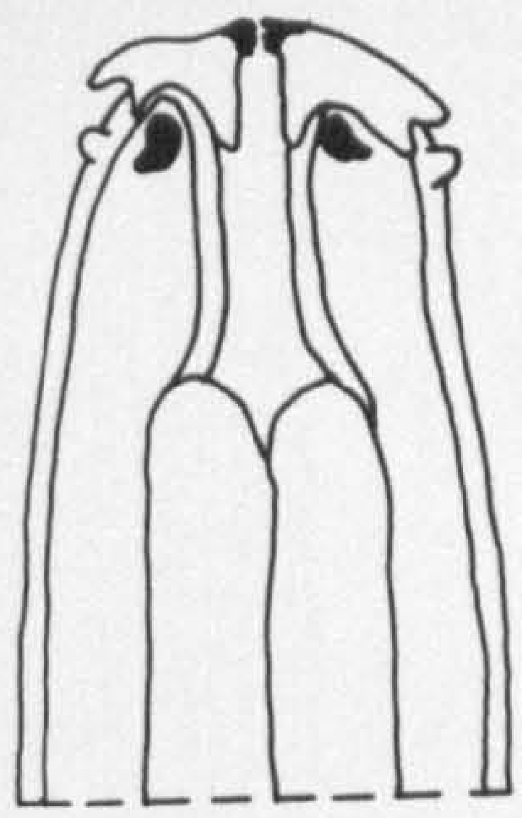
Figure 189 Male. Anterior end. H.P. x 10

Figure 190 Male. Tail end. H.P. x 6

Figure 191 Female. Vulva region. H.P. x 10

Figure 192 Egg. Oil immersion.

188 a



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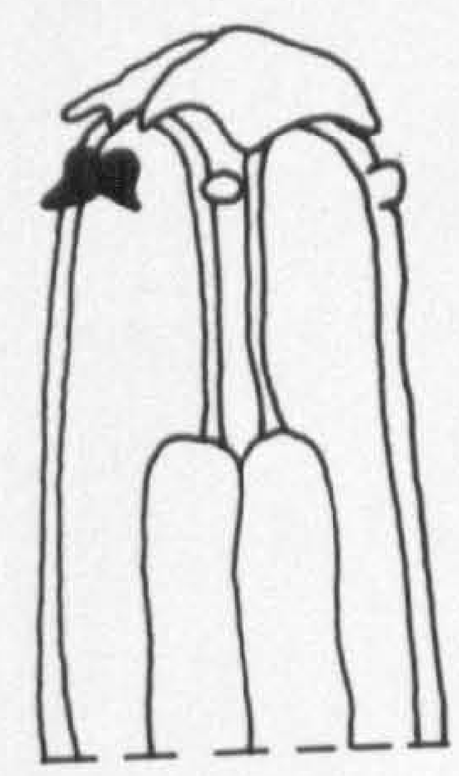

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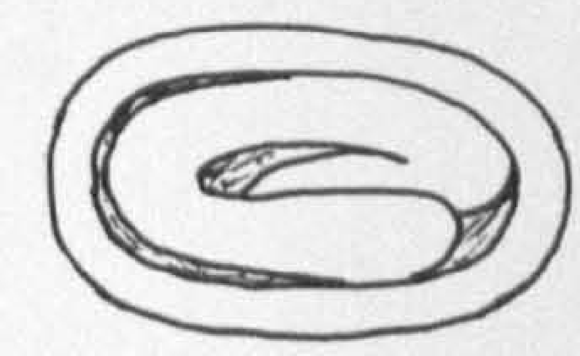

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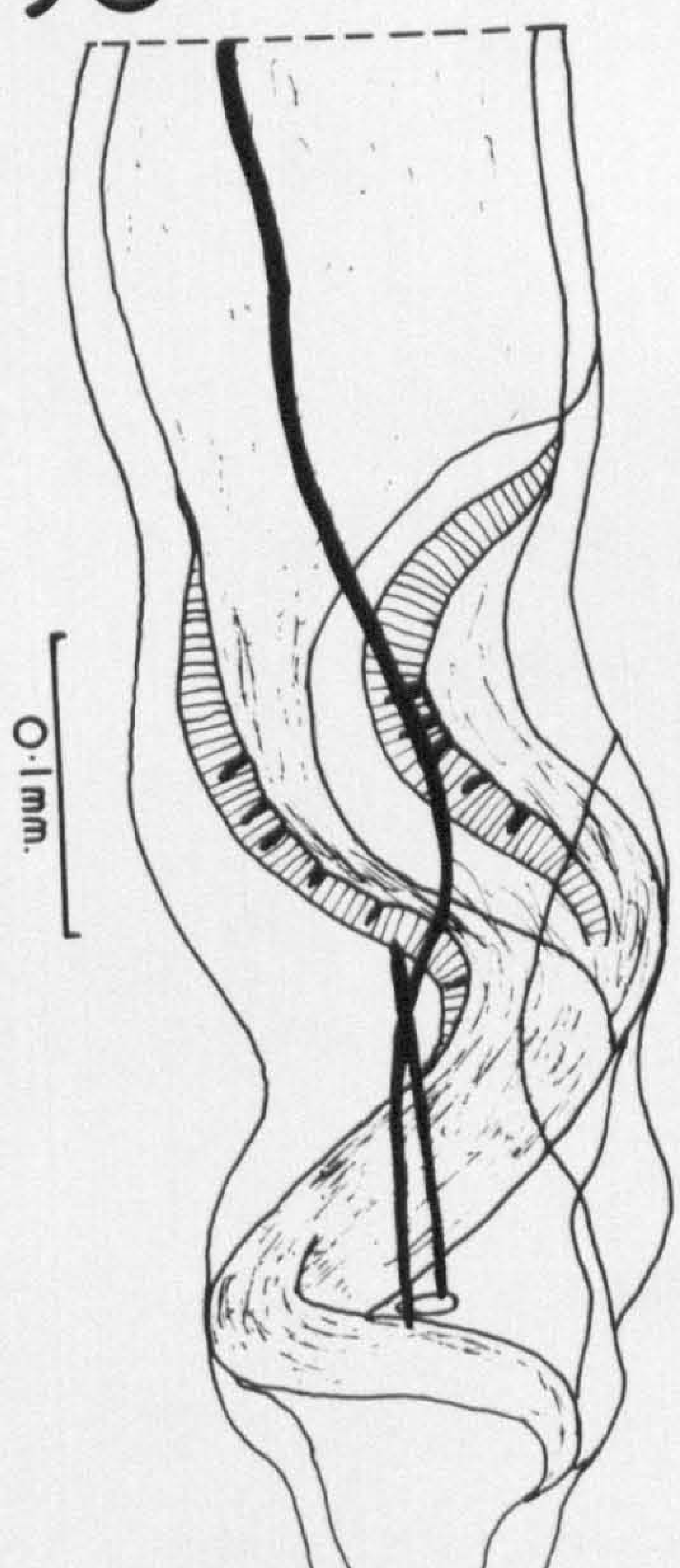

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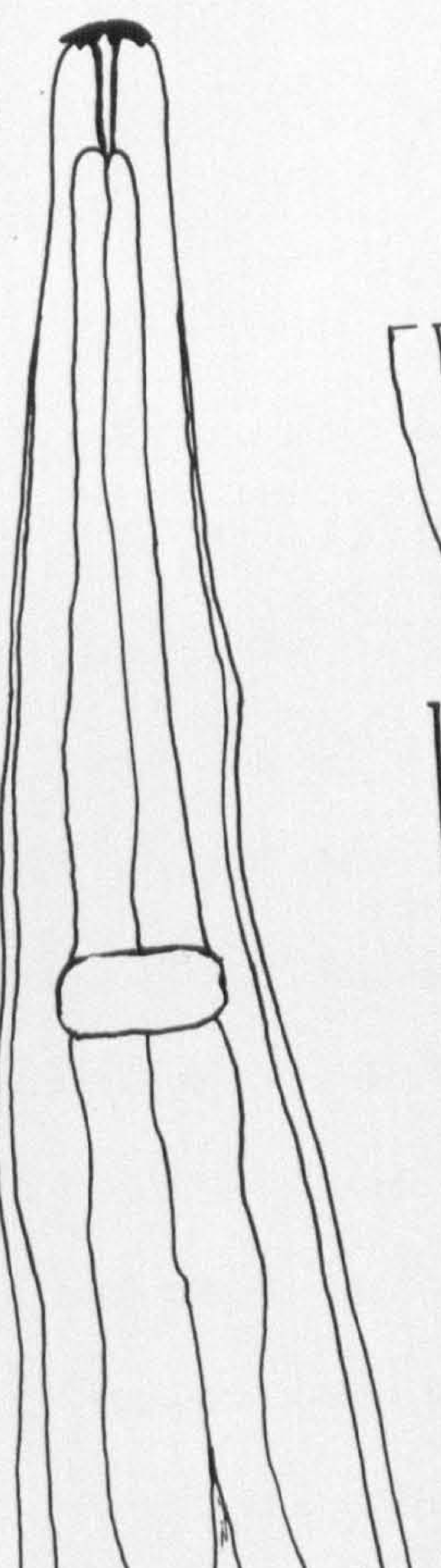

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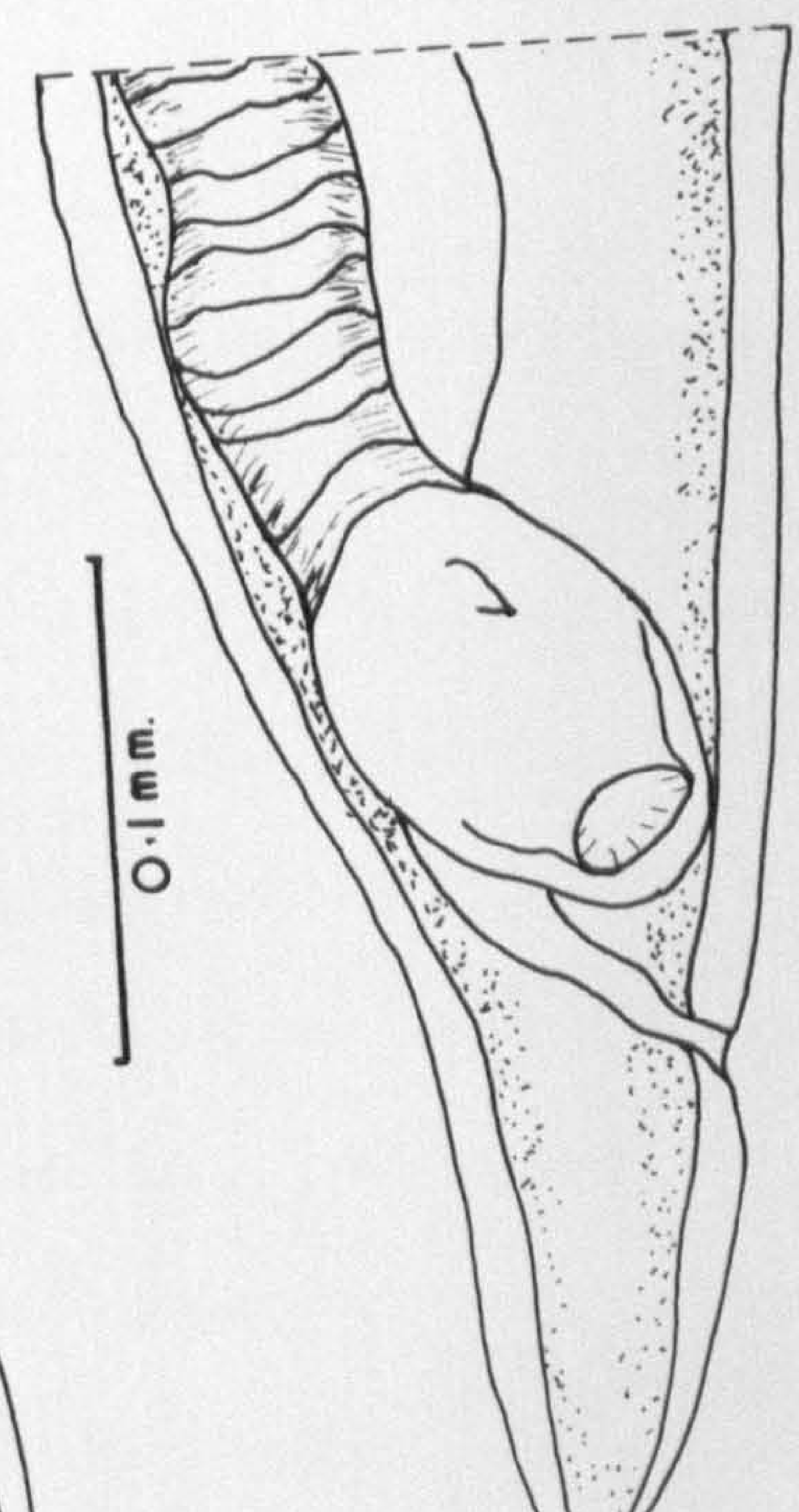

views under oil immersion were possible. There are no lips but a pair of dorsal and ventral cephalic plates each have tiny spines on the inner borders and a scalloped outer border, (Figure 188 (a) & (b)). Laterally to these plates are a pair of comma-shaped amphids and a little more posteriorly, a more median pair of cephalic papillae. The buccal capsule is elongated cylindrical and can be seen to be an invagination of the cuticle comparable with the stomodeum of coelomates. It is followed by a bi-partite oesophagus, around the anterior muscular part of which is the nerve ring (Figure 189). The glandular posterior portion is surprisingly long, between one third and one half the body length.

Male: 4.5 mm. long with an average breadth of 0.178 mm. The diameter across the buccal capsule is 0.025 mm. and across the tail 0.185 mm. The cuticle is 0.017 mm. thick, with distinct striations 0.009 mm. apart in the head region and 0.016 mm. apart towards the tail. The buccal capsule is 0.028 mm. long, and the nerve ring, 0.034 mm. in length, is 0.198 mm. from the head, (Figure 189). The muscular part of the oesophagus is 0.347 mm. long and the glandular part is 2.108 mm., making a total length of 2.455 mm. The tail is spirally coiled to the left and because there was only a single male, no attempt was made at uncoiling the tail in, what is for Britain, an unique species. The spicules are 0.007 mm. thick and unequal, the right measuring 0.132 mm. and the left 1.165 mm., that is in the ratio of 9 : 1 (Figure 190). It was difficult to determine the post-anal and pre-anal papillae, but those which were traced were pedunculate

0.015 mm. long. The left alae is larger and wider and both showed fine striations at the base.

Female: The species are 7.8 mm. and 9.1 mm. long with a breadth of 0.221 mm. and 0.279 mm. The diameter across the head is 0.029 mm. and across the anus 0.068 mm. The buccal capsule is 0.033 mm. long and the nerve ring 0.184 mm. from the anterior end. The muscular portion of the oesophagus is 0.312 mm. long but the glandular portion could not be measured since the ovary, which is parallel, overlaps much of its length. The cuticle is 0.018 mm. thick with striations 0.021 mm. apart.

The anus is 0.107 mm. from the tail. The vulva is a flask-shaped cuticular expansion some 0.03 mm. in front, (Figure 191). The aperture to the vulva is circular, 0.016 mm. diameter and the flask is 0.058 mm.by 0.039 mm. The muscular ovijector is 0.031 mm. wide and 0.165 mm. long. The thick-shelled eggs are embryonated when discharged, 0.036 mm. by 0.021 mm. (Figure 192).

Discussion

Chabaud (1957) and Wahid (1961) did not give measurements in their redescriptions. Those of Cram (1927), which are based on Seurat (1914) and Singh (1949), from new material, are given for comparison in Table 38. The only feature calling for comment is that in the male both left and right alae show striations. In the description of Seurat and Cram the left ala only shows striations, while Singh makes no mention of striations.

This is the first record of the worm in Northern Europe and the Blackbird (Turdus merula L.) is a new host. All previous

TABLE 38: *Viguiera euryoptera* (Rudolphi, 1819)

Characters	Cram (1927)	Singh (1949)	Author
Male			
Body Length	5.2 - 6.75	3.5 - 4.5	4.5
" Breadth	0.125	0.204	0.178
Head Diameter	-	-	0.025
Tail Diameter	-	-	0.185
Cuticle	Thick	-	0.012
Striations (Head)	-	0.017	0.009
(Body)	-	-	0.016
Buccal capsule	0.032	0.028	0.028
Oesophagus Anterior	0.370	0.29	0.347
Posterior	2.33	1.23	2.108
Cloaca	-	0.41	-
Preanal papillae	9	9	9
Postanal papillae	2	2	2
Spicules - Right	0.192	0.194	0.132
Left	0.93	1.136	1.165
Nerve Ring (distance fron ant.)	-	0.263	0.198
Female			
Body Length	9.0 - 10.0	6.0 - 11.0	7.8 - 9.1
" Breadth	0.290	0.25 - 0.273	0.221- 0.229
Head Diameter	-	-	0.029
Tail Diameter	-	-	0.068
Cuticle	-	-	0.018
Striations	-	0.022	0.021
Buccal capsule	-	0.03	0.033
Oesophagus Anterior	0.78	0.42	0.312
Posterior	⅓ body length	3.1	-
Vulva	-	-	0.168
Vagina	-	-	0.165
Tail	-	-	0.095
Anus (from post.)	-	0.102	0.107
Eggs	0.032 x 0.018	0.038 x 0.021	0.036 x 0.021
Nerve Ring	-	0.263	0.184

records have been from the Passerine families Laniidae, Dicruridae and Corvidae, and this is the first report from the Turdidae. A key to all known species, hitherto unavailable, is appended.

Key to the known species of *Viguiera* Seurat, 1913

A). 8-9 pre-anal papillae and 2 post-anal papillae

i). 8 pre-anal, mouth two crescentic lateral lips each with 3 small papillae in a row

a). Spicule thin, pointed, identical in shape - *buckleyi* (Yeh, 1954)

b). Spicules dissimilar, right short-thick and left thin-pointed - *osmanhilli* (Yeh, 1954)

ii). 9 pre-anal papillae with no crescentic lateral lips. Spicule ratio 9 : 1 - *euryoptera* (Rud., 1819)

B). 8 pre-anal papillae and 4 post-anal papillae - *dicruris* Gupta, 1961

C). 11 pairs of pre-anal papillae, 2 pairs post-anal. Spicules dissimilar, unequal, ratio 20 : 1 - *leiperi* Ali, 1956

PART II

Some comments on the new records, incidence of helminth species and ecological background of the hosts.

Introduction

The survey yielded thirty-seven new host records for Western Europe (Table B I), three species are recorded for the first time in Europe and five species for the first time in Britain (Tables B 2, a & b). In addition there are forty-four new host records for Britain (Table B 3) and thirty-two new host records for Wales. Several of the new records for Britain and Wales are due to the hosts not having been examined previously and are not of exceptional interest since the presence of the helminth species is to be expected in birds throughout Western Europe. The records for Wales have not, therefore, been listed. The writer must stress that it has only been possible to confirm records for Western Europe. In recent years there have been a great many intensive ecological surveys in Poland, Hungary, Czechoslovakia and the U.S.S.R., which, apart from the briefest mention in Helminthological Abstracts, are not otherwise readily accessible and as a consequence, not a few of the claimed new host records may have been already established in Eastern Europe.

SECTION A. New Records.

1). New host records for Western Europe.

(a) Trematoda.

The recovery of *Lyperosomum longicauda*, *Zoonorchis petiolatum*, and *Brachylaemus fuscatus* in their respective passerine host requires little comment since all are established in related host species and, where known, the intermediate host is included in the diet of all the birds. Only *Z. petiolatum*

Table B.1: 37 New Host Records for Western Europe

Trematoda	Host.
Lyperosomum longicauda (Rud., 1809)	Turdus pilaris L.
Lutztrema monenteron (Price & McIntosh, 1935)	Turdus musicus L.
" "	Parus major L.
" "	Passer domesticus (L.)
Zoonorchis petiolatum (Railliet, 1900)	Corvus corax L.
" "	Corvus corone corone L.
Gymnophallus deliciosus (Olsson, 1893)	Larus ridibundus L.
Parorchis pittacium (Braun, 1901)	Numenius arquata (L.)
Paraprorocephalum symmetricum Belopolskaya, 1952	Arenaria interpres (L.)
Brachylaemus fuscatus (Rud., 1819)	Corvus monedula L.
Leucochloridium certhiae McIntosh, 1927	Certhiae familiaris L.
" "	Muscicapa striata pallas
Leucochloridium melospizae McIntosh 1932	Sturnus vulagris L.
Cestoda	
Tetrabothrius cylindraceus (Rud., 1819)	Fratercula artica (L.)
Raillietina (Skrj.) bonini (Megnin, 1829)	Columba oenas L.
Ophryocotyle proteus Friis, 1870	Larus argentatus pont.
Paricterotaenia stellifera (Kr., 1869)	Lymnocryptes minimus (Brünnich)
Hymenolepis (H.) styloşa (Rud., 1810)	Parus ater britannicus Sharpe and Dresser
" "	Parus palustris L.
" "	Aegithalus caudatus L.
Aploparaksis dujardini (Kr., 1869)	Corvus corax L.
" "	Turdus pilaris L.
" "	Prunella modularis (L.)

" "	Troglodytes troglodytes (L.)
" "	Motacilla alba yarrellii Gould
Anlonaraksis crassirostris (Kr., 1869)	Numenius phaeopus (L.)
Nematoda	
Capillaria caudinflata (Molin, 1858)	Turdus merula L.
Capillaria contorta (Creplin, 1839)	Turdus pilaris L.
" "	Anthus pratensis (L.)
" "	Anthus spinoletta (L.)
" "	Alauda arvensis L.
Capillaria vanelli (Rud., 1819)	Numenius arquata (L.)
Capillaria spp.	Carduelis flavirostris L.
Porrocaecum ensicaudatum (Zeder, 1800)	Larus ridibundus L.
Seuratia puffini Yamaguti, 1941	Puffinus puffinus (Brünnich)
Viguiera euryoptera (Rudolphi, 1819)	Turdus merula L.

in Corvus corax need be emphasised as the host's habits are rather different, feeding in isolated areas and in pairs or small groups. Molluscs and insects form a smaller part of their diet. The two birds were shot feeding on pasture at the end of a hard winter and the proportion of these constituents in the diet may have increased considerably. Lutztrema monenteron has been recorded previously only by Mettrick (1958a) in Hertfordshire and if this species is not yet established in Europe then the infection of a winter visitor and passage migrant such as Turdus musicus could well cause its introduction to the Scandinavian and Siberian breeding grounds and to the wintering grounds which extend to the Mediterranean.

Parapronocephalum symmetricum has been recorded only in Eastern Siberia where Arenaria interpres breeds. The smaller size of the specimens and its presence in the small intestine instead of the gall-bladder and bile ducts suggests that the migration and change of internal conditions may cause some discomfort to the trematode. The food in the wintering quarters is mainly molluscs, insects and crustacea but in the breeding grounds is likely to be supplemented by grass, seeds and terrestrial invertebrates. If any of the former prove to be suitable intermediate hosts then the species may establish itself in the resident non-breeding population.

Parorchis pittacium has been described from members of the family Charadriidae in Russia and India but only from the family Laridae in Europe. Numenius arquata is mainly a winter visitor to Pembrokeshire although there are frequent breeding pairs in marshes and hill pastures. The infected bird was shot feeding alongside gulls in a marshy field in November where the diet consisted of insects and their larvae, pulmonate molluscs and oligochaete worms. The infection almost certainly occurred outside the breeding season when it feeds on mudflats and estuaries where the diet is marine molluscs, crustacea and polychaete worms. The rarity in other Charadriidae feeding in similar conditions, finds its counterpart in the rarity of the species in its more usual hosts, where only two of sixty-seven members of the Laridae dissected were infected with three and one species respectively.

Leucochloridium carthiae has been recorded in *Muscicapa striata* in Russia where the host breeds (also in North Norway). This bird is a summer visitor and passage migrant. Its food is almost exclusively insects and the bird was shot in deciduous conifers where the new host *Certhia familiaris britannica* also feeds. The presence of a suitable intermediate host among the local fauna suggests that the species could become established throughout the migrating range of its original European host which extends over most of the Western Paleartic including North West Africa. *Leucochloridium melopspizae* in *Sturnus* vulgaris is the first European record in a passerine bird. The species is comparatively rare however and might have been introduced from North America where it is common in both Charadriiformes and Passeriformes. There are frequent records of North American land migrants in Britain, particularly Charadriidae and Passerine and the more recent theories include jet streams - strong winds at very high altitudes - which blow from east to west across the Atlantic and are known to take large flocks off course. One of the most frequent of such visitors is *Mniotilta varia*, a recorded host of *L.certhiae*, while Charadriidae include *Erolia* spp., *Totanus* spp., and *Tringa* spp. The two new species of *Leucochloridium*, therefore, may owe their introduction into Western Europe from either Russia or North America.

(b) *Cestoda*

Tetrabothrius cylindraceus in *Fratercula artica* is of no special interest as the species is found in Laridae throughout Europe and has been recorded from *Uria aalge* and *Puffinus puffinus*, birds which also tend to disperse away from breeding grounds in the non-breeding season and feed both inshore and out at sea. All have access to the intermediate host which may be a small fish. *Ophryocotyle proteus* has been recorded in *Larus argentatus* by Linton (1927) in North America but most records are in Charadriidae. Gulls feed more rarely on the polychaete worms (the intermediate host is *Nereis diversicolor*) and the only earlier record in Laridae in Britain is by Pemberton (1963) who found the species in five out of one hundred and forty-six *Larus ridibundus*. The single immature strobila indicates that other factors, besides rare contact with the intermediate host, may prevent the species from becoming established to any significant degree in the Laridae.

Hymenolepis stylosa is commonly found in the Corvidae but has not yet been recorded in the Paridae. The food of this latter family consists principally of insects, spiders and centipedes and only rarely of earthworms or slugs, the more likely intermediate hosts. The occurrence of Aploparaksis dujardini in Prunella modularis, Troglodytes troglodytes and Motacilla alba yarrelli is unusual as the intermediate host is an earthworm and the Wren and Pied Wagtail feed chiefly on insects.

(c) Nematoda

The intermediate host of Capillaria caudinflata can be one of several common oligochaete worms and yet the nematode has not previously been recorded in a passerine host although the worms form part of the diet of many of the perching birds. The single occurrence in Turdus merula is quite exceptional and is an indication that some factor of host-specificity must have been negated on this occasion. Capillaria contorta is very common in passerines and of the new host records only Anthus spinoletta need be mentioned as animal matter constitutes a very small proportion of the diet. The record of Capillaria spp., in Carduelis flavirostris is of interest for the same reason. Dr. D. Wakelin has suggested that the species may be C. angusta (from the Chaffinch) or C. rigidula (from the Hedge Sparrow) but inadequate original descriptions make identification extremely difficult.

Viguiera euryoptera has been recorded from the Laniidae in Southern Europe but not from any other passerine family. The intermediate host is Lumbricus terrestris which is also part of the diet of many other Passerines. The Laniidae breed from the Baltic down to the Mediterranean and it is surprising that there are no other records. This unique infestation is evidently the result of a break-down in host-specificity.

2). Three species recorded for the first time in Europe.

(a) Trematoda

The occurrence of Parapronocephalum symmetricum and Leucochloridium certhiae has been discussed above.

(b) Nematoda

Seuratia puffini was described in Puffinus griseus from the North Pacific. This remarkable bird nests in New Zealand and Southern South America and its migratory range is well beyond the equator in both the Pacific and Atlantic oceans. It appears first along the east coast of North America and then Greenland and only reaches the European waters as a scarce autumn visitor for its pre-nuptial migration. Its principal food is the squid but smaller fish such as sardines are often taken. The species was recovered in Puffinus puffinus which breeds in Pembrokeshire. The parent birds fly daily south to the Bay of Biscay for sardines with which to feed the young and when the schools move further south in September, the birds follow and may even winter off South America. (One bird ringed at Skokholm in 1952, was recaptured below Buenos Aires - 6,100 miles). At this time of year, it overlaps the northward migration of Puffinus griseus and cross-infection appears to take place. The intermediate host is presumably the sardine. Several young birds were examined but were not infected.

Table B.2:

(a) Three species recorded for the first time in Europe

Trematoda	Host
Parapronocephalum symmetricum Belopolskaya, 1952	Arenaria interpres (L.)
Leucochloridium certhiae McIntosh, 1927	Certhia familiaris L.
Nematoda	
Seuratia puffini Yamaguti, 1941	Puffinus puffinus (Brünnich)

(b) Five species recorded for the first time in Britain

Trematoda	Host
Cyclocoelum (Hyptiasmus) elongatum Harrah, 1921	Pica pica (L.)
Leucochloridium melospizae McIntosh, 1932	Sturnus vulgaris L.
Cestoda	
Hymenolepis (H.) naja (Dujardin, 1845)	Certhia familiaris L.
Fimbriariodes intermedia (Fuhrmann, 1913)	Somateria mollissima (L.)
Nematoda	
Viguiera euryoptera (Rudolphi, 1819)	Turdus merula L.

3). Five species recorded for the first time in Britain.

(a) Trematoda

Timon-David (1950) recorded *Cyclocoelum (Hyptiasmus) mutabile* in *Pica pica* in France. The morphological significance of the different location in the host will be discussed below. The difficulty in explaining the infection is due to the host's being a non-migratory species. (Dorst, 1962, p.261 describes the Magpie as 'sedentary'). If there is no migration of the host, then a possible explanation for this unique infection is that the intermediate host is migratory, which would of course limit it to its being an insect. Alternatively, the infected droppings of a migratory bird may have caused the infection.

The record of *Leucochloridium melospizae* is discussed above. *Sturnus vulgaris* is a winter migrant to Pemrokeshire and the infection may have occurred in Northern Europe where the species has been recovered in Charadriidae.

(b) Cestoda

Hymenolepis (H.) naja has been recorded from insectivores in Europe but not previously from *Certhia familiaris britannica* in Britain. This host is non-migratory and again must subscribe to a migratory insect as the intermediate host introducing the infection. *Somateria mollissima* was the original host for *Fimbriariodes intermedia*. It undergoes winter migrations and those which breed in Britain reach the west coast in exceptionally cold, snowy winters. There was no means of deciding whether the bird examined in February, 1963 bred in Britain or whether it was a migrant from the Continent.

(c) Nematoda

The occurrence of *Viguiera euryoptera* in *Turdus merula* in Northern Europe is unique since as is mentioned above it normally occurs in the family Laniidae. Only *Lanius senator* is an annual visitor in very small numbers to the West Coast of Britain, particularly the South Irish Sea and the Pembrokeshire coast. This bird breeds in Belgium and Poland and winters in tropical West Africa. (The species has been recorded in this host in Tunisia). It is considered that rather than this record being a chance infection of a resident bird, the Blackbird itself was a visitor. There is a considerable migration of Continental Blackbirds, which breed from Scandinavia to North Portugal and east to central Russia, into Britain in late September which remain until the beginning of April. The worm was recovered in the exceptionally cold and wet March, 1963 when the influx of migrants was especially marked in Pembrokeshire. The bird was almost certainly infected at its Continental breeding ground.

4). New Host records for Britain.

(a) Trematoda and Cestoda

There is little interest attached to the new British host records as all are established hosts in Europe. In certain cases, the new hosts listed in Table B 3, are the original hosts from which the species were described:- *Himasthla rhigedana* (Dietz, 1909) in *Numenius arquata* (L.); *Cyclocoelum (C.) mutabile* in *Gallinula chloropus* (L.); *Tetrabothrius*

Table 8.3: Forty-four new Host Records for Britain

Trematoda	Host
Plagiorchis maculosus (Rudolphi, 1802)	Hirundo rustica L.
Lyperosomum longicauda (Rudolphi, 1809)	Corvus corone corone L.
" "	Pica Pica (L.)
Lutztrema monenteron (Price & McIntosh 1935)	Erithacus rubecula melophilos Hartert
Zoonorchis petiolatum (Railliet, 1900)	Pica pica (L.)
Gymnophallus deliciosus (Olsson, 1893)	Larus marinus L.
" "	Larus canus L.
Echinostoma revolutum (Frölich, 1802)	Corvus corone corone L.
" "	Corvus monedula L.
Himasthla rhigedana (Dietz, 1909)	Numenius arquata (L.)
" "	Numenius phaeopus (L.)
Brachylaemus fuscatus (Rudolphi, 1819)	Corvus frugilegus L.
" "	Corvus corone corone L.
Cyclocoelum (Cyclocoelum) mutabile (Zeder, 1800)	Gallinula chloropus (L.)
" "	Fulica atra L.
Cestoda	
Tetrabothrius cylindraceus (Rud., 1819)	Larus marinus L.
" "	Larus fuscus L.
Tetrabothrius erostris (Lönnberg, 1889)	Larus marinus L.
Tetrabothrius immerinus (Abildgaard, 1790)	Podiceps cristatus (L.)
Dilepis undula (Schrank, 1788)	Corvus corax L.
Paricterotaenia embryo (Krabbe, 1869)	Gallinago gallinago L.
Choanotaenia unicoronata (Fuhrmann, 1908)	Turdus merula L.
Hymenolepis (H.) anatina (Krabbe, 1869)	Anus platyrhynchos L.
" "	Fulica atra L.

Hymenolepis (H.) ductilis (Linton, 1927)	Anas platyrhynchos L.
" "	Somateria mollissima (L.)
Hymenolepis (H.) parina (Fuhrmann, 1907)	Parus major L.
Hymenolepis (H.) passeris (Gmelin, 1790)	Parus major L.
" "	Parus palustris L.
" "	Aegithalos caudatus L.
Hymenolepis (H.) serpentulus (Schrank, 1788)	Corvus corax L.
Diorchis acuminata (Clerc, 1902	Fulica atra L.
Aploparaksis brachyphallos (Krabbe, 1869)	Calidris canutus (L.)
Aploparaksis filum (Goeze, 1782)	Tringa totanus L.
Aploparaksis hirsuta (Krabbe, 1869)	Gallinago gallinago L.
Fimbriariodes intermedia (Fuhrmann, 1913)	Somateria mollissima (L.)
Nematoda	
Capillaria contorta (Creplin, 1839)	Erithacus rubecula melophilos Hartert
" "	Anas platyrhynchos L.
" "	Numenius arquata (L.)
Capillaria spp.	Alauda arvensis L.
Contracaecum spiculigerum (Rudolphi, 1809)	Alca torda L.
" "	Uria aalge (Pont.)
" "	Puffinus puffinus (Brünnich)
" "	Larus fuscus L.
Streptocara tridentata (Von Linstow, 1877)	Larus marinus L.

cylindraceus (Rud., 1819) in *Larus marinus* L; *Tetrabothrius erostris* (Lönnberg, 1889) in *Larus marinus* L; *Paricterotaenia embryo* (Krabbe, 1869) in *Gallinago gallinago* (L.); *Choanotaenia unicoronata* (Fuhrmann, 1908) in *Turdus merula* L.; *Hymenolepis* (H.) *parina* in *Parus major* L.; and *Diorchis acuminata* (Clerc, 1902) in *Fulica atra* L.

(b) *Nematoda*

The finding of *Capillaria* spp. in *Alauda arvensis* is the first record of any capillarid worm in the Skylark in Britain. *Streptocara tridentata* is also a rarity in British birds and the only previous records occurred in *Colymbus stellatus* and *Larus argentatus*.

SECTION B. The Incidence of helminth species recovered.

Over five hundred and seventy-six birds belonging to twelve orders and thirty families were examined. The total number of bird species was seventy-nine, of which twelve were free of helminth infections. Three hundred and fifty-four birds were parasitised (61.4%) with at least one species of helminth. The most common helminth group was the cestodes, forty-three species and two hundred and ninety-four birds were parasitised (82.2%). The second most common group were the trematodes, eighteen species and eighty-six birds were parasitised (21.4%). Finally, eighty-five birds were infected with nematodes, seventeen species (20.2%).

1). The incidence of helminth classes related to host orders and families.

The percentage of birds infected in the survey is shown in Table B 4. When such disparate numbers of birds for each family were examined, it is invidious to draw too many conclusions concerning the susceptibility of family groups and orders to helminth infections. Certain general statements may be made, while admitting the tenuousness of arguments based on 100% infection rates when only one bird was dissected.

The incidence of trematodes generally is remarkably low. The papers of Lewis (1926a) show a far higher percentage infestation in marine, shore-birds and waders. Davies (1937 unpubl.) subsequently recorded fewer at Aberystwyth and Williams (1961) fewer again. Recently Dr. Gwen Rees has stated that the incidence of Parorchis pittacium in the Lariidae is a fraction of its former prevalence when she did her classic work on the life-cycle. It has not been possible to ascertain the factors bringing this scarcity about. The occurrence of Himasthla spp., is as rare and the number recorded in the Scolopacidae is supplemented by Gymnophallus numenii sp. nov., in a migratory bird, Numenius arquata. Resident birds, like Haemotopus ostralagus (Family Haemotopidae) are startingly lacking in the species recorded in other parts of Britain and Europe. The forty-four Lariidae were all infected by Gymnophallus daliciosus, ommiting this species, only three birds were infected - two with Parorchis pittacium and one with Himasthla elongata. The intermediate host of G. daliciosus is unknown. This is plentiful on the coast and in some way the sporocyst and rediae of the species must be more resistant to detrimental factors than are

TABLE B4: The incidence of Helminth Classes related to Host Orders and Families.

Order	Family	No. of spp.	No. of birds	No. infect.	%	Trematoda: No. birds infected.	Trematoda: No. of species	Cestoda: No. birds infected	Cestoda: No. of species	Nematoda: No. birds infected	Nematoda: No. of species
Podicipiditiformes	Podicipitidae	1	1	1	100	1	1	1	1	-	-
Procellariformes	Procellaridae	1	8	8	100	-	-	1	1	8	2
Pelicaniformes	Phalacrocorac-idae	1	1	1	100	-	-	-	-	1	1
Ardeiformes	Ardeidae	1	1	1	100			1	1	-	-
Ralliformes	Rallidae	2	4	3	75	2	1	2	2	-	-
Charadriiformes	Haematopidae	1	11	11	100	-	-	6	2	6	1
	Charadriidae	3	15	12	80	8	4	7	3	5	2
	Scolopacidae	8	26	22	85	8	4	22	9	3	2
	Laridae	5	67	51	76	44	3	46	7	3	3
	Alcidae	3	8	3	37	-	-	1	1	2	1
Anseriformes	Anatidae	7	8	7	87	-	-	7	7	1	2
Columbiformes	Columbidae	2	35	14	40	1	1	10	1	3	1
Strigiformes	Strigidae	2	2	2	100	-	-	-	-	2	1
Apodiformes	Apodidae	1	1	1	100	1	1	-	-	-	-
Piciformes	Picidae	1	1	0	0	-	-	-	-	-	-
Passeriformes	Alaudidae	1	12	2	16	-	-	-	-	2	2
	Hirundinidae	1	2	2	100	2	1	-	-	-	-
	Corvidae	6	56	47	84	12	5	43	6	26	3
	Paridae	5	9	7	77	1	1	1	1	-	-
	Certhidae	1	2	2	100	1	1	1	1	-	-
	Troglodytidae	1	2	1	50	-	-	1	1	-	-
	Turdidae	7	29	22	76	8	4	19	6	5	5
	Sylvidae	2	3	1	33	-	-	1	1	-	-
	Regulidae	1	2	0	0	-	-	-	-	-	-
	Muscicapidae	1	1	1	100	1	1	-	-	-	-
	Prunellidae	1	3	2	66	-	-	2	2	-	-
	Motacillidae	3	7	3	43	-	-	1	1	2	1
	Sturnidae	1	200 (+)	123 (+)	61	2	2	113	5	4	3
	Fringillidae	8	19	2	10	-	-	1	1	1	1
	Passeridae	1	40	2	5	1	1	1	1	-	-

those of other trematodes. There may be a lack of lime in the sea and in the principal river, the Cleddau. The presence of <u>Cyclocoelum (C.) mutabile</u> in the Rallidae (shot on the Cleddau banks), does not necessarily contradict this, since their diet also includes insects and larvae, worms, slugs and tadpoles.

Most of the ocean-going birds were examined in the summer when previous surveys have shown seasonal incidence to be at its height. The majority of the Charadriiformes and Anatidae were taken in winter when seasonal incidence is often lowest. But any seasonal incidence was not so marked in the cestodes from the same birds and the attention is directed to the different invertebrate phylla to which the intermediate host belongs. Trematodes generally use molluscs and cestodes use polychaetes, oligochaetes and assorted arthropods. In addition to the absence of lime in affecting the molluscs, one might consider also oil pollution from the tankers using the landing stages of the new oil refineries at the mouth of the Cleddau, the sewage outfall from coastal towns like Tenby, which make most of the local mollscs inedible and, finally, and perhaps most significantly, the increasing use of insecticides which inevitably get washed into the Ceddau and into many fresh-water streams which flow out from the cliffs and across the beaches. The sparsity of trematodes in passerines points to a lack of lime as the prime cause.

Despite the variation in numbers for each family, it is possible to draw some conclusions on the pattern shown when relating the host group to their diet and, indirectly, to the availability of a suitable intermediate host. This is to be seen in Table B 5 where habitat and diet are related to the number of species recovered from each helminth group. A marked increase in infestation is shown in all helminth groups as the source of infection changes from aquatic invertebrates to purely terrestrial invertebrates.

There are many records of trematodes in aquatic birds and their absence from this survey has been discussed above. The trematode infestations increase as the diet changes to pulmonate snails, or as for Brachylaemus fuscatus, when slugs are the intermediate hosts. The high rate of infection in the Turdidae appears to be due to the inclusion of slugs and worm in their diet.

Generally, the birds which have a predominantly vertebrate diet have more nematode infestations than trematode or cestode infestations - group a) and group f) Strigiformes. Similarly, nematodes with direct life-cycles are more common than trematodes in birds in which seed-eating predominates (Passeriformes; Prunellidae, Fringillidae, Alaudidae) and where vegetable matter is equal to, or in excess of, animal matter - (Columbiformes; Passeriformes - Sturnidae, Passeridae). The two nematode species in the freshwater group (marked with an asterisk) both occurred in Anas platyrhynchos which is unique in the group in that it regularly feeds on marshes and flooded pastures. The intermediate hosts for the two species concerned are earthworms, so the final host comes into contact with nematodes not normally

TABLE B.5: The incidence of Helminth Species related to the Host's diet and habitat

Habitat	Diet	Number of Species: Trematoda	Number of Species: Cestoda	Number of Species: Nematoda
(a) Marine Procellariformes Pelicaniformes Charadriiformes (Alcidae)	Fish	-	1	2
(b) Marine and Freshwater Anseriformes *Melanitta nigra* *Somateria mollissima*	Sea - Molluscs, crustacea, seaweed. Freshwater - insects, worms.	-	3	-
(c) Freshwater Ralliformes Anseriformes	Insects, worms, slugs, snails, tadpoles, fish.	- -	6	2 (x)
Podicipiditiformes Ardeiformes	(Insects, molluscs), fish, amphibia, water-voles.	-	3	-
(d) Estuarine, mudflats, arable, pasture. Charadriiformes (Laridae)	Insects, worms, mulluscs, fish, crustacea, starfish, mice, eggs, refuse, berries, grass.	3	7	3
Fam. Haematopidae S.F. Arenariinae S.F. Tringinae	Molluscs, crustacea, fish, worms, spiders, insects, ~~frogs~~, (small amount - seeds, berries).	6	9	2

TABLE B.5 continued..

Habitat	Diet	Number of species: Trematoda	Cestoda	Nematoda
(e) Marsh, arable land, woods. Chardriiformes (Scolopacidae)	Worms, insects and larvae, seeds, berries, leaves, grass.	-	6	-
S.F. vanellinae S.F. Charadriinae	Insects, molluscs, worms, spiders, crustacea, some veg.	-	1	3
(f) Terrestrial (arable land, pasture, woods, copses, parks, hedgerows). Strigiformes	Rodents, birds, frogs, fish, (insects, molluscs, worms).	-	-	1
Columbiformes Passeriformes (Sturnidae) (Passeridae)	Equal proportions: cereals, seeds, berries, fruits, nuts, grass, insects, worms, spiders, slugs, crustacea.	3	6	4
Passeriformes Fam. Corvidae	Carrion, mammals, birds, eggs, mice, molluscs, insects, worms, (cereals, fruit, seeds, grass)	5	7	3
Passeriformes (Prunellidae; Fringillidae, Alaudidae)	Seed-eaters, berries, leaves, (some insects and worms)	-	3	2
Passeriformes (Turdidae, Hirundinidae, Muscicapidae, Motacillidae, Regulidae, Troglodytidae, Certhidae, Sylvidae, Paridae.	Insect eaters. (some slugs, worms, spiders and very small amounts of vegetable matter).	6	11	2

occurring in freshwater birds.

The number of cestodes increases as the diet of the birds changes from aquatic insects to purely terrestrial insects and is at its highest in arboreal birds, such as the Paridae. The insect larvae must become infected and the cysts survive metamorphosis, to infect the birds.

2). Host species from which no helminths were recovered.

The twelve species are listed in Table B 6, together with their diet. A single *Tadorna tadorna* was examined and there are, in fact, many records of helminths in this species in Britain. The diet which is a mixture of marine and terrestrial constituents is one from which many infestations are to be expected. The bird was shot in snow in January, 1963 and the absence of helminths may be an indication of seasonal variation. The bird is rare in West Wales.

Similarly, only one *Dendrocopus major* was examined. The bird is locally common in West Wales and the diet indicates that not many helminth infections are to be expected as the principle food, wood-boring insects, are unlikely to come into contact with the droppings of other birds. The only record the writer has traced is Walker (1937 unpubl.) who found *Raillietina* spp. fragments. (Baylis, 1939 records *Z. petiolatum* and *Choanotaenia crateriformis* from the Green Woodpecker which eats wood-boring insects and ants. Ants are more suitable intermediate hosts than the insects).

The remaining birds are all passerines. A single *Oenanthe oenanthe* was dissected and the diet, almost entirely insects

TABLE 36: A list of Bird species in which no helminths were found.

Order	Species	Diet
Anseriformes	Tadorna tadorna (L.)	Marine molluscs, small crustacea; some insects small fish, worms, veg
Piciformes Family: Picidae	Dendrocopus major L. (Great spotted woodpecker)	Wood-boring insects; spiders; seeds, nuts, berries.
Passeriformes Family: Turdidae	Oenanthe oenanthe (L.) (Wheater)	Almost entirely insects
" "	Saxicola torquata (L.) (Stonechat)	Chiefly insects; some spiders and earthworms
Family: Sylvidae	Phylloscopus collybita (Vielliot) (Chiffchaff)	Chiefly insects
Family: Regulidae	Regulus regulus (L.) (Goldcrest)	Chiefly insects and spiders.
Family: Fringillidae	Chloris chloris (L.) (Greenfinch)	Seeds, berries, buds, some beetles; young partly on insects.
" "	Carduelis c.britannicus Hartert. (Goldfinch)	Chiefly seeds, some insects.
" "	Carduelis cannabina (L.) (Linnet)	Chiefly seeds (weed), some insects.
" "	Carduelis flammea (L.) (Redpoll)	Chiefly seeds, some minute insects and larvae.
" "	Pyrrhula pyrrhula (L.) (Bullfinch)	Seeds, berries, in spring buds. (trees) Young on caterpillars.
" "	Emberizia citrinella (L.) (Yellow Hammer)	Chiefly corn, seeds, berries, grass, some insects, spiders, worms

but with small quantities of molluscs, centipedes and spiders, is one from which infections are to be expected. However, the only record from these birds in Britain, is given by Williams (1956 unpubl.) who mentions an Acanthocephalan, Prosthorhynchus transversus from the E.A. Lewis collection at Aberystwyth. (Madsen, 1945, lists C. contorta, which has an oligochaeta intermediate host, as a non-British record). Saxicola torquata feeds mainly on insects but earthworms are included. There are no records for this species from Britain. Phylloscopus collybita and Regulus regulus are also insect-eaters from which there are no British records.

In contrast, the remaining species dissected, which belong to the family Fringillidae, are principally seed-eaters and the few records are mainly Capillaria spp. with direct life-cycles. Wakelin (1963 unpubl.) found C. obsignata in Chloris chloris. Evans (1938 unpubl.) also records nothing in Chloris chloris or Emberizia citrinella. Clapham (1957) found nothing in Carduelis cannabina. The Goldfinch (Carduelis carduelis britannica Hartert), the Redpoll (Carduelis flammea L.) and the Bullfinch (Pyrrhula pyrrhula (L.) appear not to have been included in previous British surveys.

SECTION C. Some ecological considerations.

Introduction

Noble and Noble (1961) wrote, "When a parasite is studied by itself, only a part, and often a small part, of its total biology can be understood". The total biology is a complex resulting from the interaction of the phylo-genetic tendencies of the parasite, the micro-environment, or the physiological condition and extent of parasitism within the host, and the macro-environment or host's external environment.

It has not been possible in a general survey to study any ecological aspect in detail. To do so it would be necessary to examine large numbers of a single host species (preferably non-migratory) over a long period so that as many features as possible of the environment are known; the diet of the species at all ages, the physiology, flight range, habits and the reaction to climatic factors would have to be studied in addition to the parasitic fauna. Physiological studies would include pH changes within the intestine and the general body temperature of the host.

For each helminth species, it would be necessary to prepare a standardised set of morphological characteristics, possibly based on computor analyses, but before computor analysis can be applied it is essential to standardise the techniques of collection and materials and methods used in preservation and study. Further staining techniques for histo-chemical differentiation must be developed. Once the morphology of a species is standardised, the specific growth rate can be determined and its variation according to dietary changes and the presence of other parasites. Finally, the range and distribution within that of the known intermediate host, should be annotated.

In default of any studies of this type, only the most generalised observations can be given here. The only birds dissected in suitable numbers were the Starling (200 plus), the Woodpigeon (34), the Great Black-backed gull (33), the Rook (21), the Herring-gull (17), the Skylark (12), the Oystercatcher (11), the Jackdaw (11), the Turnstone (9), the Lesser Black-backed gull (9), the Common Snipe (8), the Carrion Crow (8), the Manx Shearwater (8) and the Jay (8). Unfortunately, the Starling, Turnstone, Curlew and Common Snipe are winter visitors and ecological observations such as seasonal variation of parasitic fauna are inapplicable. The Skylark, although a resident, breeding bird, must be placed with this group because ten of the twelve birds were shot in part of a massive Continental migration during the cold winters of 1963 and were all negative. The remaining two birds were each parasitised by a single Capillaria spp. In contrast, the Manx Shearwater is a breeding summer visitor and for similar reasons seasonal variation cannot be stated.

The other birds listed above were examined at all seasons of the year and one or more fledglings or first-year birds were post-mortemed in addition to adults. Also all birds were taken in or near their normal breeding grounds in the summer and at points where they normally congregate at other seasons. Thus, it can be assumed that the diet was the normal one, appropriate to the season of the year and that maximum possible infestations were obtained for the species in that area. When so few of the intermediate hosts are known, the proportion they constitute in the diet cannot be estimated and the total ecology of any species remains an incomplete patchwork.

1). <u>The parasite and the micro-environment</u>.

If the parasite can establish itself and complete its development in a particular host, then the factors which most influence its relationship with the host are the host's diet, the age of the host, seasonal changes (including changes from year to year), the presence of other parasites, and the location within the host.

a). <u>The diet of the host</u>.

(i). <u>General influences</u>

The nature of the host's food influences the extent of parasitism and the type of parasites present, as was discussed above in connection with Table B 5, where definitive hosts which feed on other vertebrates are shown to be parasitised by fewer species. A fundamentally similar diet will enable a parasite with a wide range of specificity to parasitise hosts from different orders of birds. In this survey, <u>Dilepis undula</u> is recorded from both Passeriformes and Charadriiformes. Conversely, similarities of diet do not increase the range of hosts in a host-specific species such as Hymenolepis (H.) farciminosa, found only in Garrulus glandarius.

The more specialised the diet, the more restricted the number of parasitic species, because of the limitation to a particular type of intermediate host. This does not mean that intestinal chemical and physiological conditions necessarily prohibit the establishment and development of unusual parasites if their intermediate host should intermittently form part of the diet, as is shown by the recovery of Hymenolepis (H.) stylosa in Paridae in this survey. The rare infection of these insectivorous birds is obviously due to the small part that non-arthropod matter constitutes in the diet, not to any specialised chemical conditions resulting from the mainly insectivorous diet.

(ii). The effect of changes in the diet on the parasites.

Many bird species change their diet according to the season and this is especially true of the Anatidae and Charadriidae which migrate from a semi-terrestrial diet during the breeding season, to a purely aquatic diet, whether marine or fresh-water, at other times of the year. Amongst the passerines many of the omnivorous birds change to a predominantly carbohydrate rich diet of berries during the late autumn and early winter months after which the diet becomes less rich in carbohydrate than at any other period of the year, until the late Spring. These changes inevitably result in a drop in the number of species present and the extent of parasitism.

The most significant seasonal changes which can be attributed directly to a change of diet occurred in the three members of Laridae mentioned above as having been dissected in adequate numbers. Twelve species of helminth were recovered but except for the isolated infections of single Herring Gulls with single incomplete strobilae of Ophryocotyle proteus and Dilepus undula in the Decembers of 1960 and 1961 respectively, only two species, Gymnophallus delciciosus and Tetrabothrius cylindraceus were recorded in all months of the year. Even for those species there is a decline in numbers present in the winter months between the end of October and the end of February which is less strong, however, in G. deliciosus. The complete absence of the other cestodes during these months is almost certainly due to dietary influences. All three of these birds spend much of the year following the plough when the diet is restricted to terrestrial invertebrates. At no time is this mode of life maintained so consistently as in the winter months when whole colonies desert the cliff-side breeding places and roost at night in pasture. The change of diet is one which not only precludes the marine intermediate hosts so that the infestation rates are least likely to be maintained but also results in a decrease in salinity in the diet and in the intestine and these chemical changes are the most probable cause of the complete loss of established intestinal helminths such as Anomotaenia micracantha which is found in approximately 90% of the birds examined in the summer months.

The only comparable reference in the literature is Oliger (1950) who recorded destrobilization in Tetraonidae in Central Russia as the diet becomes increasingly lacking in carbohydrate during the winter months. He suggested that while the birds survive on stored fat, the tapeworms starve through lack of nourishment. A comparable destrobilization or loss through the lack of salinity in terrestrial food may be worth investigating.

b). The age of the host.

Most authorities have listed the increase in parasitic species with the age of the host but there are contradictory reports as to whether the intensity per species increases or diminishes. Where there is a subsequent change of diet, as in adult seed-eaters which include animal matter only during the nestling and fledgeling stages, an early infestation may die out altogether or be diminished in intensity. The single occurrence of Hymenolepis (H.) passeris, above, in a first-year Fringilla coelebs is a typical case of a reduced juvenile infestation persisting in an older bird.

In the gulls examined, there was invariably a greater intensity of infestation of parasites in first year birds than in older birds in all cases except the cestodes. Himasthla elongata and Parorchis pittacium were found only in juvenile birds and P. pittacium in particular is limited to the younger birds as the bursa fabricii is subsequently lost. Only G. deliciosus of the trematodes showed no age limitation and an increase in intensity of infection with age.

The highest infestation rate with <u>Seuratia puffini</u> in the Manx Shearwater, was in two young birds leaving the underground nest for the first time. The youngsters, which are fed on the regurgitated stomach contents of the adult birds, would appear to be infected both by larval stages from the semi-digested sardines and directly by dislodged adults from the stomach of the parent bird. The records of <u>Raillietina (Skrj.) bonini</u> came almost exclusively from first year Woodpigeons. The initial diet contains plenty of animal material and this is replaced by grain during the early autumn when the infestation rate began to drop. With the onset of winter, the diet in local birds is virtually restricted to acorns and the infestation died out completely. Either age or acquired immunity prevented further large infestations of Woodpigeons after their first year.

All the trematode species in the Rooks, Jackdaws and Crows occurred in the first year birds but the cestodes appeared at all ages. Conversely, <u>Capillaria resecta</u> was rare in the younger birds but in the Rooks at least it increased in intensity as the birds grew older.

c). <u>Seasonal Changes</u>.

These result not only from the change of diet and habits as discussed above, but also from cyclical changes affecting the intermediate hosts, such as hibernation. Most birds were examined in the winter months due to their status as winter visitors or from a desire to shoot outside the breeding season.

It is not possible to give figures for seasonal changes in these birds.

A distinct drop in the infestation of gulls with *G. deliciosus* was observed during the winter. Whether this is correlated with the supposed lack of salinity which was postulated for intestinal helminths, or whether it is due to some innate rhythm in the relationship of the parasite and host, it is not possible to state. *Dilepis undula* was more prevalent in the passerines during the spring and summer - a fact which cannot be related either to the hibernation of the intermediate host or to its absence from the diet during the winter. The same is true of *Hymenolepis (H.) serpentulus* and again some innate rhythm independent of the host's age or diet is postulated.

d). *The intensity of infection and the presence of other parasites.*

The intensity of infection and the presence of other parasites has been reported by many workers as causing a decrease in the size of parasites present. This has been observed during the present survey in *Sturnus vulgaris* where the presence of a large cestode such as *Dilepis undula* has resulted in small measurements both for *D. undula* itself, and in other cestodes present, for example *Aploparaksis dujardini*. The observation that it is the length and breadth of the proglottids which decrease, not the actual number, is confirmed here. The morphological changes affect only the strobila, the hook size and shape and other features of the scolex remain unchanged as does egg size and shape.

e). Change of location within the host.

Only two new locations are recorded in this survey, *Parapronocephalum symmetricum* in the small intestine of the Turnstone instead of in the bile duct and gall-bladder, and *Cyclocoelum (Hyptiasmus) elongatum* in the intestine of the Magpie instead of in the lungs and air-sacs. In each case a reduction of size was evident, but that of *Parapronocephalum* was not as extreme as that of *Cyclocoelum*. The changes in the latter case are easily understood. *Cyclocoelum* in the air-sacs inhabits a spacious cavity with small need for attachment and the ventral sucker and oral sucker are both missing. The body wall musculature is reduced as little movement is required. The region is oxygen rich and reduced muscular activity means that sufficient oxygen can diffuse in through the large surface area to satisfy the parasite's metabolic needs. Similarly, the reduced activity means that a smaller quantity of waste products need diffuse out and the surface/volume ratio is adequate.

It is believed that the parasites were coughed up and swallowed. The change to a virtually anaerobic environment has resulted in a smaller body size so that the consequent reduction in surface area (which at the lower body volume is proportionally increased) becomes sufficient for gaseous diffusion. The change to an active environment where peristalsis has to be resisted, has resulted in a reduction of the overall volume and the effectiveness of the body wall musculature in maintaining the trematode's position in the intestine, is proportionally increased. Only the ovary size and the egg size is equal to those of the trematode in the original location.

2). The parasite and the macro-environment.

a). The host's mode of life.

If the host itself is limited to a particular ecological niche, whether migratory or non-migratory, then the parasite is limited by the host's dietary requirements and by access to a suitable intermediate host. Should the host be marine, living and feeding from the sea, and only touching dry land for breeding purposes, e.g. the Manx Shearwater or the Albatross, then any parasite is limited by the necessity of a fish intermediate host, the migratory routes of which coincide with those of the hosts and which is a surface feeder.

The arboreal life of the Paridae similarly imposes a limitation in that the intermediate host must be an insect. The trematode *Leucochloridium* has adapted itself to a terrestrial host in that the sporocyst is visually attractive and the çercarial stage is eliminated.

A habit of the host such as *Anas platyrhynchos* visiting flooded pastures, makes it susceptible to parasites not normally found in other Anatidae and in this survey, *Capillaria contorta* and *Porrocaecum crassum* were recorded - species using a terrestrial oligochaete as a carrier and intermediate host respectively.

Diurnal movements of sea-birds from feeding grounds to roosting areas brings about the spread of infection and this is particularly noticeable at places like Skomer Island where many of the gulls fly daily to Milford Haven Docks and feed on discarded fish from the fishing fleet. This habit would account for the presence of infections such as *Streptocara tridentata* which is otherwise rare in British gulls and presumably utilises a vertebrate intermediate host since most records are in fish-eaters such as the Guillemots.

b). The migrations of the host

Many Russian workers have shown that migration results in a far greater variation of parasitic fauna than had previously been realised. This is most clearly demonstrated in the north-south distribution of terrestrial birds which arrive with parasites of southern origin which are incapable of infecting nestlings because of the lack of a suitable intermediate host. Nestlings and adults become infected by local parasites which are missing the following year when the birds return. There are also transitory parasites, picked up during passage. On the other hand, certain species are ubiquitous throughout the range and year, such as *Plagiorchis maculosus* in the Swallow, recorded in this survey.

Sea-birds are less affected by the north-south migratory range as is demonstrated by the occurrence of *Seuratia puffini* in the Manx Shearwater in this work. This species has previously been recorded near Japan in the Sooty Shearwater which nests in New Zealand and Southern South America. The range of the two birds overlaps in the Mid-Atlantic and the north-south migration of the sardine intermediate host and hence the distribution of the parasite is not limited to zoogeographical regions as it is in terrestrial birds, which fly from the

Paleartic to Ethiopia or the Orient and back each year.

Migration in the north temperate or Holartic is not so affected if the records of Echinostephilla virgula recorded in Britain and Eastern Siberia by Belopolskaya, in the Turnstone are accepted. (The writer's reasons for considering Skrjabinovermis vesiculata Belopolskaya 1953, a synonym of E. virgula are given in Part I, Section A above). The migration in the reverse direction has brought the first European records of Parapronocephalum symmetricum. This is of great interest because, besides demonstrating that parasites are not lost in east-west migrations in the same zoogeographical region, ringing experiments by ornithologists have not shown that the Turnstone wintering in Britain migrates beyond the Ural Mountains. This parasitological evidence, therefore, increases our knowledge of the host's habits and range.

c). The abundance of the host.

It is normally stated that the more abundant the host, the more plentiful the parasitic infections with regard to both numbers and species. Several of the more rare passerines, such as the Raven, have been examined and they are revealed to be just as strongly infected by a number of species and local dietary factors are evidently more important than the abundance of the host. Where climatic conditions bring about a massive migration of foreign birds into a locality then the possibility of alien infections among local birds is increased. Although the bird itself is considered to be a migrant, the interesting record of Viguiera euryoptera in a Blackbird in Pembrokeshire in this survey, demonstrates that provided a suitable intermediate host is present, an abundant local species such as the Blackbird could become infested by an unusual parasitic species. The parasite's range is extended as a consequence of the abundance of this host.

d). Geographical factors.

The north-south migration of the host over such barriers as the Sahara desert and Atlas mountains which separates the Paleartic from Ethiopia, or the Himalayas, which separate the Paleartic from the Orient, limits parasite spread in many instances. That an east-west migration in the same zone does not, was discussed above for the trematode in the Turnstone. A geographical barrier such as an ocean is not so effective if the bird remains in the same zone and this has induced the writer to postulate the possible introduction of *Leucochloridium* spp., from the Neartic in Section A above. The occurrence of several of the parasitic species in this survey is related to the mild winter climate and esterly location of the county, but the cooler, damper summers conversely limit summer infections of parasitic species requiring insect intermediate hosts.

The parasitic fauna is also affected by geographical or geological limitations. The small numbers of trematodes which utilize marine and freshwater molluscs has been attributed in part to a lack of lime in local waters earlier in this part of the work.

Conclusions

A knowledge of the ecological background can be of the greatest importance in understanding the biology of the individual species and must be used to supplement any taxonomic survey if the helminth species is to be correctly considered as part of a shifting, variable fauna and not part of static infections. This background can be applied more accurately to a sedentary group such as rodents but even when migratory hosts play a not inconsiderable role in any local fauna, an attempt at the estimation of ecological features as herein, cannot but add to the total conception of the species.

PART III

A Survey of the Helminths in Domestic Poultry in Pembrokeshire.

A Map illustrating the distribution of the principle farms visited is enclosed in a folder at the end of Volume II.

Poultry Managements are indicated by P (a), (b), (c), (d) and (e), according to the list on page 574, and Turkey Managements are indicated by T 1 - 8, according to Table C 13, p. 600.

Introduction

To qualify for a grant from the British Egg Marketing Board, the writer conducted a survey of domestic birds in Pembrokeshire. In a county which is predominantly agricultural, the major sources of income are derived from the early potato crop and from milk production. While many farms maintain flocks of domestic fowl of varying sizes, there are comparatively few farms of any substance which concentrate specifically on egg production or stock rearing. Those that do so are principally concerned with the Turkey (*Malaagris gallopavo* L.) and the breeding of this bird has become of significant economic importance. One farm included in the survey maintained 10,000 birds in 1960 and 40,000 birds in 1964. Such farms may also retain a shed or two of fowl but rarely more than 500. Only the small farmer and the owners of small-holdings depend much on the domestic hen (*Gallus gallus dom.* L.) and some of the latter in South Pembrokeshire house birds for a branch of the firm of Sterlings at Pentlepoir, Saundersfoot.

At the beginning of the survey, which continued from July, 1960 to December, 1963, the writer endeavoured to trace any important outbreak of helminth disease which had occurred in the County. The County Poultry Officer, Mr. J.M. Francis and the Divisional Veterinary Officer, Mr. J.E. Taylor, gave helpful advice but both stressed that helminth outbreaks were of indirect concern to animal health in the county, particularly as stock maintenance was of a high standard and ant-helmintics were regularly administered by farmers. The Veterinary Investigation Officer for South Wales, Mr.D.R.Allen, provided the following information of individual post-mortems where significant infestations were diagnosed. The number of cases for the period 1st October, 1958 to 30th September, 1959 were -

Ascariasis	15	Gizzard worm (geese)	I
Tapeworms	11	*Syngamus trachea*	I
Capillaria	3	*Acuaria spiralis*	I

The area covered was the counties of Monmouthshire, Glamorgan, Carmarthenshire and Pembrokeshire. It was evident that the proportion of serious infestations which the writer might record for Pembrokeshire would not be high.

The writer subsequently wrote to eleven Veterinary Officers in the county asking to be informed of any outbreak of helminthiasis which might have arisen in the subsequent years with particular reference to 'blackhead' in the turkey. At the end of the period under survey no information had been supplied. Finally, the writer visited the manager of Sterlings at Saundersfoot who refused both to provide information of outbreaks in the birds under his care and to allow the fowl to be included in the survey.

The results of this survey are compared with those of previous workers in the United Kingdom and two such surveys have been published since the completion of the work - Wakelin (1964) and Norton (1964). No survey of this nature has hitherto been conducted in South Wales. Most surveys are the result of laboratory post-mortems of diseased or casualty birds sent to recognised poultry research centres, the major exceptions being

Morgan and Wilson (1938), who give details of two farms 'A' and 'B', and Owen (1951) who included three categories of management in addition to autopsied birds. In general, the previous surveys have related infestation either to management - Owen (1951) and Wakelin (1964), or to seasonal incidence - Morgan and Wilson (1938) and Norton (1964). This is the first major survey, therefore, to be conducted entirely on healthy birds in their habitat and to relate seasonal variations to a specific type of management instead of to the incidence in diseased post-mortemed birds.

Methods

The survey proceeded in two distinct periods; July, 1960 to December, 1961 and January, 1962 to December, 1963. In the first period faecal samples were collected from all sources with attention given to seasonal variations but not to the type of management. In the second period selected categories of management were given more detailed consideration.

Poultry and turkeys were treated separately. This was due to the great differences in management. Whereas the turkey is consistently reared in litter, the poultry are raised under a variety of conditions and with marked variation in care and concern. To combine both sets of results would mean that the differing records for chickens would be made unacceptably more uniform by the more constant records for the turkey. The domestic fowl is dealt with in Section A and the turkey is considered in Section B. Geese, ducks and Guinea Fowl are also to be found in the county together with varieties such as the

Mandarin Duck. The numbers are not sufficient to be included in a full scale survey and the last-named birds seem to have the status of domestic pet.

The intestinal worms recorded, with the over-all total infestations for turkey and fowl during both periods are:

Heterakis gallinarum (Schrank, 1788)	73.9%
Ascaridia galli (Schrank, 1788)	35.1%
Capillaria obsignata Madsen, 1945	45.05%
Capillaria caudinflata (Molin, 1858)	2.6%

It will be observed that all are nematodes.

The method of estimation was by the examination of faecal specimens which were taken as fresh as possible before being dried by the sun or worked into litter. Because of the vast numbers, often involving several hundred birds per shed, it was possible only to collect 2 samples per 10 birds managed in the first period. From a unit housing 200 birds, 40 samples were taken. In each case a fresh intestinal and a fresh caecal sample was collected. In the second period, 2 specimens for every 5 birds were taken giving 80 samples from a unit of 200 birds. The specimens were retained individually in pieces of tin-foil or greased paper and, more rarely and less conveniently, in preserving tubes. These were stored in air-tight jars of the Kilner type prior to examination. For experimental work the warm, moist climate in the jars was found to facilitate embryonation.

To determine the effect of multiple infections, the nematode ova were estimated in numbers per gram of faeces. The method utilised was a modification of the Stoll egg counting technique suggested to the writer by Mr. P. Long of Houghton Poultry Research Station. Only a proportion of the samples were so treated and the remainder were examined by the Formol-Ether method of concentration ova and cysts as modified by Ridley and Hawgood (1956). This is the standard technique at the London School of Hygiene and Tropical Medicine. Because of day to day variability and the fact that most managements could only be visited once in each three month period, there seemed little purpose in estimating the actual numbers of eggs per gram of faeces. By using a standardised pipette so that the amount of suspension on the slide was made uniform, a rough guide to the relative rates of infestation, as opposed simply to identification of appropriate eggs, could be made by counting the numbers of eggs per slide.

In the November-December weeks, when large numbers of birds were killed, intestines and tracheae were made available to the writer by the bucketful. No attempt to count individual worms was made but there was a definite correlation between farms where a heavy infestation was predictable from the numbers of eggs concentrated on the slides and the actual recovery of large numbers of worms in the intestines. Thus a litter unit where the eggs per slide varied between 8-10 for a particular species, would yield upwards of 20 adult Ascaridia galli in the intestine, while a farm yielding 2-3 eggs per slide would rarely reveal more than 6-10 adult worms.

Litter samples were examined according to the method described by Davies and Joyner (1958) and care was taken to follow their example by selecting litter near drinking fountains where the moisture content was high and also from drier areas of the unit and beneath the perches.

SECTION A. The results of a survey on the helminth parasites of the domestic fowl (*Gallus gallus dom.* L.) in Pembrokeshire.

The total percentage infestations for both the first and second periods of survey are included in Table C 1. The absence of *Davainea proglottina* (Davaine, 1860), which was recovered by Lewis (1930) and Owen (1951), and of *Raillietina cesticus* (Molin, 1858) - also recovered by Owen (1951) - is probably due to the method of survey. The lapse between the collection of faeces and laboratory examination favoured the disintegration of any gravid proglottids present. The sieving of material through a fine wire mesh in the Formol-Ether technique also acts as an effective barrier to proglottids. The eggs of *R. cesticus* approximate in size to those of *A. galli*, and those of *D. proglottina* are slightly smaller than the eggs of *H. gallinarum*; neither were evident in any slide prepared in the survey. Wakelin (1964) stresses the absence of trematodes and cestodes, both of which require intermediate hosts, from birds maintained under intensive conditions. They might be expected from range and other types of management, however. Strobila were not recovered in the Christmas months when whole intestines were available.

Trematodes are comparatively rare in fowl in the United Kingdom - a fact not indicated by the lists of species in the

TABLE C I Records of Intestinal Helminths in Adult Domestic Fowl in the United Kingdom.

Country	Date.	Author	State of health	No. Birds	% In-fected	Ascardia galli	Capillaria anatis	Capillaria caudinflata	Capillaria obsignata	Trichostron-gylus tenuis	Heterakis gallinarum	Raillietina cesticus	Davaninea proglottina
Wales	1930	Lewis	mixed	78	-	2.6%	←	7.7%	→	-	91.0%	-	2.6%
Scotland	1933	Foggie	diseased	22	-	-	22.7%	-	36.4%	4.5%	85.0%	-	-
Scotland	1938	Morgan & Wilson	General Survey diseased	1113	-	11.1%	4.6%	36.7%	8.4%	0.01%	82.3%	0.006%	14.9%
			Farm A Healthy	170	-	30.6%	←	50.0%	→	-	97.1%	-	28.8%
			Farm B diseased	285	-	9.8%	←	69.1%	→	-	73.0%	-	17.9%
Scotland	1939	Morgan & Wilson	diseased	230	-	27.4%	←	53.3%	→	-	86.6%	-	33.5%
Wales	1951	Owen	mixed	267	91.0	27.0%	31.1%	41.2%	2.6%	3.0%	88.8%	0.4%	21.4%
Southern England	1961	Min. of Agr. Rep	diseased	-	-	-	-	23.3%	44.0%	-	-	-	-
-	1964	Wakelin	diseased	289	69.2	33.6%	10.4%	15.9%	45.3%	-	60.9%	-	0.7%
Southern England	1964	Norton	diseased	356	80.8	40.0%	9.8%	21.5%	44.9%	1.1%	77.0%	-	2.0%
Wales	1965	Writer	healthy	-	96.0%	47.2%	-	0.2%	53.1%	-	91.8%	-	-

standard text-books. Morgan & Wilson (1938) tentatively identified a single specimen of *Plagiorchis* sp., Owen (1951) found two specimens of *Brachylaemus* sp. in an adult fowl and two *Notocotylus attenuatus* (Rudolphi, 1809) in a fowl. Wakelin (1964) encountered none but Norton (1964) recovered assorted specimens and was unable to give any identification because of the poor state of preservation. Other than Owen, the only record for Wales is that of Horton-Smith and Long (1954) who recorded *Plagiorchis notabilis* Nicoll, 1909 in the intestine of a fowl.

Discussion

a): The general incidence of intestinal nematodes.

The incidence for both the first and second periods is shown in Table C 1. Table C 2 shows the incidence and seasonal variation in the first period (July, 1960 - December, 1961) and Table C 3 the incidence in specific managements in the second period (January, 1962 - December, 1963). The percentages in Table C 2 are rather higher than those of Table C 3 for reasons to be considered under c): 'The effect of the environment' and d): 'The seasonal variation' below.

All percentages are higher than those of previous workers shown in Table C 1 with the exception of *H. gallinarum* (91.8%) which is lower than the figure of Morgan & Wilson (1938) for their Farm 'A'.(97.1%). These higher percentages reflect the influence on parasite propagation of the more intensive forms of management which have more constant environmental conditions.

In Czechkoslovakia, Birova-Volosinovicova (1963) found 82.2% of the fowl infested with *H. gallinarum* and 47.2% infested

TABLE C 2 The % incidence and seasonal variation in the Intestinal Nematodes of the Adult Domestic Fowl.

(Period I - July 1960 - December 19161)

	Heterakis gallinarum		*Ascaridia galli*		*Capillaria obsignata*		Temperature	Rainfall
	% Infected	Average No. eggs per slide.	% Infected	Average No. eggs per slide.	% Infected	Average No. eggs per slide.	Inches diff. from Average	% diff. from Average.
Jan. - March	90.5	1 - 2	47.3	1 - 2	52.2	1 - 2	+ 1.26	82
Apr. - June	97.1	2 - 3	53.1	3 - 4	63.5	5 - 6	+ 1.0	140
July - Sept.	92.3	4 - 5	49.5	3 - 4	54.5	4 - 5	+ 0.6	122
Oct. - Dec.	94.5	2 - 3	48.1	1 - 2	58.2	2 - 3	- 2.15	114
Total % Average Infestation.	93.6	-	49.5	-	57.1	-	-	-

with *A. galli* while Denev (1960) in U.S.S.R. records a range of 39.6-96.4% infestation with A. galli and only 32.8-64.8% infestation with *H. gallinarum*.

With regard to *H. gallinarum*, the sources of Lewis (1930) birds (91.0%) are not disclosed but from the introductory notes would appear to derive from both diseased carcases and carcases sent to butchers. The next highest percentage, 88.8%, that of Owen (1951) is derived from various sources and reference to his Table VI (p. 119) shows that the very highest percentages, 95.9% and 92.9%, are found in healthy birds reared under different categories of management. (Sources 'B' and 'C'). Both percentages are higher than those of his source 'D' which were diseased birds (91.2%). Thus for *H. gallinarum*, a heavier worm burden is supported by healthy birds as stated by Morgan & Wilson (1938).

The health of the birds also influences the incidence of *Ascaridia galli*. Morgan & Wilson (1938) found 30.6% of the healthy birds were infected at Farm 'A' and only 27.4% of the diseased birds were infected in their survey in 1939. Owen (1951) found that 50.0% of the healthy birds at Source 'B' were infested whereas the diseased and casualty birds autopsied at source 'D' revealed 17.9% infestation.

The relation of disease to infestation is not so clear for *Capillaria obsignata*. Morgan & Wilson (1938) record a higher percentage infestation of *Capillaria* spp. amongst diseased birds at Farm 'B' (69.1%) than amongst healthy birds at Farm 'A' (50.0%). These percentages cannot be considered

It is larger than that of C. obsignata and could not have been mistaken had it occurred in the faecal specimens. The single occurrence of C. caudinflata in the faeces and straw litter of a group of birds under intensive management is even more problematic since an intermediate host is essential. The age of the birds at the establishment concerned was six months to one year. The birds had been raised on grass and subsequently transferred to litter. Infection must have occurred prior to transference. The increasing scarcity of eggs in the faeces suggested that the infection was dying out and the necessity for an intermediate host eliminated the possibility of re-infection within the unit. This compares with Wakelin (1964) finding helminths in battery birds.

It is concluded from the higher incidence of all nematodes in this survey that previous surveys utilising post-mortems birds do not reflect the percentages actually obtaining under normal conditions or even from the managements from which the diseased birds have been taken. Norton (1964) states that 'the results obtained by Morgan & Wilson (1938, 1939) and Owen (1951) who included both healthy and diseased birds in their surveys suggest that diseased birds do not necessarily carry heavier or lighter infections than healthy birds.' The writer has quoted from both surveys extensively above to show that Norton's analysis is incorrect (with the possible exception of C. obsignata) for the species in this text, and disputes Norton's conclusion, 'It follows therefore that the examination of diseased birds can be expected to give a valid guide to the as significant as those for *Heterakis* and *Ascaridia*, however, since they include *C. anatis* (Schrank, 1788) and *C. caudinflata* (Molin, 1858). It has been established by Moorehouse (1944) that *C. caudinflata* requires an intermediate host and Wakelin (1964) quotes unpublished evidence that *C. anatis* also requires an intermediate host. This being so, then the relative percentages on the respective farms surveyed by Morgan & Wilson (1938) depend more on the availability of the intermediate hosts than on the health of the final host. Differences in soil acidity and access to the intermediate hosts must be taken into consideration before these percentages carry the validity of those for nematodes with a direct life cycle. Owen (1951) shows quite clearly a higher percentage infestation with *obsignata* from diseased birds (Source 'D' - 8.8%) than from healthy birds (Source 'C' - 2.5%). As both sources represent a variety of farms in mid-Wales, diseased birds may well be more susceptible to *obsignata*.

The higher percentages of the writer reflect the increase in infestation of birds under intensive managements with *obsignata* first noted by Wakelin (1964) and further confirmed by Norton (1964). This can be attributed to the direct life cycle and a formerly uncommon nematode now occurs more frequently than *A. galli* in the domestic fowl.

The absence of *C. anatis* (Schrank, 1788) in range and other birds cannot be satisfactorily explained. The writer is familar with the very characteristic shape of the egg as a result of experimental work to be described in Part IV.

TABLE C 3 The % incidence of Intestinal Nematodes of the adult domestic fowl related to different catogories of management.

		Heterakis gallinarum		*Ascaridia galli*		*Capillaria obsignata*	
Elce	Other authors	Elce	Others	Elce	Others	Elce	Others
(a) Intensive - (i) litter - straw	Wakelin - Category III	96.9	76.0	61.5	48.0	61.8	56.0
(ii) litter - non-straw (peat, moss, bracken)	Wakelin - Category II	74.8	57.9	35.8	31.6	48.1	45.6
(iii) permanent grass pens	Owen - Source 'B'	96.2	95.5	50.0	50.0	55.9	-
(b) Semi-Intensive - litter and grass run	Wakelin - Category IV	95.3	91.7	58.7	75.9	59.8	58.3
(c) Range - grass only	Wakelin - Category V	92.8	77.1	53.6	27.1	56.3	45.7
	Owen - Source 'A'	-	80.2	-	20.9	-	-
(d) Small holdings/General Farms - run of yards and out-houses	Owen - Source 'C'	89.6	92.9	29.8	19.0	31.8	2.5
(e) Private Houses - semi-permanent runs and/or coops	-	84.4	-	24.9	-	30.0	-
Total % Infestation		90.0	-	44.9	-	49.1	-

incidence of nematode infestation.' Morgan & Wilson (1939) showed that incidence of infestation varies considerably according to the particular disease but is usually less than in healthy birds.

b): The age of the host.

The writer has followed Owen (1951) in considering all birds of more than three months to be adult, but to determine the establishment of an age immunity, four age groups were utilised as shown in Table C 5. Since the work of Herrick (1926), Ackert and Herrick (1928), Ackert, Porter and Beach (1935) and Kerr (1955) on *Ascaridia galli*, the development of an age immunity towards intestinal nematodes has always been assumed. An age immunity is claimed in *H. gallinarum* by Deo and Srivastava (1962) who reinfected chickens aged 7 weeks, 3 weeks after the primary infection. Fewer worms were recovered from the secondary infection. Only Wakelin (1964) quotes unpublished evidence for an immunity in *C. obsignata*.

Morgan & Wilson (1938) seem unable to interpret their own results: on p. 168 they ascribe the light infection (11.1%) to the diseased birds of the general survey being over six months, in agreement with Ackert and Herrick (1928), but in the table on p. 170 they show 30.6% infestation with *A. galli* in 170 healthy young cockerells killed for the market. This differences in percentage infestation suggests that the lower figure derives from the presence of disease and not from any age immunity. Their 1939 paper gives a higher percentage infestation in diseased birds, 27.4%, but this is still less than in the healthy birds of the previous year. The percentage for 1939 comes from birds in which 'the majority of deaths occurred between the ages of 10-16 months' so that an age immunity is not indicated.

The first contradictory evidence to an age immunity for _A. galli_ and _H. gallinarum_ is provided by Owen (1951) and is shown with similar results for _C. obsignata_ by Wakelin (1964) in the Table. Owen records _C. obsignata_ in older birds only from his Source 'D' (diseased and casualty birds) so that age immunity cannot be inferred from his figures.

Wakelin does not account for the discrepancy between his unpublished and published work, but suggests that the low percentages in birds of 4-10 weeks is a consequence of the higher standards of management for birds of this age and for the shorter time available for contact with parasites. This partially explains the writer's low percentages for the same age-group but special care must be taken in the interpretation of these figures. The method for the present survey is such that only the presence of mature females is indicated. _A. galli_ takes 50 days to mature (Ackert, 1937), _H. gallinarum_ takes at least 24 days (Clapham, 1933) and _C. obsignata_ takes 21 days (Levine, 1938). It follows that the writer's figures do not indicate the actual worm burden for the younger birds which will include numerous larval stages. The general increase in infestation with age shown by the writer's figures, corresponds with the increasing number of mature worms present and is similar to the results of Owen and Wakelin.

An interesting feature of the writer's method of survey is, that while the number of infected birds increases, the average number of eggs per slide remains substantially the same or may be less in the older birds. This decline in egg production is interpreted by the writer not to indicate an age immunity, but to either an acquired immunity or to the presence of multiple infections, where fewer eggs for each species is produced as the number of species per bird increases. (See Table C 10 and the discussion under g): 'The effects of multiple infections' below).

The presence of an age immunity in domestic fowl is not easily solved but the contradictory evidence may well be due to the conditions of rearing. The authors whose results indicate the lack of an age immunity all drew upon birds living under normal field conditions, with the attendant hazards of multiple infections, disease and good, bad and indifferent management. The authors whose work provides evidence of an age immunity have, for the most part, utilised birds living under experimental conditions. There are many papers by workers on poultry helminths where the great differences in percentage between laboratory infections and those under natural conditions are emphasised. Clapham (1934) found that 'it seems impossible to build up heavy infestations of _H. gallinarum_' and Morgan & Wilson (1939) conclude 'it seems evident that fowls under natural conditions are exposed to some factor or factors which tend to break down this partial immunity to heavy infestations which is so marked in experimental birds.'

In these statements would appear to be one reason for the supposed 'age immunity' of earlier workers and Kerr (1955). Under field conditions certain factors must be present which counteract the effect of age experienced under laboratory conditions. Alternately, 'age immunity' may be an "acquired immunity", irrelevant to age, such as was demonstrated by Shikhabolova (1959) where successive infections with H. gallinarum showed a reduction in the number of worms, retarded development and smaller average size. Super-infections intensified the immune reaction not only to the second infection but to the first also. Vatne (1963) has described the development of a strong immunity in chickens to H. gallinarum and it appears that the results of Deo and Srivastava (1962) should be interpreted as an acquired and not an age immunity.

These examples of acquired immunity were induced under experimental conditions and may be less marked in the field where other factors would be present. A small acquired immunity is not incompatible with the general increase in infestation with age described by Wakelin, Owen and the writer if it serves to keep the overall infestation within limits which do not weaken the bird.

c): The environment of the host.

In the second period of survey (January, 1962 - December, 1963) when the habitat was specifically considered, the writer recognised seven categories of management which can be related to those of previous workers as in Table C 3. Two establishments were selected for each of categories a), (i), (ii), b) and c); and two and ten establishments for d) and e) respectively. Only one small-holding fell into category a), (iii) and the owner has since stopped rearing fowl. Reference to Table C 3 shows higher percentages for most categories and especially for Heterakis. This is due to the criteria used in selecting the units for the second period. Managements which were infested with all three species were selected and from these, managements in which the percentages approximated to those for each nematode in the first period were given detailed treatment for the seasonal variation. Establishments with only one or two species showed quite different percentages, and were usually much lower than when all three species were present but with a higher egg count. Thus where Heterakis alone was present the highest infestation was 66.8%, but there were up to eight ova on the slides, - Category b).- semi-intensive. Where Ascaridia alone was present the highest percentage was 42.3%, Category a).(iii) - permanent grass pens, and where only C. obsignata occurred, the highest percentage was 45.8%, Category a). (i) - straw-litter.

The principle farms visited are indicated on the map. Not infrequently a farm would have more than one type of management, a factor of great value in correlating infection rates under the same conditions of climate, food, etc. Where this occurred birds of up to 3-6 months were housed in grass pens or semi-intensive conditions and later transferred to litter at the commencement of egg-laying. The single record of C. caudinflata occurred at such a farm.

Two faecal specimens were collected for every five birds, a caecal and an intestinal. In terms of management, the total number of birds housed and the total number of specimens taken at random were as follows:-

Management	Total no. Birds.	No. of Samples
a). Intensive		
(i). litter - straw.	1,000	400
(ii). litter - non-straw	800	320
(iii) permanent grass pens	200	80
b). Semi-intensive litter & grass run	1,000	400
c). Range - grass only	900	360
d). Small-holdings/General farms	870	348
e). Private houses - coops, semi-permanent runs or permanent runs	150	60

Had it been possible to take a greater number of specimens at more frequent intervals from all the establishments in each category, different results might have been obtained. While no details were recorded in the first period, a great deal of variability was noted and for each category there were establishments with a high level of infestation for each species and others with a low. Categories a). (iii), b). and c)., always showed infestations with all three species and these varied between a low and a medium rate of infestation with an average number of eggs per slide, i.e. chronic infestations at a low level. The intensive categories with litter a). (i) and (ii) showed much greater variability with either a very low rate of infestation and only a few eggs per slide or, in others equally well managed, a high level of infestation and number of eggs per slide. Categories d). and e). consistently yielded the lowest percentage but often with high egg counts which suggests that individual variability is more marked in managements where less attention is given to the rearint of the fowl.

The trends established by Owen (1951) and Wakelin (1964) are seen to be borne out by the writer's results. Thus a higher level of infestation obtains in the intensive systems for *A. galli* and *C. obsignata* especially in Category b)., where a litter and run are combined. The level of infestation for *H. gallinarum* is rather lower in a). (ii) than in the other intensive categories due to the fact that peat moss does not provide ideal conditions for embryonation.

d): The seasonal incidence of intestinal nematodes in domestic fowl.

Each year was divided into four sections and the results are listed against January to March, April to June, July to September and October to December. For each three month period, the appropriate records for Pembrokeshire published in the Monthly Weather Report of the Meteriological Office have been obtained. The temperatures are listed as maximum, minimum and difference from the average derived from a thirty-year period. The published results for 1960, 1961 and 1962 relate to the period 1921-1950 and those for 1963 to 1931-1960. Because the years 1962 and 1963 form part of a continuous survey, the writer has, in this text, adapted the temperatures for 1962 to correspond to the period 1931-1960. The temperatures for 1960 are recorded in Fahrenheit and the remainder are in Centigrade. It has been necessary to alter the temperature of 1960 to Centigrade to correspond to the remainder of the survey.

Rainfall is recorded as number of inches and the difference from the average for a thirty-year period. Again the writer has related the figures for 1962 to the period 1931-1960 to correspond with the figures for 1963. There are four weather stations in Pembrokeshire, three on the West coast - Brawdy, Dale and Milford Haven and one in the county centre at Haverfordwest. It is considered that Haverfordwest results are more appropriate for the mass of the county. There are no records for hours of bright sunlight available from the Haverfordwest station but this is not considered significant since there is no evidence that direct sunlight in any way influences the embryonation of nematode eggs. The general stimulus of heat is available under overcast skies and is perhaps more constant in litter which frequently receives little sun. Certainly there is no feasible reason to suspect any advantage obtaining from direct sunlight such as the 'hatching' mechanism for Fasciola hepatica, Linnaeus, 1758.

The variations in temperature and rainfall for the entire period are given in Table C 4. The tendency for cool summers under the influence of the gulf-stream, heavy thunderstorms and gales in the summer months is evident from the figures.

TABLE C 4. A summary of weather conditions in central Pembrokeshire from July, 1960 to December, 1963.

Period	Actual Av. Temperature	Diff. from Av. temp.	Actual ins. Rainfall	% Diff. from Av. rainfall
1960 July - Sept.	14.7°C	+ 0.5	5.17	136
Oct. - Dec.	7.9°C	- 1.9	7.12	134
1961 Jan. - Mar.	7.0°C	+ 1.26	3.59	82
Apr. - June	11.9°C	+ 1.0	3.46	140
July - Sept.	14.9°C	+ 0.7	4.15	108
Oct. - Dec.	7.4°C	- 2.4	4.92	94
1962 Jan. - Mar.	5.06°C	- 0.54	3.50	89
Apr. - June	10.4°C	- 0.8	2.44	98
July - Sept.	10.6°C	- 4.6	4.60	121
Oct. - Dec.	7.3°C	- 1.0	3.33	63
1963 Jan. - Mar.	5.2°C	- 0.4	2.79	70
Apr. - June	10.8°C	- 0.4	2.96	120
July - Sept.	14.2°C	- 1.0	2.72	71
Oct. - Dec.	8.4°C	+ 0.1	4.87	93

(i) First Period (July, 1960 - December, 1961)

Because of the overlap of years, it has been necessary to average the temperature and rainfall figures shown for July-September and October-December in Table C 4 and Table C 2. The temperature for July-September was above average in both years while those for October-December were less in each year. December, 1961 was the coldest Christmas of the century and took the average for both years well below normal. The temperature for October was above the thirty-year average for seven years in succession, 1957-1963. The rainfall for the July-September period was above average in both years but November and December, 1961 were below normal.

The total infestation for respective species in the first period is higher than those for the second period. (Compare Tables C 2 and 3). This is due partly to the effect of the above average temperatures and partly to the effect of combining the various systems of management in the same results for the first period so that some variation is eliminated. The average number of eggs per slide is also higher than in the second period.

The incidence for the various species recorded by Morgan & Wilson (1938) and Norton (1964) are compared with those of the writer in Table C 6. There is a report of seasonal variation for *H. gallinarum* in domestic fowl in Russia (Savchenko, 1959). A monthly record was kept of the incidence in ten hens. The lowest figure occurred in January-March, then there was a gradual rise in level to July and August after which the

TABLE C 5 The % incidence of Intestinal Nematodes of the Domestic Fowl at various ages.

Age.	*Heterakis gallinarum*			*Ascardia galli*			*Capillaria obsignata*		
	Elce	Owen (1951)	Wakelin (1964)	Elce	Owen (1951)	Wakelin (1964)	Elce	Owen (1951)	Wakelin (1964)
3 - 12 weeks	12.1	46.1	29.8	3.9	7.6	21.3	5.8	11.5	21.3
12 weeks to 6 months	20.3	83.2	62.0	16.2	21.7	27.3	29.3	-	43.8
6 months to 1 year	49.8	-	71.7	35.6	-	45.3	36.0	-	55.7
1 year to 3 years	61.2	98.2	73.7	39.8	57.3	40.0	43.1	-	60.0

TABLE C 6 The % seasonal incidence of Intestinal Nematodes (Period I - July, 1960 to December 1961) compared with the results of previous workers.

Period	*Heterakis gallinarum*			*Ascaridia galli*			*Capillaria obsignata*		
	Elce	Norton (1964)	Morgan & Wilson (1938)	Elce	Norton (1964)	Morgan & Wilson (1938)	Elce	Norton (1964)	Morgan & Wilson (1938)
Jan. - March	90.5	69.0	72.2	47.3	45.0	"No marked seasonal variation observed."	52.2	42.0	28.8 x
April - June	97.1	83.0	82.3 (April - Sept.)	53.1	42.0		63.5	49.0	54.3 x
July - Sept.	92.3	80.0		49.5	30.0		54.5	43.0	-
Oct. - Dec.	94.5	75.0	90.5	48.1	46.0		58.2	46.0	58.1 October x
Total % Infestation	93.6	-	-	49.5	-	-	57.1	-	-

x - **Footnote**: Morgan & Wilson (1938) record seasonal incidence for Capillaria spp. not specifically obsignata.

percentage burden gradually fell until December. This is the accepted pattern in traditional methods of management. Birova-Volosinovicova (1963), however, records the highest incidence in winter and spring months, a trend also observed by Norton (1964) for *A. galli*. Morgan & Wilson (1938) and the writer both found an equally high level in the October-December periods and the percentages for January-March in this survey were not much lower than those of the summer months.

The higher figures in this survey for the cooler months of the year can be attributed to the exceptionally high rate of embryonation occurring in the warm, wet summer. This would give a strong incidence of secondary infections in the warm September and October months which is evidently maintained through the winter in the birds. The fowl in litter benefit from this external warmth and litter conditions are such that further small infections can occur in the winter months when the climatic conditions lower the incidence in birds under non-intensive systems of management. As a result the average percentages for January-March is higher than previously recorded in the United Kingdom. In the second period, this is more clearly demonstrated.

Norton (1964) records the highest incidence in *A. galli* in the January-March and October-December months, while Morgan & Wilson (1938) state, 'no marked seasonal variation.' A small seasonal variation is indicated by the writer but again the conditions obtaining in straw litters raise the incidence in colder months above that which might be expected. Birova-Volosinovicova (1963) like the writer found the highest infections in the late spring.

The same pattern of infestation is recorded by the writer for C. obsignata. Morgan & Wilson (1938) state that the highest period of infestation is in the April-June months with a gradual decrease towards the early months of the following year. In October, they recorded an exceptionally high percentage infection.

This sudden increase in infection rate in October is a consequence of secondary infections. It is seen in Norton's figures for July-September which fall below those of April-June only to rise again in October-December, and in the work of Birova-Volosinovicova in Czechoslovakia, who noted two peaks of infection per year in May and in September. After a warm summer like that of 1961 this is very evident and is seen in the intensive systems in the second period of survey despite the cold wet summers of 1962 and 1963. The high rates of infection for A. galli in the period October-March recorded by Norton (1964) reflect the trend in the intensive systems where the worm burden is maintained at a high level throughout the winter.

(ii) Second Period (January, 1962-December, 1963)

The percentage incidence for the various categories of management is shown in Table C 3. During the two year survey the temperature was above the average for the thirty-year period, 1931-1960, for six months only. These were January, 1962 (0.1°C above), February, 1962 (0.6°C above), October, 1962 (0.2°C above), June, 1963 (0.5°C above), October, 1963 (0.8°C above) and November, 1963 (1.5°C above). While the temperatures for January and February, 1962 cannot be thought relevant to any seasonal variation in the non-intensive systems, the warmer June, October and November months would appear to assist in promoting primary and secondary infections in the respective years. The warm temperatures of January and February were counteracted by heavy falls of snow and sleet on several days, while January and February, 1963 were the coldest of the century other than 1947. Birova-Volosinovicova (1963) demonstrated the ability of nematode ova to survive under snow.

The rainfall varied considerably, the extremes being January, 1963 (18.0%) and March, 1963 (183.0%). The months April-September, 1962 had above average rainfall and then a relatively dry period followed from October, 1962 (39.0%) to February, 1963 (55.0%). July-October, 1963 was also a period of below average rainfall. Except in drought, it is questionable whether rainfall is as significant in embryonation as temperature. Even in hot months, there is always some rainfall and often excessive dew. Inevitably there is moisture in the micro-climate around the drinking vessels even if the remainder of a yard or run is dry. The greater importance of temperature in hastening embryonation is shown by the work of Osipov (1958) for the months of May and July, when general humidity was the same. The experiment concerned the rate of embryonation of _H. gallinarum_ ova on the ground in central U.S.S.R.

Months	Temp.	Humidity	Embryonation
May	10.7 C	70%	37-44 days
June	21.2 C	60%	16-24 days
July	15.6 C	70%	20-26 days
August	14.8 C	81%	23-30 days

TABLE C 7 The % seasonal incidence of *Heterakis gallinarum* in Pembrokeshire (January 1962 - December 1963) related to different categories of management.

Period	(a) Litter - straw (i)		(a) Litter - non-straw (ii)		(a) Permanent grass pens (iii)		(b) Semi-intensive - litter & grass runs	
	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.
Jan. - March	96.6	3 - 4	75.1	3 - 4	96.0	2 - 3	95.1	3 - 4
April - June	99.1	5 - 6	76.8	4 - 5	99.3	5 - 6	98.0	5 - 6
July - Sept.	93.8	3 - 4	72.0	2 - 3	92.0	2 - 3	92.0	4 - 5
Oct. - Dec.	98.1	4 - 5	75.7	3 - 4	97.5	2 - 3	96.1	4 - 5
Total % Infestation.	96.9	-	74.8	-	96.2	-	95.3	-

Period	(c) Range - grass only.		(d) Small-holdings & General Farms.		(e) Private Houses	
	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.
Jan. - March	93.5	3 - 4	90.5	3 - 4	85.1	2 - 3
April - June	99.2	6 - 8	97.9	6 - 8	95.8	6 - 7
July - Sept.	82.9	2 - 3	75.7	3 - 4	69.1	3 - 4
Oct. - Dec.	95.6	3 - 4	94.3	4 - 5	87.6	3 - 5
Total % Infestation.	92.8	-	89.6	-	84.4	-

Because of the consecutive colder summers of 1962 and 1963, it is regretted that the work could not be extended to include 1964, when their effect on the incidence of nematodes in the fowl maintained in the non-intensive units, could have been studied.

The incidence of Heterakis is shown in Table C 7. All managements showed two peaks of infestation; one in the spring and a second in the autumn with a drop during the later summer months. The intensive categories showed less variation than the non-intensive, the seasonal variation being in a). (i) - 5.6%, a). (ii) - 4.8%; Category a). (iii) showed greater variation, 7.3%, as can be expected in the greater susceptibility to climatic changes in permanent grass runs. Of the free-range birds, c). showed only 6.3% but d). showed 22.2% and e). 27.7% variation respectively. The influence of climate is clear and must be attributed to the effect of temperature on embryonation rate. Thus the cool, wet summers of July-September, 1961 and 1962 depressed the embryonation for the following year in the non-intensive systems, but the warmer Octobers slightly increased the embryonation rate during the winter months. Both units a). (iii) and c). possessed coops with perches. These were cleaned regularly but evidently the intensity of infection was such that sufficient ova could embryonate in the warmer confines despite external conditions. The influence of the cooler summers is more clearly revealed by the variations in the numbers of eggs per slide. Thus in a). (iii) and the non-intensive units, the second peak showed

TABLE C 8 The % seasonal incidence of *Ascaridia galli* in Pembrokeshire (January 1962 - December 1963) related to different categories of management

Period	(a) Litter - straw (i)		(a) Litter - non-straw (ii)		(a) Permanent grass pens (iii)		(b) Semi-intensive - litter & grass runs	
	%	Av. No. of eggs per slide.	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide
Jan. - March	61.3	4 - 5	35.2	4 - 5	51.0	2 - 3	55.6	4 - 5
April - June	62.3	6 - 8	37.3	6 - 8	57.2	7 - 8	62.4	6 - 8
July - Sept.	60.5	3 - 4	34.8	4 - 5	43.1	2 - 3	54.7	3 - 4
Oct. - Dec.	61.9	4 - 6	36.2	4 - 6	48.9	2 - 3	59.1	4 - 5
Total % Infestation.	61.5	-	35.8	-	50.0	-	58.7	-

Period	(c) Range - grass only		(d) Small-holdings & General Farms.		(e) Private Houses	
	%	Av. no. of eggs per slide	%	Av. no. of eggs per slide	%	Av. no. of eggs per slide
Jan. - March	49.6	2 - 3	33.9	2 - 3	25.2	1 - 3
April - June	63.6	6 - 7	38.3	5 - 6	30.1	5 - 6
July - Sept.	49.3	1 - 3	19.9	1 - 2	19.8	1 - 2
Oct. - Dec.	51.9	2 - 3	27.1	1 - 3	23.8	1 - 2
Total % Infestation.	53.6	-	29.8	-	24.9	-

a much smaller egg count even though the percentage infestation of the fowl rose.

The percentage infestation with Ascaridia is shown in Table C 8. Categories a). (i), a). (ii), and b). showed the usual twice yearly peaks, with a seasonal variation of 1.8%, 2.5% and 7.3% respectively. The remaining categories showed a depression after the summer months from which the percentage gradually increased until the spring. This accords with Morgan & Wilson (1938) and Birova-Volosinovicova (1963) for H. gallinarum and Birova-Volosinovicova (1963) for A. galli. It is evident from the writer's results that, in the non-intensive managements, A. galli is more sensitive to climatic conditions than is H. gallinarum. This can be attributed to the embryonation rate, Birova-Volosinovicova having demonstrated that at 15oC, H. gallinarum embryonates in 72-75 days while H. galli takes up to 100 days. The cool, wet summers will slow down the ambryonation rate of Ascaridia so that a second peak is not evident in the non-intensive units, and the warm October months instead contribute to a slow build up in infestation until the following spring. The seasonal variation for Categories a). (iii), c)., d). and e), were 14.1%, 14.3%, 18.4% and 10.3% respectively.

In the intensive units, the average number of eggs per slide showed peaks identical with those of the infestation rates. In a). (iii) and the non-intensive systems, the average number of eggs remained at a low level, even when the actual infestation rate increased. Thus the worm burden remained low due to the influence of cool summers on embryonation.

TABLE C 9 The % seasonal incidence of *Capillaria obsignata* in Pembrokeshire (January 1962 - December 1963) related to different categories of management.

Period	(a) Litter - straw (i)		(a) Litter - non-straw (ii)		(a) Permanent grass pens (iii)		(b) Semi-intensive - litter & grass runs	
	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide.
Jan. - March	61.9	4 - 5	47.9	4 - 5	57.1	2 - 3	59.4	4 - 5
April - June	63.1	5 - 7	51.5	4 - 5	60.1	5 - 6	62.0	6 - 8
July - Sept.	59.3	4 - 5	45.0	2 - 3	51.6	1 - 3	56.3	5 - 6
Oct. - Dec.	61.9	5 - 6	48.9	4 - 5	54.8	2 - 3	61.5	6 - 7
Total % Infestation.	61.8	-	48.1	-	55.9	-	59.8	-

Period	(c) Range - grass only		(d) Small-holdings & General Farms.		(e) Private Houses	
	%	Av. No. of eggs per slide.	%	Av. no. of eggs per slide.	%	Av. no. of eggs per slide
Jan. - March	57.1	3 - 4	32.3	2 - 3	31.2	2 - 3
April - June	62.1	6 - 7	39.5	7 - 8	39.5	4 - 6
July - Sept.	50.7	2 - 3	25.5	2 - 3	20.8	1 - 3
Oct. - Dec.	55.3	2 - 3	29.9	2 - 3	28.5	2 - 3
Total % Infestation.	56.3	-	31.8	-	30.0	-

The seasonal variation of *Capillaria obsignata* (Table C 9) is similar to that of *A. galli*, with a twice yearly peak in the intensive units and a single peak infestation in the spring, in the non-intensive managements. The least variation is seen in *a). (i)*, - 3.7%, and the greatest in *e)*. - 18.7%. The egg counts also followed the pattern demonstrated for *A. galli*.

e): *The pathogenicity of intestinal nematodes.*

From the farms visited in both the first and second periods, information was requested of any birds dying under conditions which indicated that death was due to heavy helminthic infections. No cases occurred although there were deaths from fowl pest, birds becoming 'egg-bound' and other miscellaneous causes. The pathogenicity of intestinal nematodes, even in heavy infections, is considered to be doubtful by the writer. This contrasts strongly with the often quoted Report of of Poultry Technical Committee for Great Britain (1938) which stated that worm infestation is one of the three most frequently diagnosed causes of death. There are few records where death is attributed solely to the nematodes occurring in this survey under natural conditions. In elucidating the survey life cycle of *C. obsignata*, Levine (1938) was able to cause death by massive experimental infections but in the field various factors work against such super-infections.

The only pathogenic nematode of poultry is *Syngamus trachea* (Montagu, 1811), the absence of which in the report of Owen (1951) and in the present survey, indicates that this species is of little significance in South Wales. The single case in South Wales quoted in Dr. Allen's letter in the introduction above was not stated as the cause of death. In the Christmas months, when the tracheae of large numbers of birds were available to the writer, not a single infection was recovered from any system of management. As mentioned in Part I, Section C, it was not recovered from any of the migratory starlings and it is a parasite of minimal importance in the local Corvidae.

f): The conditions for the establishment of chronic infections.

In the absence of any fatal infections, the intensive systems, even on well managed establishments, appear ideal for the persistence of an infection at a high level of intensity and the more constant percentages devoid of much seasonal variation is found in these units. (See Tables C 7, 8, 9). This is especially true of the nematodes which do not require an intermediate host and reference to Table C 2 for the adult domestic fowl bears out the statements of Wakelin (1964) concerning the increase in infestation rates of these nematodes, especially for *C. obsignata*. Chronic infections of either a high or low intensity both show two seasonal peaks of infestation in the intensive units and egg counts are uniformly high. Infections are less persistent in peat moss and bracken litters than in straw.

Dampness through leakage of the roof or of the drinking appliances is a major factor in maintaining a chronic infection as are infrequent changes of litter. Similarly, the rearing of chicks in units which are not cleaned at least every twenty days, tends to increase the worm burden and it is essential to rear chicks on ground which has not been utilised for adult fowl. Birds reared in pens on the range must be moved to clean ground every fifteen days.

g): <u>The effect of multiple infections</u>.

A correlation between number of species present and the number of individual worms in an infected bird has been demonstrated by Morgan & Wilson (1939), Owen (1951) and Wakelin (1964) amongst others. In the present survey, where eggs and not the actual numbers of worms have been counted, no such relationship is evident. The writer suggests that the results of previous workers may not have the significance attributed to them since, inevitably, large numbers of larval stages will be included in any counts. While a heavy infestation of a particular species may increase the susceptibility to further infections by the same and other species, the success of such infections depends on the maturation and production of eggs by fertilised females. Morgan & Wilson (1939) show that for <u>Heterakis gallinarum</u>, a heavy worm burden does not increase their pathogenicity in healthy birds and before the effect of a multiple infection can be thought significant all larval stages must reach maturity. The hatching mechanism for the ova is unlikely to be influenced by the presence of other species, but age immunity if present, greater resistance in the 'heavy' breeds, and the presence of previously established adult worms, must minimise the chances of maturity being attained by successive infections of the same and other species.

The writer has, in fact, recovered fewer numbers of eggs for each species per gram of faeces, where two or more were present than where single infestations were indicated by the presence of only one type of egg (Table C 10). This suggests that many of the stages which make up the impressive numbers shown by Owen (1951) in his table 4, are larvae which do not mature because of prevailing competition. If maturity is not attained by the majority of worms present in any count, then such statements as 'the possibility of fowls becoming heavily infected could be substantially reduced by preventing the number of helminth species available to infest the birds from rising above two' (Owen, 1951), have little significance in the essentially non-pathogenic nematodes under consideration. The worm burden in terms of numbers recorded is, in the absence of disease, rarely sufficient to endanger the health of the bird, and Savenchenko (1962) has shown that super-infection leads to spontaneous expulsion of _Heterakis gallinarum_ in the faeces.

The decrease in the number of eggs per gram of faeces is in part explained by Shikhabolova's account (1959) of acquired immunity to both normal and super-infection. The effect of the density of single infections has also been shown by Savenchenko (1962) who fed controlled numbers of between 5 and 1,000 ova of _H. gallinarum_ to fowl. An increase in density led to a reduction of length, a reduction in length of life and a lengthening of the time of development. _H. gallinarum_ remains in the host for a year (Osipov, 1957) and it is to be expected that the introduction of further species to the primary infection would

TABLE C 10 The effect of multiple infections on the numbers of each species present, expressed in eggs per gram faeces.

	No. of eggs per gram of faeces when 1, 2 or 3 parasites are present.		
Species of parasite	1	2	3
Heterakis gallinarum	6	4	2
Ascaridia galli	4	2	1
Capillaria obsignata	5	4	3

result in suppression through the combined effects of density and acquired immunity. Hence the fewer numbers of egg per gram faeces per species recorded by the writer.

It is concluded that an increase in the number of species present means that fewer of each will mature and the chances of dissemination will be mitigated, not increased, by multiple infections. The writer's counter-proposition that multiple infections are self-limiting can only be confirmed by further experimental work in which factors other than the number of larvae and adults are recorded.

SECTION B. The results of a survey on the helminth parasites of the domestic turkey (*Meleagris gallopavo dom.* L.) in Pembrokeshire.

The total percentage infestations for both first and second periods are shown in Table C 11. In the first period, the distribution, seasonal variation and age of the host was considered and in the second, selected types of management. Table C 11 also gives the results of Owen (1951), the only earlier worker to study the parasites of the turkey in the United Kingdom. Unlike Owen, no cestodes were recovered, even in the Christmas months when many intestines were made available for dissection. Neither were trematodes recovered although there are several reports from the turkey. Rees (1952) described *Plagiorchis (Multiglandularis) megalorchis* Rees, 1952, from Wales, Varicak and Erlich (1944) recorded *Echinostoma revolutum* (Fröhlich, 1802) from turkeys in Germany, Birova and Busa (1957)

TABLE C 11 The helminth parasites of the domestic turkey (*Meleagris gallopavo dom.* L.) in Pembrokeshire. (July 1960 - December 1963).

Species of Parasite	% Infestation.	
	Owen, 1951	Elce
Heterakis gallinarum	60	5.6
Ascaridia galli	5	23
Capillaria caudinflata	40	5
Capillaria anatis	10	-
Capillaria obsignata	-	37
Trichostrongylus tenuis	25	7
Davainea proglottina	5	-
Amoebotaenia sphenoides	5	-

reported *Prosthogonimus cuneatus* (Rudolphi, 1809) in the oviducts of turkeys in Czechoslovakia, Valente (1958) described *Echinoparyphium recurvatum* (Von Linstow, 1873) in Italy, and Paudere (1958) found four species of trematode, two species of cestode and six species of nematode in Latvia.

The most common nematode in the turkey is *Heterakis gallinarum* and of the seventeen species occurring in Czechoslovakia, Birova-Volosinovicova (1963) lists *H. gallinarum*, *A. galli*, *C. caudinflata*, *C. bursata* (considered a synonym of *caudinflata* by most authorities) and *C. obsignata* as the most common. The least common were *Thominx phasianina*, *Ganguleterakis dispar*, *Trichostrongylus tenuis* and *Thominx collaris* (*C. anatis* of most workers). Vasilev (1962) listed thirteen species of nematodes from turkeys in Bulgaria.

In an interesting paper, comparing the nematode burden of wild, pen-reared wild and domesticated turkeys, Maxfield, Reid & Hayes (1963) found *Ascaridia dissimilis* Vigueras, 1931 to be most common in wild turkeys, *C. obsignata* in pen-reared wild turkeys and *H. gallinarum* in domesticated birds. *Ascaridia dissimilis* is the common ascarid nematode of turkeys although the only report for Britain is by Horton-Smith and Long (1957). The size of the egg does not differ from that of *A. galli* and despite the presence of males which could undoubtedly be identified as *dissimilis* in the Christmas post-mortems, the predominant species in this survey is considered to be *galli*. Kerr (1957, 1958) has worked on both species and has shown that while turkeys are more readily infected with *dissimilis*, they have a greater affinity with *galli* than is shown by chickens for *dissimilis*.

There were no cases of syngamiasis during the survey and the nematode was not reported by Owen (1951). Long (1957) described a serious outbreak in 2,000 turkeys which he believed had been introduced by starlings. The poults were housed in pens and the earth and litter beneath contained infected *Eisenia foetida*. Most of the birds in this survey were housed in litter systems with concrete or wooden floors and when an earth floor was utilized, the layer of litter usually prevented access by the poults to any fauna present. Small birds such as the ubiquitous and indigenous sparrow are able to enter the units but larger birds, such as the migratory starling and the corvids, were prevented from entering by wire-netting. Thus careful management ensures against tapeworm infections.

Discussion

a). *The general incidence of intestinal nematodes.*

A comparison of the two surveys included in Table C 11, indicates that *H. gallinarum* is not as common in the highly efficient litter techniques now being practised, but the uniform conditions make for higher infestations with *A. galli* than formerly occurred. The fact that *A. galli* has not the affinity for turkeys that it has for chickens is seen in the comparatively low rate of infestation. The careful rearing of turkey poults has not eliminated these nematodes which must be introduced from infected fowl at an early age. Owen did not recover *C. obsignata* but found a relatively high percentage infestation

TABLE C 12 The % Infestation of the Turkey with intestinal nematodes related to seasonal variation. (July 1960 - December 1961).

PERIOD	Heterakis gallinarum		Ascaridia galli		Capillaria caudinflata		Capillaria obsignata		Tricho-strongylus tenuis	
	%	No. of eggs.	%	No. of eggs.	%	No. of eggs	%	No. of eggs	%	No. of eggs
Jan. - March	26	1-2	-	-	-	-	12	1	-	-
April - June	50	4-5	17	2-3	14	1-2	30	3-4	12	1-2
July - Sept.	48	4-5	15	1-2	6	1	29	3	11	1-2
Oct. - Dec.	68	5-6	22	2-4	-	-	45	4-5	19	2-3
Total % Infestation.	48	-	18	-	10	-	29	-	14	-

of C. caudinflata. This last species requires an intermediate host and the great efficiency of the turkey industry in Pembrokeshire is indicated by its almost complete elimination. Trichostrongylus tenuis is similarly of little importance.

In the first period, July, 1960-December, 1961, nineteen establishments were visited which together maintained about 38,000 birds. Two faecal samples were taken for every ten birds, an intestinal and a caecal, between July, 1960 and December, 1960. In the following year a typical unit at each farm was sampled representing about 10,000 birds. The percentage infestation is shown in Table C 12.

In the second period, January, 1962-December, 1963, eight typical units were examined and two faecal specimens were taken for every five birds. (Table C 13). The units were selected because they represented a form of management and because they showed an average rate of infestation by all three of the more common nematodes. The percentage infestation was therefore higher than in the first period which had included a number of establishments with sparse infestations. The total percentages were: H. gallinarum - 74%, A. galli - 28%, and C. obsignata - 45%. The number of birds sampled at each unit is given in Table C 13.

b). The age of the host.

None of the establishments maintain their flocks for more than ten months and it is not possible to study the effect of the age of the host on the worm burden. There is no reduction of nematode parasites up to the age of one year as is demonstrated by the progressive increase in percentages in Table C 12.

c). <u>The Seasonal variation of intestinal nematodes</u>.

For similar reasons, there is scarcely any seasonal variation. All species show a peak infection in the April-June months and there is a slight host reaction evident in July and August. The intensive conditions favour repeated re-infection and an increasing number of ova are passed and poults infected until the birds are killed (Table C 12). The only exception is <u>C. caudinflata</u> which dies out owing to the absence of the intermediate host.

d). <u>The environment of the host</u>.

Davies & Joyner (1955) found that the increase in the moisture content of the litter in winter months caused a great increase in the coccidial oocyst population from November to February, and the progressive build-up of nematode infections which must in part be due to an increase in humidity, is seen in Table C 12. The drainage of moisture from litter is important and in Table C 13, it is demonstrated that the establishment with earth floors support a lower infestation of nematodes than those with concrete floors. (Units 4, 5 and 6). Straw-litters provide the best medium for embryonation (units 1, 4, 6 and 7), with peat moss as the least suitable medium (units 2, 5 and 8). An important factor is heat absorption by the environment in summer, and retention in winter. The prefabricated buildings are all constructed of a non-inflammable concrete/asbestos mixture commonly utilized. The converted barns both have tiled

TABLE C 13: The % infestation of the turkey with intestinal nematodes related to different categories of management. (January 1962 - December 1963).

Type of Management.	No. of Birds.	*Heterakis gallinarum*	*Ascaridia galli*	*Capillaria obsignata*
(1) Prefabricated building Concrete floor - straw litter.	500	92	67	69
(2) Prefabricated building Concrete floor - peat moss.	500	73	18	35
(3) Prefabricated building Concrete floor - sawdust and chaff.	500	87	43	63
(4) Converted barn Earth floor - straw	250	75	30	51
(5) Converted barn Earth floor - peat moss.	150	46	11	20
(6) Lean-to outhouse Earth floor - bracken and straw.	300	81	37	58
(7) Corrugated iron unit Concrete floor - straw, chaff and sawdust.	300	74	23	41
(8) Corrugated iron unit Concrete floor - peat moss with some earth.	500	64	15	23

roofs and brick walls, while units 6, 7 and 8 all had corrugated iron roofs. Units 1, 2 and 3 are cooler in summer but warm in winter when heat and moisture together are most important for embryonation. Similarly the tiled roofs are cooler in summer but warmer in winter. The units with corrugated iron roofs are very hot in summer and dry out the litter and are cooler in winter through heat conductivity. Thus an ideal unit would permit absoption of moisture via an earth floor, brick walls and a roof which permits some conduction of heat, with peat moss as the principle component of the litter. However, there is generally more leakage from corrugated iron roofs than with tiles or a prefabricated roof. Thus unit 5 showed the lowest infection rate. Least suitable is unit 1, in which a very warm humid atmosphere is maintained. These conclusions assume that there is little leakage from drinking appliances, but several units visited possessed open drinking troughs and litter in the vicinity was very wet. Ruf (1955) has shown that *Heterakis* eggs can only be dessicated at a surface humidity of less than 5%. *A. galli* is apparently more susceptible to humidity than *Heterakis* or *Capillaria* and McRae (1935) stated that a humidity of 82-86% is required for the complete development of the ova at 22°C.

The only lethal factor for ova in the litter is dryness. Thus a high temperature and lack of moisture must be the aim of the farmer. Chronic infestations are propagated where heat and a high humidity are found together as in unit 1.

e). <u>The pathogenicity of intestinal nematodes</u>.

At none of the establishments could death be attributed solely to a nematode infection. On one farm a shed of 500 birds died from 'blackhead'. Various workers have shown that the naked protozoon is not infective and that it must be transmitted through *Heterakis* ova (Wehr, 1954). In view of the high rate of infestation with *Heterakis*, enterohepatitis is rare in the county. It is known that only one in 200 *Heterakis* ova will contain the protozoon and at present an even lower ratio must occur in the county. The migratory larvae of *A. galli* are destructive and cause emaciation and death. The relatively low percentages of this nematode can be ascribed to the small affinity with the turkey and mitigate against deaths due to this species. Egg counts for this species were below those for *Heterakis* and *Capillaria*. Except in the case of super-infections artificially induced, death is unknown with regard to *C. obsignata*.

<u>Summary</u>

1) A higher percentage infestation of intestinal nematodes in the domestic fowl has been recorded than hitherto. This is considered to be more representative of the worm burden of healthy poultry in their environment than the results of previous workers who have recorded the percentage infestation in casualty and diseased birds sent to centres for post-mortem.

2) In agreement with Owen (1951) and Wakelin (1964), the present survey records no reduction in infestation with the increasing age of the host. Any reduction in numbers occurring is considered to be an acquired immunity from previous infections and not the result of an increase in the age of the host.

3). The influence of environment is seen to vary considerably depending on whether the birds are maintained in intensive or non-intensive conditions. Intensive conditions favour repeated re-infections regardless of climatic conditions whereas non-intensive managements maintain a lower infection rate and show greater variability in intensity.

4). The fowl in intensive conditions show two peaks of infection per year, one in the spring and a second in the early autumn. Ascaridia galli and Capillaria obsignata may be suppressed altogether if a cold, wet summer depresses the rate of embryonation unduly. Correlated with this depression is a decrease in the number of eggs passed.

5). There is no evidence of the pathogenicity of the intestinal nematodes recorded in the survey and Syngamus trachea did not occur.

6). It is considered that the effect of the multiplication of the nematode species present is to decrease the number of adult worms of each species, in evidence based on the number of ova for each species passed in the faeces.

7). Turkey poults are less strongly infested with intestinal nematodes and the uniform environment in which they are reared precludes any significant seasonal variation.

8). Chronic infections are found in intensive units which maintain a high temperature coupled with a high humidity and are not influenced by climatic variation. Regular forking of litter will disperse the heat of fermentation and cause the litter to dry out, thus slowing the rate of embryonation.

PART IV

Some experimental work on the dissemination of the nematodes of Poultry. (With an account of an attempt to determine the life-cycle of *Capillaria resecta* (Dujardin, 1843) parasitic in the Rook). (*Corvus frugilegus* L.).

Introduction

To comply with the requirements of the British Egg Marketing Board, it was necessary to devote time to experimental work with poultry. Dr. C. Horton-Smith of Houghton Poultry Research Station in Huntingdon was appointed supervisor and in discussion it was decided to link the taxonomic section of the thesis with a survey of farms as described in Part II and to an estimation of the importance of wild birds in the dissemination of helminths of poultry.

Apart from C. obsignata Madsen, 1945, which has been recorded from a wide variety of Passeriformes, Galliformes and Anseriformes, there are few records in the literature of helminths which occur naturally in both wild and domesticated birds. Collyrichum faba Ward, 1917, is found in subcutaneous cysts in the house sparrow, starling and other passerines and it has been recorded from the fowl and the turkey in both Europe and North America. Several Typhlocoelum spp. have been found in waterfowl and in ducks and geese. Echinostoma revolutum (Fröhlich, 1802) inhabits the chicken and the turkey in addition to many wild bird species and there are records of Hypoderaeum conoideum (Bloch, 1782) in the chicken. There are no records of cestodes infesting both wild and domesticated birds and very few referring to nematodes except by experimental infection. Miller (1937) attempted, unsuccessfully, infected pigeons with Ascaridia galli (Schrank, 1788) and Heterakis gallinarum (Schrank, 1788) and Stoican (1960) infected chickens with Capillaria corvorum (Rudolphi, 1819) from rooks. Schwabe (1951) was able to infect five species of wild birds including the Rock Dove (Columbia livia L.) with Oxyspirura mansoni, but decided that wild birds are of little importance in dissemination despite its natural occurrence in five local species. Gibson and Barnes (1957) found Acuaria uncincita in domestic geese and ducks and considered that the outbreak originated through contact with wild waterfowl. Numerous workers have shown that it is possible to infect poultry experimentally with Syngamus treachea (Montagu, 1811) obtained from rooks, starlings and blackbirds (e.g. Taylor, 1928; Clapham, 1935).

Materials and Methods

Two lines of research were decided upon with Dr. Horton-Smith. First, the discovery and extent of natural infections by examination of wild birds. This was covered by the dissections for the taxonomic work but, in addition, dirt from claws and beak was collected and examined for nematode ova. Particular attention was given to those passerine birds which are naturally associated with range birds and poultry runs; rooks, crows, jackdaws, magpies, sparrows, chaffinches, blackbirds, starlings and, less frequently, thrushes and wag-tails. These birds can be divided into two groups: those which have an extended flight range over five square miles - rooks, jackdaws, crows and starlings - and those which are localised at one farm and, while possibly forming a reservoir of infection, cannot be thought to disseminate helminth infections.

Because of the greater significance of the former birds, additional sources of rooks, jackdaws and starlings were sought.

Mr. Peter Miller gave permission to trap rooks and jackdaws at Abbotshay Duck Farm, Ayot St. Laurence and later Smith, Kline and French Ltd., gave permission to erect a trap at Tallents Farm, Kimpton. In all some two hundred rooks and jackdaws were dissected from both farms. Starlings breed only in small numbers in Pembrokeshire and in the summer months of 1962 and 1963, more than five hundred carcases were sent to the writer by Mr. David Taylor of Blofield, Norwich.

Clapham (1940a), published the results of an experiment she carried out at Winches Farm, St. Albans, in which the importance of wild birds as disseminators of poultry helminths was stressed. As the facilities of Winches Farm were available, it was decided to repeat Miss Clapham's work to determine any change in carrier transmission which the more intensive methods of poultry farming might have effected in the intervening years.

The second approach was by the infection of selected wild birds with poultry nematodes to determine how much active carrier transmission of adult nematodes is possible as opposed to passive transmission of eggs on external parts. The birds used were rooks, jackdaws, starlings and wood-pigeons, and the nematodes those shown in the survey to be the most common in poultry, Heterakis gallinarum, Ascaridia galli and Capillaria obsignata.

Initially, small suspensions of A. galli and H. gallinarum ova were supplied by Dr. Horton-Smith from Houghton. These were embryonated at 28°C and fed to chickens. The resultant ova formed the basis of several subsequent infections. Mr. J.D.

Blaxland at the Veterinary Laboratory, New Haw, Weybridge gave permission to use the facilities of the Poultry Disease Diagnosis Section and Dr. Kendal of the Parasitology Section also gave advice and some suspensions of _Heterakis_, _Ascaridia_ and _C. obsignata_ ova.

Ova suspensions were made by collecting adult worms from the carcases sent to Weybridge for post-mortem purposes. The adult females of _galli_ were cut in half and the contents of the pseudo-coelom squeezed into a bowl prior to being ground by hand with a pestle and mortar. The mixture was passed through Endecott sieves at meshes 100 and 150 and the ova were cultured in 2% formalin in petri dishes at 28°C. All specimens of _gallinarum_ and _obsignata_ were collected with no attempt to separate males from females. These were ground and the mixture left to digest in a solution of ½% HCL and 1% pepsin to isolate the ova. After four hours in a stoppered bottle at 37°C, the suspension was passed through Endecott sieves at meshes 100, 150 and 200. No attempt was made to differentiate the various species of _Capillaria_ which may have been present since the resulting suspensions were fed _per os_ to the final host and species such as _caudinflata_ which require an intermediate host would be automatically eliminated.

The cultured solutions were stirred daily to provide fresh oxygen and the medium was changed every four days as a precaution against concentration through evaporation. The method of collection included many infertile ova but sufficient embryonated were obtained to develop strong infections in trial tests on 12-day

day old chicks. The infective doses administered consisted of two hundred to three hundred ova for _gallinarum_ and _galli_ of which about one-third were infertile and four hundred to five hundred for _obsignata_. The higher dosage for _obsignata_ was used to conteract any dilution through the presence of the ova of _caudinflata_ or _anatis_.

The rooks were maintained in an aviary at Winches Farm and fed on a diet of minced meat and grain. Birds were identified by ringing as it was not possible to isolate individuals for any length of time. The birds were trapped mainly in the winter, spring and early summer. In late summer and autumn, much grain was available in fields and the birds were not tempted into the traps. The experimental infections were divided into two periods corresponding to the availability of the birds. The first period occupied the summer and autumn of 1961 when birds were obtained from Abbotshay Duck Farm. Experiments continued through the winter, but in the following year the rearing of ducks was discontinued and no new birds were available as rooks were not tempted into the traps in the absence of the ducks and the associated food. Nine birds from the original trappings were used through the summer of 1962. In March, 1963 the traps at Tallents Farm were erected and fresh birds were available.

The rooks and jackdaws from Tallents Farm were maintained on a Vitamin A deficient diet and successive infections were given to find out if resistance would be lowered by repeated doses. The deficiency diet was that commonly used in such work and was recommended by Dr. D. Wakelin. The ingredients are:

	Pts/100
Wheat	45
Oats	15
Wheat middlings	25
Fish Meal	10
Unextracted Yeast	2.5
Limestone Flour	2
Salt	0.5

with 1 million I.U. Vitamin D per ton. It was made by Sherrifs of Welwyn Garden City.

In the winter of 1962, when it seemed doubtful whether more rooks would be trapped, starlings were caught in Pembrokeshire and given infections of galli. Four wood-pigeons were loaned to the writer and these were infected with galli and gallinarum in the same period.

Results

A). Natural Infestations.

(i) Examination of wild birds by post-mortem.

None of the wild birds examined in this survey contained nematodes which are normally parasitic in domestic poultry, or Galliformes generally. Only Capillaria obsignata, which occurred in starlings, is also found in chickens and the turkey. On a single occasion, a rook from a rookery at Ivy Towers, St. Florence, Tenby was found to possess a third stage larva which was atypical of Porrocaecum ensicaudatum (Zeder, 1800), the common ascarid nematode of Corvidae, and on examination it was thought to be a larval Ascaridia spp.

(ii) Examination of dirt from external parts.

Clapham (1940b) has suggested that soil attached to the feet and beak acts as a medium for the mechanical transport of helminths from pasture but was unable to offer any evidence.

Care was taken to scrape all feet but only in three birds taken from Abbotshay Duck Farm were any ova recovered. These were a *Heterakis* spp. and were successfully embryonated. The eggs were then given *per os* to three two-week old cockerels but no adult worms were found when the birds were killed and dissected after forty days. It is possible that the species was *dispar* (Schrank, 1790), which inhabits the caeca of the goose and the duck. Thus, there is unsatisfactory evidence that the rooks were capable of infecting pens placed on previously uncontaminated ground at the farm and could easily transmit the nematodes to any similar farm in the vicinity.

(iii) *The introduction of nematodes to clean pasture*.

Clapham (1940a) reported the introduction of *Capillaria longicollis*, *Heterakis gallinarum*, *Trichostrongylus tenuis*, *Ascaridia galli* and *Hymenolepis corvi* to young birds kept on plots which were formerly helminth free. This last species is doubtful as the only cestode with this name occurs in rooks in the Southern United States and the writer has not been able to trace the species as a synonym for any hymenolepid in the Corvidae of Europe.

A plot of ground was chosen at Winches Farm, which was sheltered and within ten yards of a copse. There had been no poultry reared on this ground since at least the end of the war, so that it could be assumed to be free of helminth ova from direct contact with chickens and any ova present would have been introduced by wild birds. In May, 1962, an arc was placed in the run and fourteen ten-day old chickens were introduced together with a broody hen. The faeces of the hen were examined daily for six days and the bird proved to be free of helminth parasites. The chicks had been reared from eggs in a brooder.

At first none of the local fauna entered the run and when a poult was killed after one month, no parasites were recovered. (Table D 1). Later blackbirds, thrushes and house sparrows started to use the run. The second and third poults, also killed at monthly intervals, were negative. The fourth bird, killed in September, was infested with three adult *Heterakis gallinarum*. The remaining birds were killed in successive months and the final eight at the beginning of December. In the meantime, starlings were frequenting the run and rooks were observed on adjacent trees. Ultimately large infestations with *Heterakis* were recovered with a maximum of 273 from one cock. A single bird was infested by six adult *C. obsignata*.

In 1963, the experiment was repeated on the same ground. This was thought advisable since most small establishments have not the facilities to renew pasture yearly, and more indication would be obtained of the build up of infections. Again young cocks were placed under the same broody hen. An ant-helmintic was administered to the hen but did not entirely remove the *Heterakis* infection. This was not considered important since inevitably ova would be present on the ground surface from the previous year. By this time wild birds were using the run quite

TABLE D.1: The increase in nematode infections of poultry placed on 'clean' pasture through contact with wild birds. (Expressed as number of worms per bird).

1962	Bird	*Heterakis gallinarum*	*Ascaridia galli*	*Capillaria obsignata*	*Capillaria caudinflata*
June	1	-	-	-	-
July	2	-	-	-	-
August	3	-	-	-	-
Sept.	4	3	-	-	-
Oct.	5	-	-	-	-
Nov.	6	31	-	-	-
Dec.	7-14 x	97	-	6 (one bird only)	-

x:- Two birds uninfected. The figures given represent the average number of worms present in the six infected birds.

1963					
June	1	11	-	3	7
July	2	15	-	28	11
August	3	23	3	-	15
Sept.	4	53	4	30	-
Oct.	5	69	9	45	22
Nov.	6	-	2	31	-
Dec.	7-12 x	71	5	42	-

x : One bird uninfected. The figures given represent the average number of worms present in the five infected birds.

freely and only rooks were rarely seen to alight within the wire-netting boundary. Sparrows flew in from a poultry run at the far end of the farm.

The first bird of the second series was infected with Heterakis and subsequent birds were found to contain Ascaridia galli, C. obsignata, and C. caudinflata. No cestodes or trematodes were recovered. Since nematodes could be introduced by mechanical transmission, the lack of cestodes could be attributed to either the lack of a source of infection for the wild birds or to the absence of a suitable intermediate host. The infection with C. caudinflata was slight and had died out by Christmas. The infection is most likely to have been introduced via infected worms, parts of which would have passed out in the faeces of the wild birds. Experimental work was discontinued in January, 1964, and it was not possible to find out whether the earthworms in the run became infected. In this second period a definite seasonal incidence was found which reached a peak in September and October. The bird killed in October was the only one to be infested by all four species of nematode.

B). Artificial Infections

The series of forty-two experiments is listed consecutively in Tables D 2 and 3.

(i) Rooks maintained on a normal diet (July,1961-November,1962).

Altogether there were thirteen attempted infections, five with Heterakis (Nos. 1, 4, 7, 9, 12), five with Ascaridia (Nos. 2, 5, 6, 8, 14) and three with Capillaria obsignata (Nos. 3, 10, 16).

Table D.2: Experimental infections of Birds maintained on normal diets. (July, 1961 - January, 1963)

Expt.	*Heterakis gallinarum*	*Ascaridia galli*	*Capillaria obsignata*
1	Rook (1)		
2		Rook (1)	
3			Rook (1)
4	Rook (2)		
5		Rook (2)	
6		Rook (3)	
7	Rook (3)		
8		Rook (4)	
9	Rook (4)		
10			Rook (2)
11	Pigeon (1)		
12	Rook (5)		
13		Pigeon (1)	
14		Rook (5)	
15	Pigeon (2)		
16			Rook (3)
17		Pigeon (2)	
18-21		Starling (1-4)	

In the first half dozen experiments, six birds were infected, killed after eight weeks, and examined for adult worms. (Ackert, 1937, showed that A. galli takes fifty days to attain maturity). There followed a dearth of birds and the same rooks were re-infected every four weeks from March, 1962 to November, 1962. (Expts. 7, 8, 9, 10, 12, 14, 16). After experiment 16, six birds were killed and examined for adult worms, the other three birds having died in the meantime.

The control birds used for each infection were chickens maintained in parasite-free conditions at the Animal House of the London School of Hygiene and Tropical Medicine. The viability of each suspension was proven by the successful establishment of adults in these birds.

Not unexpectedly, it proved impossible to infect rooks with Heterakis. The normal habitat in the chicken is the caeca and only in super-infestations are the nematodes regularly found in the adjoining regions of the small intestine. It was thought that the infection of an un-natural host, which has only very small caeca about an 1" long, might induce the development of the nematodes in abnormal regions of the small intestine but this did not prove to be so. Fresh faecal samples from the rooks, collected twenty-four to forty-eight hours after infection contained the unhatched ova which, when given to chickens, produced an infection. Thus the rook cannot act as host to Heterakis but can passively transport the ova in the intestine.

In contrast examination of faeces of rooks infected with Ascaridia galli showed that 75% of the ova hatched and first stage larvae were present. One bird was isolated and killed after twelve days, by which time, in the chicken, the duodenal mucosa would have been penetrated by the larvae. There were no larvae present and no signs of penetration. It is concluded that while rooks under special conditions might act as host to adult Ascaridia, they are less likely to spread infections of Ascaridia than of Heterakis because fewer ova pass intact through the anus and it is known that chickens rarely become infested by ingesting larvae as opposed to eggs. This is seen in Table D 1 where A. galli was the least prevalent intestinal nematode.

The third series of infections with Capillaria obsignata was successful and adults were recovered in small numbers. (Experiment 16). As adults had not been established in the previous experiments, the possibility arose that the diet might have modified intestinal conditions over a period of months. All birds were infected with C. resecta (Dujardin, 1843) and several with Porrocaecum ensicaudatum (Zeder, 1800). (Established by faecal analysis). The ensicaudatum infection disappeared after about three months, but the C. resecta infection was retained throughout the period, so that the diet might well have been more favourable for infestation with Capillaria spp. Rooks can be considered to be active carriers of C. obsignata. Ova concentrated from the rook faeces were infective when fed to chicks.

Stoican (1960) fed ova of "C. corvorum" obtained from the intestines of rooks to chicks and was able to effect an infection. Most authorities considered C. cornorum (Rudolphi, 1819) to be nomen nudum and there is no relevant description in the literature. The species recovered by Stoican may have been C. corvicola (Wassilkowa & Gouchanskaja, 1930), C. resecta (if this species is a synonym of anatis) or C. obsignata. Experimental evidence in this thesis and that of Wakelin (1963) suggests that anatis requires an intermediate host and Stoican's species is most likely to have been obsignata.

(ii). Pigeons maintained on a normal diet (Sept.1962-Dec.1962).

Miller (1937) was unable to infect pigeons with Heterakis or Ascaridia. Four wood-pigeons which had previously been used for bird malaria experiments were loaned to the writer. While their importance as disseminators of poultry nematodes is minimal since wild pigeons rarely move in the vicinity of dwelling places, it was of interest to see whether they would tolerate infections of Heterakis and Ascaridia as they are frequently parasitised by C. obsignata and C. longicollis (Mehlis, 1831) a parasite of game birds. There were two attempted infections (Expts. 11 and 15) with Heterakis and two with Ascaridia (Expts. 13 and 17). Neither species established itself and the ova passed in the faeces were still viable.

(iii) Starlings maintained on a normal diet.(Dec.1962-Jan.1963).

Six starlings were kept in a trap in Pembrokeshire. The small size of the caeca would preclude development of Heterakis and it seemed unlikely that so large a worm as Ascaridia could be tolerated. Of all species of birds, the starling is the most suspect in the dissemination of disease and super-infestation with A. galli was attempted by administering four weekly infections. Predictably, no adults developed and the ova, which were passed in the faeces within twenty-four hours were taken to London and proved infective when given to chicks. C. obsignata has been recorded from the starling and experimental infection was superfluous.

(iv) Rooks and Jackdaws on a Vitamin A deficient diet (March, 1963-November, 1963).

There are many reports of an increase in the number and size of nematodes infesting fowl maintained on a deficiency diet. As it had been possible to infest rooks with C. obsignata and demonstrate a partial toleration for A. galli, when rooks and jackdaws became available from Tallents Farm, it was decided to determine whether the ability of the nematodes to establish themselves in these birds would be increased in combination with a deficiency diet. The sequence of infections is seen in Table D 3. It was not possible to separate the two species of birds in the aviary so care was taken to infect only one species of bird with a particular species of nematode at any one time. Thus experiments 22 and 23, 25 and 26, 27 and 28 etc., took place simultaneously with a four week interval between each successive dosage. As before, control chickens were reared in the Animal House at the London School of Hygiene and Tropical Medicine. Initially, six birds were infected at one time but towards the end of the period, odd birds died and lesions showed that death was due to the deficiency.

There were sixteen experiments, three for each host with Ascaridia and Heterakis, and two for each host with C. obsignata. This last species established itself in both birds and in larger

Table D.3: Experimental infections of Birds maintained on vitamin A deficient diets. (March, 1963 - October, 1963)

(N.B. The infection of ducks with C. resecta is included in the sequence for convenience. The birds were, of course, maintained on a normal diet.)

Expt.	*Heterakis gallinarum*	*Ascaridia galli*	*Capillaria obsignata*	*Capillaria resecta*
22	Jackdaw (1)			
23		Rook (1)		
24				Duck (1)
25		Jackdaw (1)		
26	Rook (1)			
27			Jackdaw (1)	
28			Rook (1)	
29	Jackdaw (2)			
30		Rook (2)		
31				Duck (2)
32		Jackdaw (2)		
33	Rook (2)			
34			Rook (2)	
35				Duck (3)
36	Jackdaw (3)			
37		Rook (3)		
38				Duck (4)
39		Jackdaw (3)		
40	Rook (3)			
41			Jackdaw (2)	
42				Duck (5)

numbers in the rook than when the bird was reared on a normal diet. *Heterakis* was not established in either host. The *Ascaridia* ova hatched and immature adults were established in later infections. The intestinal lesions resulting from the deficiency lowered the host's resistance and made it possible for the larvae to develop in the mucosa. The birds died or were killed before the adult stage was reached but corvid birds can evidently be infected with *A. galli*. In the field such birds are most unlikely to be deficient in a factor such as Vitamin A and it must be concluded that wild birds do not act as hosts for the more common poultry nematodes with the exception of *obsignata*.

Summary

1). Wild birds are shown to be capable of transmitting the ova of poultry nematodes. The most probable method is by ingesting the ova either in faeces or in infected earthworms, which pass unharmed through the intestine. This is more true for *Heterakis* than *Ascaridia* which can hatch in the intestine of certain corvid birds.

2). Wild birds transmit *Capillaria obsignata* both by passive transmission of ova and by acting as hosts to small numbers of adults.

3). The importance of wild birds as carriers of infections is limited to free range poultry and those intensive systems to which they have access. The poultry in such units will usually have contact only with small passerines such as the domestic

sparrow which is indigenous to a particular farm or dwelling place. It is possible that sparrows might carry ova from the faeces of larger birds into units but evidence could only be provided with difficulty and is not offered in the present work.

APPENDIX The life-cycle of Capillaria resecta (Dujardin, 1843), parasitic in the small intestine of the Rook (Corvus frugilegus L.).

The rooks trapped at Abbotshay Duck Farm were 100% infested with C. resecta. Their morphology is described in Part 1, Section C. The principle interest lies in the proximity of the rookery and the duck farm and the fact that certain authorities, notably Madsen (1945) consider resecta to be a synonym of anatis (Schrank, 1790), which inhabits the small intestine of wild duck and various domestic and gallinaceous birds. The question arose whether the species could be proved to be synonymous and whether the rooks were infected by the ducks or vice versa. If cross-infections could be obtained then the small morphological differences such as egg shell pattern and shape might prove to be due to change of host. In an instance such as this, where both hosts ate the same diet, i.e. the duck food, then physiological adaptation might be partly negated and cross-infections more easily obtained. It was decided to attempt cross-infection and to determine the necessity or not of an intermediate host. However, the examination of many duck intestines which were placed at the writer's disposal, showed the complete absence of any Capillaria spp., and experiments were restricted to the attempted infection of ducks with ova obtained from the rooks.

Materials and Methods

The nematodes were collected from the rook intestine and the ova isolated and embryonated as described for *obsignata* in the introduction to Part IV. By the time the preparations for the experiments were complete, the duck farm had closed and no further rooks were available to act as control birds until March, 1963. These latter birds were less frequently infested with *resecta* and the isolation of several, followed by faecal examination at daily intervals, resulted in six 'clean' birds being used as controls in the experiments.

The ducklings were reared in parasite free conditions and were kept in the Animal House at the London School of Hygiene and Tropical Medicine. The control birds were also kept at the Animal House. Two methods of infection were used; direct *per os* and indirect via an annelid intermediate host. The earthworms at the farm were identified as *Allolobophora caliginosa* and *Eisenia foetida* by Mr. R.W. Sims, Annelida Section, British Museum.

Results

The sequence of five experimental infections are shown in Table D 3. (Experiments number, 24, 31, 35, 38, 42).

(i). Direct infection *per os*

In experiments 24 and 31, eighty to one hundred and fifty embryonated ova were given to each of six three week old ducklings. A single infection of ova was given to one control bird. After four weeks the control bird was killed and adult *resecta* were recovered. The faeces of the ducklings were analysed daily for ten days and were consistently negative. After experiment 31, the ducklings were killed and examined for adults but none were present.

(ii). Indirect infection via three species of earthworm

If *resecta* and *anatis* are synonyms, then while the *resecta* form was shown in the previous two experiments to have a direct life cycle, it is possible that the *anatis* form may require an intermediate host. Three of the more common genera of earthworms were collected and used in consecutive experiments, *Eisenia* in experiment 35, *Allolobophora* in experiment 38, and *Lumbricus* in experiment 42. The worms were infected with sixty to eighty ova which were introduced into the buccal cavity by a very fine pipette. After twenty days, six earthworms were given to each of six ducklings and a further six to the control bird. The control bird was killed four weeks later in all experiments and in 35 and 38 the duckling faeces were examined. At the conclusion of experiment 42, the ducklings were killed and dissected.

None of the ducklings were infected and the control bird was infected only via *Allolobophora*, the more common of the two species at the duck farm.

Conclusions

Capillaria resecta (Dujardin, 1843) has a direct life-cycle. Unless an unusual intermediate host is required, *resecta* is not capable of infecting ducklings and *resecta* is probably not synonymous with *anatis* (Schrank, 1790). Wakelin (1963, unpubl.) was able to show that the feeding of infective earthworms from contaminated ground resulted in infections of *anatis* in chickens, but was not able to obtain infections *per os*. The failure to infect ducklings with *resecta* via an intermediate host is further evidence that the two species are distinct.

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REFERENCES

ABILDGAARD, P.C. (1790) Allgemeine Betrachtungen über Eingeweiderwürmer. Revu danaise Skrift. Naturhist. Selsk. Kjobenhaven, I, 24-64.

ACKERT, J.E. (1937) Morphology and life-history of the fowl nematode Ascaridia lineata (Schneider). J. Parasit., 23, 360-

ACKERT, J.E. & HERRICK, C.A.,(1928) Effects of the nematode Ascaridia lineata (Schneider) on growing chickens. J. Parasit., 15, 1-13.

ACKERT, J.E., PORTER, D.D. & BEACH, T.D. (1935) Age resistance of chickens to the nematode Ascaridia lineata (Schneider). J. Parasit., 21, 205-213.

ALI, S.M. (1956) Studies on the nematode parasites of fishes and birds found in the Hyderabad State. Ind. J. Helm., 8(1), 1-83.

ANDRE, E.H. (1917) Contribution à l'étude de la faune helminthologique de la Suisse. Rev. Suisse Zool., 20, 471-485.

ANGEL, M. (1959) An account of Plagiorchis maculosus (Rud.), its synonymy and its life-history in South Australia. Trans. Roy. Soc. S. Aust., 82, 265 -281.

ASH, J. (1957) Post-mortem examinations of birds found dead during the cold spells of 1954 and 1956. Bird Study, 4, 159-166.

BAER, J.G. (1925) Sur quelques cestodes du Congo Belge. Rev. Suisse Zool., 32, 239-251.

________ (1932) Contribution à la faune helminthologique de Suisse. Rev. Suisse Zool., 39, 1-57.

________ (1943) Les trématodes parasites de la musaraigne Neomys fodiens. Bull. Soc. Neuchâtel Sc. Nat., 68, 33-84.

________ (1954) Revision taxonomique et étude biologique des cestodes de la famille des Tetrabothriidae parasites d'oiseaux de haute mer et de mammifères marins. Mem. Univ. Neuchâtel Sér. 1. 121 pp.

________ (1956) Parasitic helminths collected in West Greenland. Medd. Grønland, 124 (10), 1-55.

________ (1959) Helminthes parasites. Explorations des Parcs nationaux du Congo belge. Mission J.G. Baer et W. Gerber (1958) Fasc. I. 163 pp. Inst. des Parcs nationaux du Congo belge. Edit. (Tervuren Belgique).

BAER, J.G. et BONA, F.V. (1960) Revision des cestodes Dilepididae Fuhrmann 1907 des Ardeiformes. Note preliminaire. Boll. Inst. Mus. Zoo. Univ. Torino, 6,(4), 1-53.

BAIRD, W. (1853) Catalogue of the species of Entozoa, or intestinal worms, contained in the collection of the British Museum. B.M. 132.

________ (1853) Description of some new species of Entzoa from the collection of the British Museum. Proc. Zool. Soc. London, 18.

________ (1862) Descriptions of some new species of Entzoa. Ann. Mag. nat. Hist., Ser. 3 (10), 314-315.

BATSCH, A.J.G. (1786) Naturgeschichte der Bandwürmgattung überhaupt und ihrer Arten im besonderen nach den neuren Beobachtungen in einem systematischen Augzuge. Halle. 298 pp.

BAYLIS, H.A. (1920) On the classification of Ascariidae (I) Systematic value of certain characteristics of the alimentary canal. Parasit., 12, 253.

________ (1922) Some notes on parasitic nematodes (III) Note on two species of Porrocaecum from birds. Ann. Mag. nat. Hist. Ser. 9 (9), 494.

________ (1928) Records of some parasitic worms from British vertebrates. Ann. Mag. nat. Hist. Ser. 10 (1), 329-343.

________ (1931) On the structure and relationships of the Nematode Capillaria (Hepaticola) hepatica (Bancroft). Parasit., 23, 533-543.

________ (1934) Some parasitic worms from Australia. Parasit., 26, 129-132.

________ (1939) Further records of parasitic worms from British vertebrates. Ann. Mag. nat. Hist. Ser. 11,(4), 473-498.

BAYLIS, H.A. & DAUBNEY, R. (1926) A synopsis of the families and genera of Nematoda. Brit. Mus. Nat. Hist., London, 1-273 pp.

BELLINGHAM, O'B. (1844) Catalogue of Irish Entozoa with observations. Ann. Mag. nat. Hist., (82) 101-105, 167-174, (84) 254-260, (85) 335-340, (86) 422-450, (90) 162-165, (91) 251-256, (92) 317-323, (93) 396-403.

BELOPOLSKAYA, M.M. (1952) Parapronocephalum symmetricum. Uchen. Zapiski Leningr. Gasudarst. Univ. S. Biol., 28.

________ (1953) Parasitic fauna of marine swimming birds. Uchen Zapiski Leningr. Gasudarst. Univ. S. Biol. Nauk., 28.

________ (1953) Faune helminthologique des Chevalier de l'URSS. Travaux d'Helminthologique en l'honneur du 75^{e} anniversaux de l'Acad. K. I. Skrjabine. 47-65.

BEVERLEY-BURTON, M. (1964) Studies on the cestodes of British freshwater birds. Proc. Zoo. Soc. Lond., 142, 307-346

BHALERO, G.D. (1926) The trematodes of Corvus insolem (a Burmese House Crow) with a description of four new species. Parasit., 18, 387-398.

________ (1935) On two new monostomes (Trematoda) from avian hosts in British India. Indian J. Vet. Sci. Animal Husb., 5, 1-15.

BIROVÁ, V., & BUŠA, V. (1957) Biológica. Bratislavá. 12, 288-291.

BIROVÁ-VOLOSINOVIČOVÁ, V. (1963) Predbežná pravó a študin epizootológie Heterakis gallinarum (Schrank, 1788) a Ascaridia galli (Schrank, 1788) u kury domácaj.

BLAINVILLE, DE (1828) Dictionaire Sc. Nat., 57, 588.

BLANCHARD, E. (1847) Recherches sur l'organisation des vers. Ann. Sci. Nat. Zool., 3, 119-149.

________ (1849) Recherches sur l'organisation des vers. Ann. Sci. Nat. Zool. Paris, 10, 321, 11,106, 12, 5.

BLANCHARD, R.A.E. (1891) Histoire zoologique et médicale des téniadés du genre Hymenolepis Weinland. Paris. 112 pp.

BLOCH, M.E. (1779) Beitrag zur Naturgeschichte der Würmer welche in anderen Thieren leben. Boschäft. Berlin Ges. Naturf. Fr., 4, 534-561.

_________ (1782) Abhandlung von der Erzeungung dor Eingeweiderwürmer und der Mitteln wider dieselben. Berlin. 54 pp

BOCH, J. & FORSTNER, M.J. (1959) Untersuchungen über die Würmbefall des Averund Birkwaldes. Berl. Münch. tierärztl. Wschr. 72, 220-228.

BONA, F.V. (1957) Istologia delle capsule uterine di Choanotaenia marchali (Mola, 1907) e consideraioni sul ganere Monopylidium Fuhrmann, 1899 (Cestoda, Dilepididae). Boll. Inst. Mus. Zoo. Univ. Torino, 5, 69-99.

BRANDES, G. (1892) Revision der Monostomiden. Centrbl. Bakt., 12, 504-511.

BRAUN, M. (1894-1900) Vermes. Abth. Ib. Bronn's Klass. Ordn. Thierreichs, Leipzig.

_________ (1900) Trematoden der Chiroptera. Ann. K.K. Naturh. Hofm., 15, 217-236.

_________ (1901) Zur revision der Trematoden der Vogel. Centrb. Bakt., 29, 560-568, 895-897, 941-948.

_________ (1902) Fascioliden der Vogel. Zool. Jhb. Abt. Syst., 16, 1-162.

BREMSER, J.G. (1811) An Naturforscher überhaupt und an Enthelminthologen inbesondre von der k.k. Naturalienkabinets-Direktion in Wien. 31 pp.

BURT, M.D.B. (1962) A contribution to the knowledge of the cestode genus Ophryocotyle Friis, 1870. J. Linn. Soc. Lond., XLIV, 645-668.

BYKHOVSKAYA-PAVOLOVSKAYA, I.E. (1951) The variation of the morphological characters and its significance in the classification of the trematodes of the Leucochloridium Carus, 1835. Parazitologicheskii Sbornik, 13, 45-74.

_________ (1953) Trematode fauna of the birds of Western Siberia. Parazitologicheskii Sbornik, 15, 5-116.

BYKHOVSKAYA-PAVOLOVSKAYA, I.E. & DUBININA, M.N. (1951) New species of trematode Leucochloridium phragmitophila n. sp. from Passeriformes. Dokladi Akad. Nauk.SSSR., 76, 161-162.

BYRD, E.E. (1955) Notes on the anatomy of Ligula intestinalis (L., 1758) a pseudophyllidean cestode of birds. J. Parasit., 41, 6, 28-29.

CABLE, K.M. & MARTIN, W.E. (1937) Parorchis avitus (Linton, 1914) a synonym of Parorchis acanthus (Nicoll, 1906). J. Parasit., 21, 436-437.

CALLOT, J. (1946) Materiaux pour servir à la Faune des Distomes de France. Ann. Parasit. hum. comp., 21, 199-201.

CARUS, C.C. (1835) Beobachtung über einen merkwurdigen schöngefärbten Eingeweidewürm L. paradoxum mihi under desser parasitische Ergengung in einer Landshanke Succinea amphibia Drap., Helix putris L. Nova Acta Leop., 17, 85-100.

CARUS, J.V. (1863) Handbuch der Zoologie. Wilhelm Engelmann, Leipzig, 2, 1-642.

CHABAUD, A.G. (1952) Sur un Capillaria du Vanneau. Ann. Parasit. hum. comp., 27, 400-406.

__________ (1957) Nématodes parasites d'oiseaux en Tunisie. Arch. Inst. Pasteur de Tunis, 34 (1), 155-166.

CHAPIN, E.A. (1926) Southwellia Ransomi, new species. J. Parasit., 13, 29-33.

CHATTERJI, P.N. (1958) On a new avian trematode of the genus Cyclocoelum Brandes, 1892. J. Parasit., 44, 559-565.

CHERTKOVA, A.N. (1952) (cited Skrjabin et al., 1957)

CHING, H.L. (1960) Some digenetic trematodes of shore birds at Friday Harbour, Washington. Proc. Helm. Soc. Wash., 27, 53-62.

CHITWOOD, B.G. (1940) 'New relationships' in 'An introduction to Nematology.' Sec. I, Pt. 3. Leader Pr., Babylon N.Y., 190-204.

__________ (1958a) The designation of official names for the higher taxa in invertebrates. Bull. Zool. Nom., 15, 860-895.

__________ (1958b) The classification of plant nemas and related forms. Proc. XVth. Int. Congress Zool. (1958), 681-682.

__________ (1962) Steps in a revised classification of the Nemata. Nematologica, 7, 12.

CHITWOOD, B.G. & CHITWOOD, M.B. (1933) The characters of a protonematode. J. Parasit., 20, 130.

__________ (1950) An introduction to nematology. (rev. ed.) Monumental Printing Co., Baltimore, Md.

CHOLODOWSKY, N. (1906) Cestodes nouveaux ou peu connus. I. Arch. Parasit., 10, 332-345.

CLAPHAM, P.A. (1933) On the life-history of Heterakis gallinae. J. Helm., 11, 67-82.

__________ (1935) Some helminths from partridges and other British birds. J. Helm., 13, 139-147.

__________ (1936) Further observations on the occurrence and incidence of helminths in British partridges. J. Helm. 14, 61-68.

__________ (1937) On some lesions association with helminths in birds of ecomomic importance. J. Helm., 15, 48-52.

__________ (1938) New records of helminths in British birds. J. Helm., 16, 47-48.

__________ (1940a) On wild birds as transmitters of helminth parasites of domestic stock. J. Helm., 18, 39-44.

__________ (1940b) On helminths of corvid birds in the British Isles. J. Helm., 18, 89-94.

__________ (1957) Helminth parasites in some wild birds. Bird Study, 4, 193-196.

CLARK, D.T. (1952) Three new dilepid cestodes Dictymetra numenii, n. gen. n. sp., Dictymetra paranumenii, n. sp. and Anomotaenia filarata n. sp. Proc. Helm. Soc. Wash., 19, 18-27.

CLARK, M.L. (1962) Capillariasis in poultry. Vet. Rec., 74, 1431-1432.

CLERC, W. (1902) Contribution à l'étude de la faune helminthologique de l'Oural. I, II. Zoo. Anz., 25, 589-575, 658-664.

_______ (1903) Contribution à l'étude de la faune helminthologique de l'Oural. III. Rev. Suisse Zool., 11, 241-368.

_______ (1911) Matériaux pour la faune helminthologique du gouvernment de l'orel. Bull. Soc. Sc. nat. do gouvernment de l'Orel, 15, 24 pp.

COBB, N.S. (1919) The orders and classes of Nemas. Contrb. Sc. Nemat., 8, 213-216.

COBBOLD, T.S. (1861) Synopsis of the Distomidae. Proc. Linn. Soc. Lond., 5, 1-57.

_______ (1861) List of the Entzoa, including Pentastoma from animals dying at the Society menagerie between the years 1857-1860 inclusive, with descriptions of several new species. Proc. Zool. Soc. Lond., 1861, 117-127.

COHN, L. (1899) Zur Systematique der Vogeltaenien. I, II. Ctrbl. Bakt. u. Parasit., 25, 415-422, 26, 222-227.

_______ (1900) Zur Systematik der Vogeltaenien. IV. Ctrbl. Bakt. u. Parasit., 27, 325-328.

_______ (1900) Zur Kenntnis einiger Vogeltaenien. Zool. Anz., 23, 91-98.

_______ (1901) Zur Anatomie und Systematik der Vogelcestoden. Nova Acta Acad. Leop.,carol. Nat. Bd., 79, 263-450.

COOPER, A.R. (1918) North American Pseudophyllidean Cestodes from birds. Illinois Biol. Monograph., 4, 288-541.

CRAM, E.B. (1927) Nematode parasites of birds. United States Government Printing Office. Washington, D.C. 465 pp.

_______ (1936) Species of Capillaria parasitic in the upper digestive tract of birds. Technical Bulletin 516, U.S. Dept. Agric., Washington, D.C.

CREPLIN, Fr. Chr. H. (1829) Novae observationes de entozois. 134 pp Berlin.

_______ (1829) Filariae et Monostomi specimen movam in Balaena rostrata repertam. Nova acta phys. med. Acad. nat. curio, Bonnae 14, 871.

_______ (1839) Eingeweidewürmer, in L.S. Froch & I.J. Gruber, Allgem. Ensykl. Wiss. Künste, I Sept., 32, 277-302.

CZAPLINSKI, B. (1956) Hymenolepididae Fuhrmann, 1907, (Cestoda) Parasites of some domestic and wild Anseriformes in Poland. Acta Parasit. Polon., 4, 175-373.

DAVIES, S.F.M. & JOYNER, L.P. (1958) Observations on the parasitology of deep-litter in poultry houses. Vet. Rec., 67, (11), 193-199.

DAVIES, T.I. (1935) The anatomy of Dilepis undula (Schrank, 1798). Proc. Zool. Soc. Lond., (1935), 3-4, 717-772.

_______ (1937)(unpubl.) Ph.D. Thesis (Wales). Studies on the cestode parasites of British birds.

_______ (1938) A description of Hymenolepis neoartica n. nom. syn. H. fusus Linton, 1927, with a discussion on the synonymy of Taenia fusus Krabbe, 1869. Parasit., 30, 339-343.

DAVIES, T.I. (1939) Four species of Hymenolepis Weinland, parasitic in the Oystercatcher Haematopus ostralegus L. Parasit., 31, 401-412.

_____ (1940) Three closely related species of Aploparaksis Clerc, 1903. Parasit., 32, 198-207.

DAVIES, J.A. (1958) On some trematodes from the Jackdaw Corvus monedula in Britain. J. Helm., 32, 33-44.

DAWES, B. (1946) The Trematodes. Cambridge Univ. Press. 644 pp.

DEBLOCK, S., BIGUET, J. et CAPRON, A. (1960) Contribution à l'étude des cestodes de Lari des côtes de France. I. Le genre Hymenolepis. Ann. Parasit. hum. comp., 35, 538-574.

DEBLOCK, S., CAPRON, A. et ROSÉ, F. (1960) Redescriptions d'Hymenolepis (nec Aploparaksis) cirrosa (Krabbe, 1869) (Cestoda, Hymenolepididae). Bull. Soc. Zool. Fr., 85, 58-67.

DEBLOCK, S. et ROSÉ, F. (1962) Les Hymenolepis (sensu lato) de Charadriiformes (à propos de 23 descriptions.) Ann. Parasit. hum. comp., 37, 767-847.

DENEV, I. (1960) Seasonal dynamics of Ascaridia and Heterakis infections of chickens in the Turnovo district. Nauchni Trudove, Sofia, 2, 405-411.

DENTON, J.F. & BYRD, E.E. (1948) Dicrocoeliid trematodes of North American birds. J. Parasit., 34, 24.

_____ (1951) The helminth parasites of birds. III. Dicrocoeliid trematodes from North American birds. Proc. U.S. Nat. Mus., 102, (3274), 157-202.

DEO, P.G. & SRIVASTAVA, H.D. (1962) The acquired immunity of chickens to Heterakis gallinae (Gmelin) Freeborn. Indian J. Vet. Sci. Animal Husb., 32, 139-142.

DESLONGCHAMPS, E. (1824) Histoire naturelle des zoophytes. Encyclopédie methodique. Paris. 16 vols.

DIAMARE, V. (1893) Note su Cestodi. Boll. Soc. Nat. Napoli, 7, 9-13.

DIESING, K.M. (1850) Systema helminthum, I, 478-608.

_____ (1851) Systema helminthum, II, 588 pp. Vindobonae.

_____ (1856) Zwanzig Arten von Cephalocotylen. Denkschr. Akad. Wiss. Math. Naturw. Klasse, 1, 23-33.

_____ (1861) Revision der Nematoden. S.B. Akad. Wiss. Wien. 42, 595-736.

_____ (1863) Revision der Cephalocotylen. Abt. Cyclocotyleen. S.B. Akad. Wiss. Math. Naturw. Klasse, 49, 347-430.

DIETZ, E. (1909a) Die Echinostomiden der Vogel. Zoo. Anz., 34, 184.

_____ (1909b) Die Echinostomiden der Vogel. Inaug. Diss. Königsberg.

_____ (1910) Die Echinostomiden der Vogel. Zool. Jhb. Suppl., 12, 265-512.

DOLLFUS, R. Ph. (1934) Sur quelques Brachylaemus de la faune françaises recoltés principalment à Richelieu (Indre-et-Loire). Ann. Parasit. hum. comp., 12, 551-575.

_____ (1935) Sur quelques Brachylaemus. (cont.). Ann. Parasit. hum. comp., 13, 52-79.

DOLLFUS, R. Ph. (1948) Sur deux Monostomes (Cyclocœlidae) pourvus d'une ventouse ventrale. Observations sur la classification des Cyclocoelidea Albert Henry, 1923, liste de leur hôtes, repartition géographique. Ann. Parasit. hum. comp., 23, 129-199.

______________ (1949) Distoma rubens F. Dujardin, 1845, (= exasperatum Rud., 1819), retrouvé en France et rédecrit. Ann. Parasit. hum. comp., 21, 199-201.

______________ (1954) Deux Dicrocoeliinae d'oiseaux Passeriformes du Maroc. Discussion de quelques genres de Dicrocoeliinae d'Homeotherms. Misc. Helminthol. Maroc, XIII. Arch. Inst. Pasteur Maroc, 4, 583-602.

______________ (1957) Les Dicrocoeliinae d'oiseaux decrits ou mentionnes par Alcide Railliet quelques autres. Ann. Parasit. hum. comp., 32, 521-527.

______________ (1960) Recherches sur Plagiorchis cirratus II. Description et Identification. Ann. Parasit. hum. comp., 25, 282-291.

DORST, J. (1962) The migration of birds. Heinemann. 476 pp.

DOUGHERTY, E. (1958) Notes on the naming of higher taxa, with special reference to the Phylum (or Class) Nematoda. Bull. Zoo. Nom., 15, 896-906.

DUBININA, M.N. (1953) Cestodes of birds nesting in Western Siberia. Parasit. Sborn. Akad. Nauk. SSSR, 15, 117-233.

DUBOIS, G. (1955) Les trématodes de chiroptères de la collection Villy Aellen. Rev. Suisse Zool., 62, 469-506.

__________ (1959) Revision des 'Cyclocoelidae' Kossack, 1911. Rev. Suisse Zool., 66, 67-147.

DUBOIS, G. & MAHON, J. (1958) Études de quelques trématodes Nord-Americanis (avec note sur la position systematique de Parorchis Nicoll, 1907) suivre d'une revision des genres Galactosomum Looss, 1899 et Odestoma Braun, 1901 Bull. Soc. Neuchâtel Sci. Nat., 82, 191-229.

DUJARDIN, F., (1842) Mémoires sur les helminths des Musaraignes et en particulier sur les Trichosomes, les Distomes et les Taenias sur leurs metamorphoses et leurs transmigrations. Ann. Sci. Nat. Zool., 2, (20), 329-345.

____________ (1843) Mémoire sur la structure anatomique des Gardius et d'un autre helminthe, le Mermis qu'on a confondu avec eux. Ann. Sci. Nat. Zool., 20, 345-349.

____________ (1845) Histoire naturelle des Helminthes ou vers intestinaux. 654 pp. Paris.

DUTT, S.C. & MEHRA, K.N. (1962) Studies on the life-history of Hymenolepis fárciminosa (Goeze, 1782). (Cestoda: Hymenolepididae). Parasit., 52, 397-400.

ELCE, J.B. (1962) On a new cestode, Choanotaenia larimarina sp. nov. from the Greater Black-backed Gull, Larus marinus L. J. Helm., 36, 365-374.

EVANS, W.M.B., (1938, unpubl.) Helminth parasites of the bird population of a South Wales Farm. M.Sc. Thesis. University of Wales.

FAUST, E.C. (1929) Human helminthology: manual for clinicians, sanitarians and medical zoologists. Lea & Fehiger. 616 pp. Philadelphia.

FEDOROVA, O.E. (1954) La variabilité des caractères morphologiques et leur importance pour la systematique des Trématodes du genre Plagiorchis Lühe, 1899. Résumé d'auteur d'une dissertation présentée pour la candidature en sciences biologiques, Université de Leningrad, 1954.

FERNANDO, W. (1950) Cyclocoelum (Pseudohyptiasmus) sinhaladvipa sp. nov., a parasite from the nasal sinus of the Ceylon Jungle Fowl (Gallus lafayetti). Ceylon J. Sci. (B), 24, 127-129.

__________ (1952) Leucochloridium ceylonicum sp. nov. provis., a trematode from the Ceylon Jungle Fowl. Ceylon J. Sci. (B), 25, 55-58.

FOGGIE, A. (1933) A note on the helminth parasites of poultry. Scot. Nat., 200, 60-64.

FREITAS, J.F.T. de (1959) Esbâça de novo arranjo sistemátivo para as nematódeos capillariineos (Trichuroidea). Atas Soc. Biol., Rio de Janeiro, 3, 4-6.

__________ (1960) Novo nematódeos do genere 'Pterothominx Freitas, 1959'. (Trichuroidea, Capillaridae). Rev. bras. Biol., 20, 269-272.

FREITAS, J.F.T. de & ALMEIDA, L. de (1935) O gênere Capillaria Zeder, 1800 (Nematoda - Trichuroidea) e as capillariosises nos aves domesticas. Rev. Dep. noc. Prod. anim., Rio de Janeiro, 4, 5, 6, 311-363.

FREITAS, J.F.T. de & LENT, H. (1935) Capillariinae de animes de sangue furo (Nematoda - Trichuroidea). Mem. Inst. Osw. Cruz., 30, 241-284.

FREITAS, J.F.T. de & MENDONCA, J.M. de (1960) Novo nematódea parasito de Procyon cancrivorus Cuv: Pearsonema pearsoni gen. nov., sp. nov., (Trichuroidea, Capillaridae). Atas Soc. Biol., Rio de Janeiro, 4, 63-66.

FREITAS, J.F.T. & SILVA, A.A.J. (1960) Alguns nematodeos parasitos de Gallus gallus dom. (L.), no estudo de Batria. Mem. Inst. Osw. Cruz., 58, 189-207.

FRIIS, St. (1870) En hidtil ubeskreven Baendelorme hos Fugle. Vidensk. Meddel naturh. Foren. Kjoebenhaven (aar 1869) 3 ser., I, 121-124.

FROHLICH, J.A. (1791) Beitrag z. Naturg. der Eingeweidewürmer. Der Naturforsch., 25, 75.

__________ (1802) Beitrag z. Naturg. der Eingeweidewürmer. Der Naturforsch., 29, 5-96.

FUHRMANN, O. (1899) Das genus Prosthecocotyle. Ctrbl. Bakt. u. Parasit., 25, 863-877.

__________ (1901) Neue Arten und Genera der Vogeltaenien. Zoo. Anz., 24, 271-273.

__________ (1906a) Die Hymenolepisarten der Vogel. II. Ctrbl. Bakt. u. Parasit., 42, 620-628, 730-755.

__________ (1906b) Die Hymenolepisarten der Vogel. I. Ctrbl. Bakt. u. Parasit., 41, 352-358, 440-452.

FUHRMANN, O. (1907a) Bekannte und neue Arten von Vogeltaenien. Ctrbl. Bakt. u. Parasit., 45, 516-536.

________ (1907b) Die Systematik der Ordnung der Cyclophyllidea. Zoo. Anz., 32, 289-297.

________ (1908) Nouveaux ténias d'oiseaux. Rev. Suisse Zool., 16, 27-73.

________ (1909) Neue Davaineiden. Ctrbl. Bakt. u. Parasit., 49, 94-124.

________ (1911) Vogelcestoden der Aru Inselm. Abhandlung der Senckengergischen Naturforschenden Ges. Bd., 34, 251-266.

________ (1913) Nordische Vogelcestoden aus dem Museum von Göteborg. Medd. Göteb. Mus. Zool., Afd., I, 1-41.

________ (1920) Considerations générales sur les Davainea. Festschrift für Zschokke, 27, 19 pp.

________ (1926) Cestodes. Catalogues des Invortébrés de la Suisse. Fasc., 17, 149 pp.

________ (1928) The Trematoda. Kükenthal u. Krumbach's Handbuch Zool.

________ (1932) Les ténias des oiseaux. Mém. Univ. Neuchâtel, 8, 383 pp.

FURMAGA, S. (1956) Plagiorchis stefanskii sp. nov. and Plagiorchis roabae sp. nov., parasites of field rodents (Rodentia). Acta Parasit. Polon., 4, 583-600.

GAGARIN, V.G. (1951) - cited Skrjabin et al., 1957.

________ (1959) (Observations on the systematics of capillarids) Trudy Inst. Zool. Parazit. Akad. Nauk Kirgiz. SSSR, 7, 123-131.

GARRISON, P.E. (1908) A new intestinal trematode from man. Philipp. J. Sc., 3, 385-393.

GEDOELST, L. (1919) Un genre nouveau de Spiruridae. C.R. Soc. Biol., 82, 1145.

GEGENBAUR, C. (1859) Grundsüge der vergleichenden Anatomie. Leipzig, I-XIV. 606 pp.

GIEBEL, C. (1866) Die im zoologischen Museum der Universität Halle aufgestellten Eingeweidewürmer, nebst Beobachtungen über dieselben. Zeitsch. ges. Naturwiss., 28, 253-278.

GMELIN, J.F. (1790) Systema naturae. I. Part 6. Leipzig

________ (1796) (Reference untraced).

GOEZE, J.A.E. (1782) Versuch einer Naturgeschichte der Eingeweidewürmerthierischer Körper. Blankenburg, 471 pp.

GOWER, W.C. (1939) Host parasite catalogue of helminths of ducks. Amer. Midl. Nat., Notre Dame, 22, 580-628.

GRAYBILL, H.W. (1924) Capillaria columbae (Rud.,) from the chicken and turkey. J. Parasit., 10, 205-207.

GROBBEN, K. (1910) Die systematische Einteilung der Thierreichs. Verhandl. K.K. Zool. Bot. Gesellesch. Wien.(1908) 58, 491-511.

GUPTA, S.P. (1960) New species Viguiera dicrurusi from Dicrurus macrocercus albirctus. Canad. J. Zool., 38, 575-584.

HALL, M. C. (1916) Nematode parasites of mammals of the Orders Rodentia, Lagomorpha, and Hyracoidea. U.S. Na. Mus. Proc., 50, 1 - 258

HARRAH, E. C. (1921) Two new monostomes from Asia, J. Parasit., 7, 162 - 165

_____ (1922) North American Monostomes. Illinois Biol. Monograph. 7, 219 - 328.

HARTWICH, G. (1959) Revision der Vogel parasitischen. Nematoden Mitteleuropas. 1. Die Gattung Porrocaecum. Mitt. Zool. Mus. Berlin, 35, 107 - 147.

HECKERT, G. A. (1899) Leucochloridium paradoxum. Monographische Durstellung der Entwicklungs and Lebegeschichte des Distomum macrostomum. Bibliothecea Zool., 4, 66 pp.

HERRICK, C. A. (1926) Studies on the resistance of the chickens to the nematode Ascaridia perspicullum. Amer. J. Hyg., 6, 153 - 171.

HORTON-SMITH, C., & LONG, P. L. (1954) Occurrence of Plagiorchis notabilis Nicoll, 1909 in the small intestine of a domestic fowl (Gallus gallus). Vet. Rec., 66, 611

_____ (1957) Ascardia dissimilis Vigueras, 1931, in British Turkeys. Vet. Rec., 69, (15), 431.

HSÜ, H. F. (1936) Studien zur Systematik und Entwicklungsgeschichte der Gattung Leucochloridium Carus. 11. Über zwei Leucochloridium Arten der Kurischen Nehrung sowie uber Futerungsusuche mit grunen sporocysten dieser Gattung. Zeitschr. Parasit., 8, 714 - 728.

HUGHES, R. C. (1940) A key to the species of tapeworms in Hymenolepic. Trans. Amer. Micro. Soc., 60, 375 - 414.

HUNTER, W. S. and Vernberg W. B. (1952) L. beauforti, n. sp., (Trematoda : Brachylaemidae) from the seaside sparrow. Ammospiza maratima macgillivrai (Audubon). J. Parasit., 38, 215 - 217.

HYMAN, L. H. (1951) The Invertebrates. Volume III. McGraw Hill Book Co. 572 pp.

ISHII, N. (1932) Studies on bird trematodes. 1. Bird trematodes in Japan., II. Four new bird trematodes. Jap. J. Exp. Med., 11, 91 - 100.

_____ (1942) New parasitic records from the ruffed grouse. J. Parasit., 28, 92.

ISSAITSCHIKOFF, L. M. (1919) Trématodes nouveaux du genre Lyperosomum Loss. Merc. Inst., 1, 1 - 11.

JAMESON, H. L. and NICOLL, W. (1913) On some trematodes of the Scoter Duck (Oedemia nigra) and their relation to the pearl-inducing trematode in the edible mussel. Proc. Zool. Soc. London., 11, 53 - 63.

JENNINGS, A. R. (1954) Diseases in wild birds. J. Comp. Path., 64, 356 - 359.

__________ (1955) Diseases of wild birds. Bird Study, 2, 69 - 72.

__________ (1959) Diseases in wild birds. Bird Study, 6, 19 - 22.

JENNINGS, A. R. and SOULSBY, E. J. L. (1953) Biol. Bull., 119, 529 - 549.

__________ (1955) Diseases of wild birds. 111 Bird Study, 3, 270 - 272.

__________ (1957) Diseases of wild birds. IV Bird Study, 4, 216 - 220.

__________ (1958) Diseases in a colony of Black-Headed Gull, Larus ridibundus L. Ibis, 100, 305 - 312.

JOHNSTON, S. J. (1913) On some Queensland trematodes with anatomical observations and descriptions of new species and genera. Quarterly J. Micro. Soc., 59, 361 - 400.

JOHNSTON, T. H. (1937) Entozoa from the Australian Hair Seal. Proc. Linn. Soc. New South Wales, 62, 9 - 16.

JOHNSTON, T. H. and SIMPSON, E. R. (1940) The adult stage of the trematode Leucochloridium australiense. Trans. Roy. Soc. Aust., 64, 119 - 124.

JOHRI, L. N. (1959) Report on the cestode Hymenolepis farciminosa (Goeze, 1782) collected from Acridotheres tristus (L.) of Delhi State, together with observations on its testicular patterns. Proc. Nat. Acad. Sc., B, 29. 245 - 247.

JONES, A. W. (1945) Studies on cestode cytology. J. Parasit., 31, 213 - 235.

JOYEUX, Ch., (1923) Recherches sur la faune helminthologique africane. Arch. Inst. Pasteur de Tunis, 12, 119 - 167.

JOYEUX, Ch., et BAER, J. G. (1927) Notes sur les Cyclocoelidae (Trematodes). Bull. Soc. Zool. Fr., 52, 416 - 434.

__________ (1934) Sur quelques cestodes de France. Arch, museum nat. hist., Paris, 11, 157 - 171.

__________ (1954) Cestodes et Acanthocephales récoltés par M. Patrice Paulian aux Iles Kuguelan et Amsterdam, 1951 - 1952. Mém. Inst. Sc. Madagascar. A, 9, 123 - 140.

__________ (1955) Cestodes d'oiseaux récoltés dans le centre de la France. Bull. soc. Zool. Fr., 80, 174 - 196.

JOYEUX, Ch., BAER, J. G. et TIMON-DAVID, J. (1934) Recherches sur les trématodes du genre Brachylaemus Dujardin. Biol. Bull., 68, 385.

JOYEUX, Ch., et FOLEY, H. (1930) Les helminths de Meriones shawi (Rozet dans le nord de l'Algerie. Bull. Soc. Zoo. Fr., 55, 353 - 374.

KAGAN, I. G. (1950) Revision of the subfamily Leucochloridinae (Trematoda : Brachylaemidae). J. Parasit., 36, Suppl. p.19.

__________ (1952) Revision of the subfamily Leucochloridiinae Poche. 1907. (Trematoda : Brachylaemidae). Amer. Midland. Nat., 48, 257 - 301.

KERR, K. B. (1955) Age resistance of chickens and the rate of maturation of Ascardia galli. J. Parasit., 41, 233 - 235.

__________ (1957) Notes on Ascarilia dissimilis J. Parasit. Sect. 2, 20.

__________ (1958) Notes on Ascarilia dissimilis J. Parasit., 44, 507 - 511.

KEYMER, I. F. ét al.(1962) A Survey and Review of Parasitic Disease in wild and game birds in Great Britain. Vet. Rec., 74, 887 - 894.

KHALIL, L., (1962) Systematic studies on the trematode, cestode and nematode parasites mainly of fishes and birds in the Sudan. Ph.D. Thesis (Zoology), Univ. London.

KINTNER, R. K. (1938) Notes on cestode parasites of English Sparrows in Indianna. Parasit., 30, 347 - 357.

KOSSAK, W. (1911) Über Monostomiden. Zool. Jhb. Syst., 31, 491 - 590.

KOTLAN, A. (1940) Beiträge zur Kenntnis der Parasitenfauna der inheimischen Fasanae. Acquila. 42-45, 1935 - 1938, 630 - 657.

KOTLAN, A., and OROSZ, D. (1931) A hazi madarakban eloforduló Capillaria fajok synonymiaja (Die Capillaria-Würmer der Hausevogel) Allator Hopok, 54, 112.

KOWALEWSKI, M.(1894) Studya Helminthologique. I. Bull. inter. Acad. Polon. Comptes. rend. Séanc. 278 - 280.

__________ (1904) Materyaly do fauny helminthologiczne pasarzyt niczej polser. Physiograph. Commission Akad. Wiss. Krakau. 28, 2.

KRABBE, H. (1869) Bidrag til Kundskab am Füglenes Baendelorme. Dansk. Vidensk. Selsk. Skr., naturvid. Math. Afd. (5), 8, 249 - 363.

__________ (1882) Nye Bidrag til Kundskab am Füglenes Baendelorme. Dansk. Vidensk. Selsk. Skr., naturvid Math. Afd., 6, 349 - 366.

KURISU, Y. (1932) Studien an Trematoden die Japan an Hühnern als Endwirten schmarotzen. Kumamoto Igakkwai Zasski, 8, 283 - 298.

LAL, M. B. (1936 a) On a new species of Parorchis from Totanus hypolcucos with certain remarks on the family Echinostomidae. Proc. Indian Acad. Sci, B, 4, 27 - 35.

________ (1936 b) New genus of Trematode of the subfamily Typhlocoelinae from the Shoveller Duck, Spatula clypteata. Proc. Indian Acad. Sci., 4, 568 - 572.

LANKESTER, E. R. (1877) Notes on the embryology and classification of the Animal Kingdom. Quart. J. Micro. Soc., 2, 17, 399 - 454.

LAPAGE, G. (1961) A list of the parasitic Protozoa, Helminths and Acanthocephala recorded from the species of the Family Anatidae (Ducks, Geese, and Swans). Parasit. 51, 1 - 109.

LAYMAN, E. M. (1922) Zur characteristik neuer Lyperosomum - Arten Ctrb. Bakt. u. Parasit., II, 56, 568 - 572.

________ (1926) Trematodes from the bile ducts of birds of Russia. Rabot. Parazitol. Lab. I. Moskovsk. Gasudarstv. Univ., 57 - 72.

LEBOUR, M. V. (1905) Notes on the Northumbrian Trematodes. report Sci. Invest. Northumberland Sea Fish. Comm., 82 - 84.

________ (1909) Trematodes of the Northumberland Coast, No. III, A preliminary note on Echinsotephila virgula, a new trematode in the turnstone. Trans. Nat. Hist. Soc. Northumb., 3, N.S. 440 - 444.

LEBOUR, M. V. and ELMHIRST, R. (1927) A contribution towards the life of history of Parorchis acanthus, Nicoll, J. Mar. Biol. Assoc. Plymouth., Xii 829 - 832.

LEIDY, J., (1887) Tapeworms of Birds. Journ. Comp. med Surg., 8, 1 - 11.

LEIPER, R. T. (1908) An account of some helminths contained in Dr. C. M. Wenyon's collection from the Sudan. 3rd. report of the Wellcome Research Lab., Gordon Memorial College, Khartoum. 187.

________ (1912) Check list of helminths parasitic in cattle. J. Lond. School Trop. Med., I, 115

LEVIN, N. L. (1957) Life history Studies on Porrocaecum ensicaudatum, an Avian Nematode. J. Parasit., 43, 47 - 48.

LEVINE, P. P. (1938) Infection of chickens with Capillaria columbae. J. Parasit., 24, 45 - 52.

LEVINSEN, G. N. R. (1881) Bidrag til kindskab an Grønlands trematoden fauna. Overs. K. Danske Vidensk. Selsk. Forh., I, 52 - 84.

LEWIS, E. A. (1925) Starlings as distributors of 'Capes'. J. Helm., 3, 81 - 82.

________ (1926 a) Helminth of wild birds found in the Aberystywth area. J. Helm., 4, 7 - 12.

________ (1926 b) Starlings as distributors of 'Gapes' J. Helm, 4, 43 - 48.

________ (1930) An account of a survey of the parasitic helminths of some domesticated animals in Mid-Wales. J. Helm., 8, 1 - 8.

LINNAEUS, C. (1758) Systema Naturae per Regnen Trie Naturae. Laurentii Salvi Holmiae, 10, 1 - 823.

LINSTOW, O. von (1872) Sechs neue Taenien. Arch. Naturg. Jg. 38, 55 - 58.

________ (1873) Einige neue Distomum und Bemerkungen über die weiblichen Sezualorgane de Trematoden. Arch. Naturg., Jg., 39, 95 - 108.

________ (1873) Einige neue Nematoden nebst Bemerkungen über bekannte Arten. Arch. Naturg., Jg., 39, 293 - 307.

________ (1875) Beobachtung an neue und bekannten Helminthen. Arch. Naturg., Jg., 41, 183 - 207.

________ (1877) Enthelminthologica, Arch. Naturg. Jg., 43, 173 - 198

________ (1879) Helminthologische Studien. Arch. Naturg. Jg., 45, 165 - 188.

________ (1893) Zur anatomie und Entwicklungs geschichte der Taenien Arch. mikrosk., Anat., 42, 442 - 459.

________ (1900) Tetrabothrium cylindraceum Rud., und das Genus Tetrabothrium. Ctrbl. Bakt. u. Parasit., 27, 362 - 366.

________ (1901) Entozoa des zoologischen Museums der Kais. Bull. Acad. sc. St. Petersburg, 15, 271 - 292.

________ (1904) Zur Anatomie und Entwicklungs geschichte der Taenien. Arch. mikrsk. Anat., 42, 442 - 459.

________ (1905 a) Helminthen der russichen Polarexpedition, 1900 - 1903, Mem. Acad. St. Potersburg, 18, 16 pp.

________ (1905 b) Helminthologische Beobachtungen. Arch. mikrosk. Anat., 66, 355 - 366.

________ (1905 c) Neue Helminthen. Arch. Naturg., Jg. 71 267 - 276.

________ (1906) Neue und bekannte Helminthen. Zool. Jahb. Abt. Syst., 24 15 - 17.

LINTON, E. (1892) Notes on avian Entozoa. Proc. U.S. nat. Mus., 15, 87 - 113

__________ (1914) Notes on a viviparous distome. Proc. U.S. nat Mus. 46, 551 - 555

__________ (1927) Notes on the cestode parasites of Birds. Proc. U.S. nat Mus. 70, 1 - 75

__________ (1928) Notes on the trematode parasites of birds. Proc. U.S. nat. Mus. 73, 1 - 36

LONG, P. L. (1957) An account of a serious infestation with gapeworms (Syngamus trachea) in growing turkeys. World Poult. Sci. Journ., 13, 288 - 290.

LÖNNBERG, E. (1889) Bidrag till kännendonnen am i Sverige forekommende Cestoder. Svensk. Vet. Akad. Handlinger. 14, 469 pp.

__________ (1890) Helminthologische Beobachtungen von der Westküste Norwegens. I. Thl. Cestoden Svensk. Vet. Akad. Handlinger, 16, 47 pp.

__________ (1893) Bemerkungen über einige cestoden. Svensk. Vet. Akad. Handliner, 18, 17 pp.

__________ (1896) Cestoden Hamburger Magelhänische Sammelreise. Vol. 3.

LOPEZ-NEYRA, C. R. (1929) Consideraciones sobre el genero 'Davainea' (s.l.) y descripcion de das especies nuevas. Bol. Soc. espan. nat. Hist. Madrid, 29, 345 - 359.

__________ (1935) Sobre algunos generos de Dilepididae. Bol. Acad. Cien. Exact. Nat., Madrid, 1, 9.

__________ (1942) Division del genero Hymenolepis Weinland (s.l.) en otros mas naturales. Rev. Iberica Parasit., 2, 46 - 93, 113 - 256.

__________ (1944) Compendio de helminthtologia iberica. Rev. Iberica Parasit., 4, 75 - 96, 135 - 192, 209 - 342, 403 - 492.

__________ (1947) Los Capillariinae. Mem. Acad. Cien., Madrid, 12. 1 - 248.

__________ (1951) Analsis critica de los generos Choanotaenia, Anomotaenia, y afines con redescripcion do la Taenia porosa Rud., 1819, e invalidez de generos Paricterotaenia (Primera parte). Rev. Iberica Parasit., 11, 337 - 368.

__________ (1952) Idem. (Secunda parte y Final). ibidem, 12, 1 - 58.

LOOSS, A. (1899) Weitrere Beiträge zur Kenntnis der Trematoden fauna Aegyptens, zugleich versuch naturlichen Gliederung des Genus Distomum Retzius. Zool Jhb., Syst., 12, 521 - 784.

__________ (1900) Nachtragliche Bemerkungen zu der Namen von mir vorgeschlangen Distomidengattungen. Zool. Anz., 23, 601 - 608.

__________ (1902) Über neue und bekannte Trematoden aus Schildkroten, nebst Erörterungen zur Systematik and Nomenclature, Zool. Jhb. Syst., 16, 411 - 894.

LOOSS, A. (1907) Zur Kenntnis der Distomon familie Hemiuridae. Zool. Anz., 31, 585 - 620.

LÜHE, M. (1899) Zur Kenntnis einiger Distomen. Zoo. Anz., 22, 524 - 539

_______ (1909) Die Süsserwasser fauna det Deutschlands. I. Die Trematoden Heft. 17, 215 pp. Gustav Fischer. Jena.

_______ (1910) Die Süsserwasser fauna der Deutschlands. II. Cestoden Heft. 18, 153 pp. Gustav Fischer. Jena.

LUMSDEN, R. D. & ZISCHKE, J. A. (1963) Studies on the trematodes of Louisiana birds. Zeitschr. Parasit., 22, 316 - 366.

MADSEN, H. (1945) The species of Capillaria (Nematoda; Trichinelloidea) parasitic in the digestive tract of Danish Gallinaceous and Anatine Game birds with a revised list of species in birds. Dan. Rev. Game Biology I, 1 - 112.

_______ (1951) Notes on the species of Capillaria Zeder, 1800, known from gallinaceous birds. J. Parasit., 37, 257 - 265.

MAHON, J. (1954) Tapeworms from the Belgian Congo. Ann. Mus. Congo belge Zool. Sci., 5, 137 - 264.

MARKOWSKI, S. (1933) Untersuchungen über die Helminthenfauna der Raben (Corvidae) von Polen. Mem. Acad. Polon. Sc. et Lett. Cracovie, Ser. B., 5, 1 - 65.

MASSINO, B. G. (1929) Die Trematoden der Gattung Plagiorchis Lühe, 1899, der Vögel Russlands. Beitrag zue Konntnis der Helminthenfauna Russlands. Centrbl. Bakt., 2 Abt., 78, 125 - 145.

MAWSON, P.M. (1956) Ascaroid nematodes from Canadian Birds. Cand. J. Zool. 34, 35 - 47

MAYHEW, R. L. (1925) Studies on the avian species of the Cestode family Hymenolepididae. Illinois Biol. Monograph., 10, 125 pp.

MAXFIELD, B. G., REID, W. M. & HAYES, F. A. (1963) Gastrointestinal helminths from turkeys in south eastern United States. Journal of Wild Life Management, 27, 261 - 271.

MEGGIT, F. J. (1924) Cestodes of Mammals. London 282 pp.

_______ (1930) Report on a collection of cestodes mainly from Egypt. Conclusion. Parasit., 22, 338-345.

MEGNIN, P. (1881) De la caducité des crochets et du scolex lui-même chez les ténias. J. Anat. et Physiol., 17, 27 - 44.

_______ (1899) Un ténia du pigeonramier (Columba torquatus) Davanies Benini N. sp. Vol. Jubil. cinquintenaire, Soc. biol. Paris, (9), 1, 751 - 753.

MEHLIS, E. (1831) Anzeige von Creplin's 'Novae observationes de entozois'. Isis. Jg., p. 177.

MEHRA, H. R. (1937) Certain new and already known distomes of the family Lepodermatidae Odhner (Trematoda), with a discussion of the classification of the family. Zeitschri. Parasitenk., 9, 429 - 469

MENDHEIM, H. (1940) Beiträge zur Systomatik und Biologie der Familie Echinostomatidae (Trematoda). Nova Acta Leopoldina, 8, 489 - 588.

METTRICK, D. F. (1958a) Helminth parasites of Hertfordshire Birds. I. Trematoda. J. Helm., 32, 49 - 64.

__________ (1958b) Helminth parasites of Hertfordshire Birds. II. Cestoda. J. Helm., 32, 159 - 194.

__________ (1959) "On the nematode genus Capillaria in British Birds" Ann. Mag. nat. Hist., Ser. 13, 2, 65 - 84.

__________ (1960) Helminth parasites of Hertfordshire Birds III. Nematodes. J. Helm., 34, 259 - 266.

McGATH, (?)., (1920) Reference for Leucochloridium problematicum not traced.

McINTOSH, A. (1927) Notes on the genus Leucochloridium Carus. Parasit., 19, 353 - 364.

__________ (1932) Some new species of trematode worms of the genus Leucochloridium. Carus, parasitic in birds from Northern Michigan with a key and notes on other species of the genus. J. Parasit., 19, 32 - 53.

McINTOSH, W., and NICOLL, W. (1927) Additions to the marine fauna of St. Andrews since 1874. Ann. Mag. nat. Hist., Ser. 9, (19), 49 - 94.

MILLER, M. J. (1937) Experimental infection of pigeon and poultry with Ascaridia and Heterakis. Canad. J. Research, 15, (D), 105 - 110.

MIRAM, (?), (1840) Notata quaed de enthelm. Bull Soc. Natural Moscow, 2, 158.

MOGHE, M. A. (1925) A new species of Monopylidium, M. chandleri, from the red-nettled Lapwing (Sarcogrammus indicus Stoliczka) with a key to the species of Monopylidium. Parasit., 17, 385 - 400.

MOLA, P. (1929) Il nuovo genero Viscoia Mila, 1929. (Nota) Studi Sassaressi. 7.

MOLIN, R. (1859) Secunda parta. Idem. S.B. Akad. Wiss. Wien. math. Nat., Kl., 33, 287 - 302.

__________ (1860) Una Monographia del genre Spiroptera. S.B., Akad. Wiss. Wien. math Nat., Kl., 38, 911.

__________ (1861) Il sottordine degli acrofalli ordinato scientificamente secondo i resultamenti delli indogini anatomide ed embriogenide. Mem. Inst. Veneto di Sc. lett. edenti. Venezia. 9.

MONTAGU, (?) (1811) Reference for Fasciola trachea (i.e. Syngamus) not traced.

MONTICELLI, F. S. (1888) Reference for Urogonimus not traced.

_____ (1892) Nota intorna a due forme di Cestoda. Bull. dei Musei di Zoologia ed anatomia comp. della Universita di Torino, 7, 6.

MOOREHOUSE, N. F. (1944) Life cycle of Capillaria caudinflata, a nematode parasite of the common fowl. Iowa State Coll. J. Sci., 18, 217 - 253.

MORGAN, D. O. (1932) 'On three species of the genus Capillaria from the English Domestic fowl'. J. Helm., 10, 183 - 194.

_____ & WILSON, J. E. (1938) 'Observations on the helminth parasites of poultry in Scotland'. J. Helm., 16, 165 - 172.

_____ (1939) The occurrence of Heterakis gallinae in poultry and its relation to disease, breed and other helminths. J. Helm., 17, 177 - 182.

MOSGOVOY, A. A. (1952) The life cycle of Porracaecum crassum, a nematode of aquatic birds. Dokl. Akad. Nauk. SSSR., 83, 981 - 983.

_____ (1953) In Skrjabin 1956.

MUELLER, J., (1784) Reference for Plagiorchis vespertilionis not traced.

NEILAND, K. A., (1953) Leucochloridium perisorae a new species of trematode (Leucochloridinae) from the Oregon Jay. J. Parasit., 37, 563 - 568.

NESLOBINSKY, N., (1911) Zur Kenntnis der Vogeltaenien Mittelrusslands. Centrbl. Bakt. U. Parasit., 57, 436 - 442.

NEVEU-LEMAIRE, M., (1936) Traité d'helminthologie. Paris.1-1514.

NICOLL, W. (1907a) Parorchis n. nov. for Zeugorchis, Nicoll, 1906. Ann. Mag. nat. Hist., ser. 7, (19), 128.

_____ (1907b) Parorchis acanthus, the type of a new genus of trematodes. Quart. Journ. Microscop. Sci., 51, 345 - 355.

_____ (1909) Studies on the structure and classification of digenetic trematodes Quart. Journal MicroscopicSci., 53, 391 - 487.

_____ (1923) A reference list of the trematode parasites of British Birds. Parasit., 15, 151 - 202.

NOBLE, A. E. (1933) Two new trematodes from the American Coot. Trans. Amer. micro. Soc., 52, 353 - 360.

NÖLLER, W AND ULLRICH, K. (1927) Die Entwicklung einer Plagiorchis - Art. Sitzungsb. Gesellsch. Naturf. Fr., Berlin (4 - 7), 81 - 96

NORDMANN, A., von (1832) Mikrographische Beiträge zur Naturgeschichte der Wirbellosen Thiere. Heft. I, Berlin.

NORTON, C. C. (1964) A survey of Nematodes from the Lower Digestive Tract of Fowls. J. Helm., 38, 269 - 282.

ODENING, K., (1959) Über Plagiorchis, Omphalometra und Allocreadium. (Trematoda - Digenea) Zeitschr. Parasitenk., 19, 14 - 34.

ODHNER, T., (1900) Gymnophallus, eine neuer Gattung von Vogeldistomum. Centrbl. Bakt., I, 28, 12 - 23.

——— (1905) Die Trematoden des arktischen Gebeites, Fauna Artica, 4, 291 - 372.

——— (1910) Nordöstafrikanische Trematoden, grosstenteils vom Weissen Nile. I. Fascioloden. 4, no. 23A, 166 pp.

——— (1911) Zum natürlichen System der digenen Trematoden. Zoo. Anz., 37, 237 - 253.

——— (1912) Zum natürlichen System der digenen Trematoden. Zoo. Anz., 41, 54 - 71.

——— (1913) Zum natürlichen System der digenen Trematoden. Zoo. Anz., 42, 289 - 318.

OERSTED, A. S. (1844) Entwurf einer systematischen Einteilung und speciallen. Beschreibung der platwürmer. Kapenhagen. 1 - 96.

OGURI, M. and CHU, G. W. T. C. (1955) Influence of diet on the susceptibility of domestic ducks to parasitism by a marine trematode. Hawaiian Acad. Sci., (Abstract). 30th. Annual Meeting (1954-55)

OLIGER, I. M. (1950) Causes of destrobilization in cestodes of Tetraonidae. Dokladi Akad. Nauk. S.S.R. 74, 869 - 872.

OLSEN, O.W. (1937) A systematic study of the trematode sub-family Plagiorchiinae Pratt, 1902. Trans. Amer. Micor. Soc., 56, 311 - 339.

OLSSON, P. (1893) Bidrag till skandinaviens helminth fauna. I. Kongl. Svensk. Vetensk. Akad. Handl., 14, 4.

OROSZ, D., (1931) Capillaria - Arten des Hausgeflügels. In Aug. Diss. Budapest, 30 pp.

OSCHE, G. (1957) Die Wirtskreiser Weiterung bei parasitischen Nematoden und die sie bedingenden biologisch okdogischen Faktoren. Zeitschr. Parasit. 17, 437 - 489.

——— (1959) Uber zwischenwirte, fehlwirte und die Morphogenese der lippenregion bei Porrocaecum und Contracaecum- arte . (Ascaridoidea, Nematoda) Zeitschrift. Parasit., 19, 458 - 484.

OSIPOV, A. N. (1957) Epizootology of Heterakis in chickens. Trud. Mosk. Vet. Akad. 19, 30 - 42.

OWEN, R. W. (1951) The helminth parasites of domesticated birds in Mid-Wales. J. Helm., 25, 105 - 130.

__________ & PEMBERTON R. T. (1962) Helminth infection of the starling (Sturnus vulgaris L.) in Northern England. Proc. Zoo. Soc. (Lond.) 139 557 - 587.

PALLAS, P. S. (1781) Bermenkungen über Bandewürmer in Menschen und Tieren. Neue Nord. Physik., I, Petersburg und Leipzig. 39 - 112.

PARK, T. J. (1936) New trematodes from birds, Plagiorchis noblei sp. nov., (Plagiorchidae) and Galactosomum humbargari sp. nov. (Heterophyida Trans. Amer. Micro. Soc., 55, 360 - 365.

PARONA, C. (1899) Catalogo de elminto raccolti in Vertebrati dell' Isola d'Elba dal Dott. G. Damiani. Boll. Mus. Zool. Anat. Comp. Genova. 77, 16 pp.

__________ (1902) Idem. Boll Mus. Zool. Anat. Comp. Genoova 113 20 pp.

PATWARDAN, S. S. (1935) Three new species of trematodes from Birds. Proc. Indian Acad. Sci., 2, 21 - 28.

PAUDERE, V. Y. (1958) The helminth fauna of turkey and the dynamics of Ascaridia and Heterakis infections in the domestic fowl in Latvian.S.S.R. Trud. Inst. Biologii. Akad. Nauk Latv.S.S.R., 5, 263 - 269.

PAVLOV, A. N. (1955) In Skrjabin et all. 1957

PEARSE, A. S. (1936) Zoological names. A list of Phyla. Classes and Orders. Sect. F. A.A.A.S., Duke University Press, Durham. N.C., 1 - 24.

PEMBERTON, R. T. (1960) Helminth parasites of some British Birds. Ann. Mag. nat. Hist. ser. 13, 455 - 463.

__________ (1963) Helminth parasites of three species of British Gulls, Larus argentatus pont., L. fuscus L., and L. ridibundus L. J. Helm., 37, 57 - 88.

PERRIER, E., (1897) Traite de Zoologie. Part II. 1345 - 2140. Paris.

POCHE, F., (1907) Über die Kennzeichnung in ohrem Verhältnis zur Gültigkeit eines Namen. Zoo. Anz., 32, 99 - 106.

__________ (1925) Das System der Platodaria. Arch. Naturgesch, 2, 1 - 240.

__________ (1926) Das System der Platodaria. Arch. Naturgesch, 3, 241 - 458.

PONT, A. M. del (1926) Contribucion al estudio de los zoopárasitos de los animales alvajes. Semana medica, Buenos Aires, 26, 24 pp.

POTTS, F. A. (1932) In Borrodaile, L. A., and Potts, F. A., 'The Invertebrata' Camb. Univ. Press. 1 - 645.

PRATT, H. S. (1902) The Trematodes. Part II. Amer. Nat., 36, 887 - 910, 953 - 979.

PRICE, E. W. & McINTOSH, A. (1935) A new trematode Lyperosomum monenteron sp. nov. (Dicrocoeliidae) from a Robin. Proc. Helm. Soc. Wash., 2, 63 - 64

PRUDHOE, S. (1944) On some Trematodes from Ceylon. Ann. Mag. Nat. Hist., ser. II (II) 1 - 13.

RAILLET, A. (1892) Notices parasitologies remarques sur la classifications des cestodes parasites des oiseaux. Bull. Soc. Zool. France. 17, 115 - 117.

__________ (1893) Traité de Zoologie médicole et agricole. Paris.

__________ (1896) Quelques rectifications de nomenclature des parasites. Réc. Méd. Vet. (8) 3, no. 5 p. 159

__________ (1899) Sur la classification des téniades. Ctrbl. Bakt. u. parasit., 26, 32 - 34.

__________ (1900) Trématodes hepatiques des oiseaux. C.R.S.B., 52, 239 - 242.

__________ (1915) Reference not traced.

__________ (1916) Reference nottraced.

__________ et HENRY, A. (1909) Les cestodes des oissoaux par O. Fuhrmann Rec. Med. Vet. Alfort, 86, 337 - 338.

____________________ (1912) Helminthes recueilles par l'expedition antartique française du 'Pourquoi-pas'. I Cestodes d'oiseaux. Bull. du Muséo nat. d'hist. nat., 35 - 39.

____________________ (1912) Quelques Nématodes parasites de Reptiles. Bull. Soc. Path. Exot., 5, 251.

____________________ (1915) Sur les nématodes du genre Goezia Zeder. Bull. Soc. Path. Exot., 8(s), 270 - 275.

____________________ et SISOFF, P., (1912) Sur les Affinités des Dispharages (Acuaria, Bremser). Nematodes parasites des Oiseaux. C.R. Soc. Biol., 73, 622.

RANSOM, B. H. (1909) The taeniod cestodes of North American Birds. Smithsonian Institute, U.S. Nat. Mus. Bull., 69, 141 pp. 42 figs.

RASHEED, S., (1964) Systematic studies on the nematode parasites of marine fish from Pakistan. Ph.D. Thesis (Zoology) Univ. London.

READ, C. P., (1949) Studies on the North American Helminths of the genus Capillaria Zeder, 1800 (Nematoda) III. Capillarids from the lower digestive tract of North American birds. J. Parasit., 35, 240 - 249.

REES, F. G. (1933) On the anatomy of the Trematode Hypoderaeum conoideum Bloch, 1782, together with attempts at elucidating the life-cycle of two digenetic trematodes. Porc. Zool. Soc. Lond., 1932. 817 - 826.

_______ (1937) The anatomy and encystment of Cercaria purpurea Lebour, 1911. Proc. Zool. Soc. Lond., 107, 65 - 73.

_______ (1939) Studies on the germ cell cycle of the digenetic trematode Parorchis acanthus. Part I. Parasit., 31, 417 - 433

_______ (1940) Studies on the germ cell cycle of the digenetic trematode Parorchis acanthus. Part II. Parasit., 32, 372 - 391.

_______ (1952) The structure of the adult and larval stages of Plagiorchis (Multiglandularis) megalorchis n. nom., from the turkey and an experimental demonstration of the life history. Para., 42, 92 - 113.

REIBISCH, J. (1893) Trichosomum strumosum n. sp., ein parasit aus dem Epithel des oesophagus von Plasianus colchius. Arch. Naturg., 59, 331 - 340

REPORT, (1961) Report on the Animal Health Services in Great Britain, 1959. H.M.S.O., London.

RIDLEY, D. S. & HAWGOOD, B. C. (1956) The Value of Formol-Ether concentration of Faecal Cysts and Ova. J. Clin. Path., 9, 74.

RITCHIE, J. (1915) A contribution to the parasitic fauna of the West Coast of Scotland. Glasgow Nat., 7.

ROBINSON, E. J. (1948) Notes on the life-history of Leucochloridium fuscostriatum n. sp. provis. J. Parasit., 33, 467 - 475.

ROSSETER, T. B. (1906) On Drepanidotaenia undulata (Kr.). J. Queckett Micro. Club 9, 269 - 274.

RUDOLPHI, C. A. (1795) in York and Maplestone (1926)

_______ (1802) Beobachtungen über die Eingeweidewürmer. Arch. f. Zool., 2, 65 pp.

_______ (1803) Neue Beobachtungen über Eingeweidewürmer Arch. f. Zool. Zoot., 3, 1 - 32.

_______ (1808) Entozoorum sive vermium intestinalium historia naturalis. Amestelaedami, I, 1 - 527.

_______ (1809) Entozoorum sive vermium intestinalium historia naturalis. 2, 457 pp.

_______ (1810) Idem.

_______ (1819) Entozoorum synopsis cui accodunt mantissa duplex et indices locupletissimi. Berolini.

RUF, M. (1958) Dissertation. Munich. 77. pp.

RUSSELL, J. H. T. (1958) A review of the genus Parorchis. J. Parasit., 44, sect.2.

RYSAVY, B. (1962) Neue Befunde von Bandewürmer (Cestoiden) der Vogel der Ordnung Passeriformes aus dem Gebiete der Tschechoslovakia. Vestnik. Cesk. Zool. Spol., 26, 14 - 24.

SANDEMAN, I. M. (1959 a) A contribution to the revision of the dilepid worms from Charadriiformes. Preliminary Note. Zoo. Anz., 163, 278 - 288.

__________ (1959 b) Capsulata edenensis gen. et sp. nov., a new cestode with an unusual type of growth, from Limosa lapponica (L.) with systematic notes on the genera Southwellia Moghe, 1925 and Malika Woodland, 1929. J. Helm., 33, 171 - 188.

__________ (1959 c) Une espèce nouvelle du genre Protorogynotaenia Fuhrmann. Ann. parasit. hum Comp., 34, 265 - 270.

SAVENCHENKO, M. E. (1959) Seasonal dynamics of Heterakis infections in Krivorogh Veterinariya, 36, 43.

__________ (1962) Individual variation and survival of Heterakis gallinae at different population densities. Zhurnal Obshchei Biologii, 23, 318 - 319.

SCHILLER, E. L. (1951) 'Studies on the helminth fauna of Alaska. VIII Some cestodes of the Pacific Kittiwake (Rissa tridactyla Ridgeway) with the description of Haploparaxsis rissae n. sp.' Proc. Helm. Soc. Wash., 18, 122 - 123.

SCHMIDT, J. E. (1894) Die Entwicklungsgeschichte und der anatomische Bau der Taenia anatina (Kr.). Arch. Naturgesch., 60, 65 - 112.

SCHRANK, F. P., von (1788) Vergeichnis der bisher hinlänglich bekannten Eingeweidewürmer nebst einer Abhandlung über ihre Anverwandschaften. München. 116 pp.

__________ (1790) Förtechning på några hittills obes krifue intestinal-krak. Vetensk. Ac. Handl. (N.S.) II, 118 - 126.

SCHULZ, R. E. (1932) Trematoden der Gattung Plagiorchis Lühe der Nagetiere. Vestnik. Microbiol. Epidemiol. i Parzit., II, 53 - 60.

__________ et SKWORZOW, A. A. (1931) Plagiorchis arvicolae aus der Wasseratte Zeitschrift, f. Parasit., 3, 765 - 774.

SCHULTZ, R. L. (1940) The genus Diorchis Clerc, 1903. Amer. Midl. Nat., 23, 382 - 389.

SCHWABE, C. W. (1951) Studies on Oxyspirura mansoni - thr tropical eyeworm of poultry. II. Life history. Pacific Sci., 5, 18.

SCOTT, R. E. (1957) Some intestinal parasites from an Iceland Redwing. British Birds. 50, 122 - 123.

SEMENOV, V. D. (1927) Vogel trematoden des wetlichen Bereiches der Union SSSR. Sammlung. Helminth. Arbeiten K.I. Skrjabin gewidnet. Moscou. 221 - 271.

SEURAT, L. G. (1913 a) Sur un Dispharage de la Chevêche et les Affinités du genre Acuaria Bremser. C.R. Biol. Soc., 74, 103.

__________ (1913 b) Sur le Spiroptère des Pies-grieches. Bull. Soc. Hist. nat. de l'afrique Nord, 4, 75.

SHABILOVITSCH, T. S. (1946) Cited in Skrjabin et al. 1957.

SHELSWELL, E. M. (1954) A re-description of Echinostephilla virgula Lebour, 1909 J. Helm., 28, 127 - 134.

SHIKHABOLOVA, N. B. (1959) Experimental data on immunity in Heterakis infection in domestic birds. Trud. Gelm. Lab. Akad. Nauk. S.S.S.R., 9, 377 - 383.

SHIPLEY, A. E. (1909) (a) The threadworms (Nematoda) of the Red grouse (Lagopus scoticus). (b) Internal parasites of birds allied to the grouse. Proc. Zool. Soc. Lond., 1909. (a) 335 - 350, (b) 363-368.

SIEBOLD, C. T. (1836) Syngamus trachealis. Ein doppelleiber Eingeweidewürmer. Arch Naturg., 2, 105 - 116.

SINHA, S. (1958) Studies on the trematode parasites found in Hyderabad State Zietschr. f. Parasit., 18, 161 - 218.

SING, K. S. (1964) Parasitological Survey of Kumaun Region XXIX. Ind. J. Helm., 16, 63 - 64.

SINITZIN, D. F. (1896) Les vers endoparasites des oiseaux des environs de Varsovie. Trav. Lab. du cabinet de zoologie de l'Université de Varsovie. 20 pp.

SINGH, S. N. (1949) 'Studies on the helminth parasites of Birds in Hyderabad State J. Helm., 23, 25 - 38.

SKRJABIN, K. I. (1913) Tracheophilus sisowi n. gen., n. sp., Ein Beitrag zur Systematik der Gattung Typhlocoelus Stossich und der verwandten Formen. Centrbl. Bakt., I., 69, 90 - 95.

__________ (1914) Vogel cestoden aus Russich Turkestan. Zool. Jahrb. Abt. Syst., 37, 411 - 492.

__________ (1916) Nématodes des oiseaux du Turkestan Russe. Ann. Mus. Zool. Ac. Imp. Sci. St. Petorb., 20, 457 - 557.

__________ (1924) Microntrematoden der Vögel Russlands. Centrbl. Bakt., II, 62, 1 - 6.

__________ (1926) (Reference for P. crassum not traced).

SKRJABIN, K. I. (1928) Sur la faune des trématodes des oiseaux de Transbaikali. Ann. Parasit. him Comp., 6, 80 - 87.

__________ (1947-1956) 'The Trematodes of Animals and Man'. Moscow. Akad. Sci. USSR. 12 volumes.

__________ et ANTIPIN, D. N. (1958) Superfamilie Plagiorchidae Dollfus, 1930. 'Trematodes of Animals and Man' Volume 14.

__________ et EVRANOVA, V. G. (1952) Principles of Trematodology. 'Trematodes of Animals and Man'. Volume .

__________ et MATHEVOSSIAN, E. M. (1945) Tapeworms - Hymenolepdidae of domestic and game birds. Moscow 488 pp.

__________, SHIKHABOLOVA, N. P., ET ORLOV, I. V. (1957) Trichocephalidae and Capillariidae of animals and man and the diseases caused by them. OSM. Nemat. 6, 587 pp.

SOLIMAN, K. N. (1955) Observations on some helminths from ducks in Southern England. J. Helm., 29, 17 - 26.

SOLOMAN, S. G. (1934) Note on the Entozoa of a Herring Gull shot at Millport, Glasgow Nat., 12, 20 - 23.

SOLOWIOW, P. (1911) Helminthologische Beobachtungen cestodes avium. Centrbl. Bakt., 60, 93 - 132.

__________ (1912) Vers parasitaries des oiseaux du Turkestan (Russe). Ann. Mus. Acad. imp. Sci., St. Petersb., 17, 86 - 115.

SPASSKY, A. A. et SPASSKAYA, L. P. (1954) The construction of the classification of the hymenolepids parasitic in birds. Trudy. Gelm. Lab. Akad. Nauk. SSSR., 7, 55 - 119.

SPREHN, C. E. W. (1932) Lehrbuch der Helminthologie. Berlin 998 pp.

STAFFORD, T. (1905) Trematodes from Canadian Vertebrates. Zoo. Anz., 28, 681 - 694.

STEINER, G. (1960) Chap. 3 in 'Nematology'. Sasser, J. N. and Jenkins, W. R. Univ. North Carolina Press. 48 pp.

STEWART, BONNER T. (1953) Thominx phasiannina (Nematoda - Capillaria) and other Nematodes from the Ring Neck Pheasant (Phasianus colchicus) in Illinois. J. Parasit., 49, 701 - 702.

STILES, C. W.(1896) Report upon the present knowledge of the tapeworms of poultry. Bull. 12. Bureau of animal Industry. U.S. Dep. Agric., Washington, 1 - 79.

__________ AND ORLEMAN, M. (1926) Le nomenclature des genre de cestodees Raillietina, Ransomia et Johnstonia. Ann. Parasit. hum. Comp., 4, 65 - 67.

STOICAN, E. (1960) Contribution to the study of helminths in Rooks. Probleme de Parasitologie Veterinara. Institutul de Patalogie Igiena Animala; Bucharest. No. 8, 67 - 74.

STOSSICH, M. (1890) Il genere Trichosoma Rud., Bull. Soc. Adviat. Sc. nat. Trieste, 12, 3 - 38.

__________ (1892) I distomi degli uccelli. Lavero monografico. Bull. Soc. adriat. Sc. nat. Trieste, 13, 143 - 196.

__________ (1895) Notizie elmintologiche. Boll. Soc. adriat. sc. nat., 15, p 44.

__________ (1896) Richercho elmintologiche. Boll. Soc. adriat. sc. nat., Trieste, 16, 143 - 196.

__________ (1897) Note parasitologiche. Boll. Soc. adriat. sc. nat., Trieste, 17, 1 - 10.

__________ (1899) La smembramento dei Brachycoelium. Boll. Soc. adriat. sc. nat. Trieste, 19, 7 - 10.

__________ (1900) Contributo all studio degli elminti. Boll. Soc. adriat. sc. nat. Trieste, 20, 1.

__________ (1902) Il Monostomum mutabile Zeder e le sue forme affini. Boll. Soc. adriat. sc. nat., Trieste, 21, 1 - 40.

STRENZKE, K. (1952) Der Wirtswechsel von Plagiorchis masculosus. Zeitschr. Parasit. 15, 369 - 391.

STUNKARD, H. W. (1938) Parasitic flatworms from Yucatan. Carn. Inst. Wash. Pibl., 491, 33 - 50.

__________ (1959) Specific determination in the trematode genus Gymnophallus Int. Congress of Zoology (15th). London July 1959. Report, 672 - 674.

__________ (1960) Further studies on the trematode genus Himasthla, with a description of H. mcintoshi sp. nov., H. pisicola sp. nov. and stages in the life-history of H. compacta sp. nov., Biological Bill, 119, 529 - 549.

__________ AND CABLE, R. M. (1932) The life-history of Parorchis avitus (Linton), a trematode from the cloaca of the Gull. Biol. Bull. 60, 179 - 186.

SZIDAT, L. (1936) Studien zur Systematik und Entwicklungs geschichte der Gattung Leucochloridium Carus. Zietschr. f. Parasit., 8, 645 - 653.

TADROS, G. (1965) Systematic studies on helminthes from mammals, birds, reptiles and fishes mainly from Africa. Ph.D. Thesis (Zoology) Univ. London.

TAYLOR, E. L. (1928) Syngamus trachea from starling transmitted to the chicken and some interesting physiological variations. Ann. Trop. Med. parasit., 22, 307 - 318.

TAYLOR, E. L. (1938) '<u>Davainea proglottina</u>' and disease in fowls. The pathogenicity of the common poultry parasites. An unknown factor in the causation of disease. Vet. R., <u>89</u>, 500 - 504.

THOMAS, L. G. (1937) On the life-cycle of <u>Contracaecum spiculigerum</u>. J. Parasit., <u>23</u>, 429 - 431.

THORNE, G. (1960) Principles of Nematology. McGraw-Hill Book Co. 553 pp.

TIMON-DAVID, J. (1950) Un Cyclocoelidé nouveau dans les sacs aériens de la Pie. <u>Cyclocoelum (Pseudohyptiasmus) Dollfusi</u> nov. sp. Bull Soc. Zool. Fr., <u>75</u>, 243 - 246.

______________ (1951) Recherches sur les trématodes de la Pie en Provence. Ann. Parasit. hum. Comp., <u>28</u>, 247.

______________ (1960) Recherches experimentales sur le cycle de <u>Dicrocoeliodes petiolatum</u> (Railliet, 1900). (Trematoda: Dicrocoeliidae). Ann. Parasit. hum. Comp., <u>35</u>, 251 - 267.

TRAVASSOS, L. (1914) Sobre as espécies brazileiras do gênero <u>Capillaria</u>, Zeder Braz. Med., <u>28</u>, 427 - 429.

______________ (1915) Contrabucioes para a conhecimento da fauna helminthologica brazileira. V. Sobre as espécies brazileiras do genèro <u>Capillaria</u>, Zeder. Mem. Inst. Oswaldo Cruz., <u>7</u>, 146 - 171.

______________ (1917) Espécies brazileiras do genêro. <u>Lyperosomum</u> Loss, 1899. Arch. Exot. Sup. Agric. Med. Vet., <u>3</u>, 7 - 24.

______________ (1918) Not traced (Taken from Yamaguti)

______________ (1919) " " " " "

______________ (1920) Contribuicao para o conhecimento da fauna helmintolojica brazileira. IX. Arch. Exot. Sup. Agric. e. Med. Vet., <u>4</u>, 85 - 91.

______________ (1922) Informacoes sobre a fauna helmintholojica de Matto Grosso. Folha. medica, <u>3</u>, 187 - 190.

______________ (1929) Note sobre Cyclocoeliidae. Inst. Oswaldo Cruz, Suppl. 6, 54.

______________ (1941) <u>Lutztrema</u> n.g. (Trematoda : Dicrocoeliidae) Mem. Inst. Oswaldo Cruz, <u>36</u>, 335 - 343.

______________ (1944) Revisao da familia Dicrocoeliidae Odhner, 1910. Monograph Inst. Oswaldo Cruz, <u>2</u>, 357 pp.

TSENG SHEN (1932) Etude sur les cestodes d'oiseaux de Chine. Ann. Parasit. hum. Comp., <u>10</u>, 105 - 128.

TUBANGUI, M. A. (1928) Trematode parasites of Philippine Vertebrates. Philipp. J. Sci., <u>36</u>, 251 - 271.

VALENTE, G. L. (1958) Vet. Italiana, 9, 693 - 698

VARICAK, T. & ERLICH, I (1944) Vet. Arhiv., 14, 137 - 142.

VATNE, P. D. (1963) Aspects of the biology of Heterakis gallinarum (Nematoda) in chickens and their host parasite.relations. Dissent. Abstracts, 24, 1767 - 1768.

VILLELA, J. B. (1961) Vallonia pulchella, an experimental snail host of Lyperosomum monenteron. J. Parasit., 47, 22.

VILLOT, E. (1875) Recherches sur les helminths libres au parasites des côtes de la Bretagne. Arch. Zool. expér., 80, 679 - 681, 1090 - 1101.

VILLOT, F. C. A. (1879) Organisation et develepment de quelques espèces des trématodes endoparasites marinus. Ann. Sc. nat Zool., 8, 24 - 26.

VOGEL, R. (1921) Ein cysticercus des Regen wurmes as Jugendform der Vogeltaenie. Dilepis undula (Schrank). Ctrbl. Bakt. u. parasit., 85, 370 - 372.

VOLZ, W. (1899) Die Cestoden der einheimischen Corviden. Zoo. Anz., 22, 265 - 268.

_________ (1900) Beitrag zur Kenntnis einiger Vogelcestoden. Inaug. Diss. Basel. Arch. Naturg., 331 - 335.

WAHID, S. (1961) 'On Amplicaecun iguana n. sp., with notes on Hexametra sewelli, Kalicephalus micrurus, and Viguiera euryoptera.'

_________ (1962) Studies on helminths of non-aquatic vertebrates mainly from Africa. Ph.D. Thesis (Zoology) Univ. London.

WAKELIN, D. (1963 - unpubl.) The species of Capillaria and the incidence of intestinal nematodes in the domestic fowl in Britain. Ph.D.(Sci) Thesis. University of London.

_________ (1963) Capillaria obsignata Madsen, 1945. (Nematoda) from the Black Swan. J. Helm., 37, 381 - 386.

_________ (1964) 'A survey of the intestinal helminth parasites in British Domestic Fowl'. J. Helm., 38, 191 - 200.

_________ (1965) On species of the genus Capillaria Zeder, 1800, (Nematoda) from British domestic fowl. J. Parasit., 55, 285 - 301.

WALKER, T. (1937) Preliminary report on the helminth parasites of poultry, wild-birds and small mammals of the South Wales area. Vet. J., 93, 28 - 31.

WARD, H. B. (1917) On the structure and classification of North American parasitic worms. J. Parasit., 4, 1 - 11.

WARDLE, R. A. and McLEOD, J. A. (1952) The Zoology of Tapeworms. Minneapolis. University of Minnesota Press.

WAWILOVA, N. M. (1926) Vogel nematoden des Moskauer Governments. J. Trab. Inst. Vet. Exp., 3.

WEBSTER, J. D. (1943) A revision of the Fimbriariinae (Cestoda: Hymenolepididae) Trans. Amer. Micro. Soc., 62, 390 - 397.

__________ (1949) Records of Cphryocotyle (Davaineidae) from Shore Birds. Trans. Amer. Micro Soc., 68, 104 - 106.

WEDL, C. (1856) Charakteristik mehrer grösstenteils neuer Taenien. S.B. Akad. Wiss. Wien. Math nat., Kl., 18, 5 - 27.

WEHR, E. E. (1954) Blackhead of turkeys primarily transmitted through the caecal worm eggs. J. Parasit., 40, 26.

WEINLAND, F. (1858) An essay on the tapeworms of man. Cambridge. 103 pp.

WERBY, H. J. (1928) On the trematode genus Harmostomum with descriptions of a new species. Trans. Amer. Micro. Soc., 47, 68 - 81.

WILLIAMS, I. C. (1962) A list of parasitic worms, including 22 new records from British Birds. Ann. Mag. nat. Hist., ser. 13, 4, 467 - 480.

WITENBERG, G. (1923) The trematodes of the family Cyclocoeliidae and a new principle of their systematics. Helminthofauna Russica. Helminth. Div. Inst. Exper. Vet. Med. Moscow. 61 pp.

__________ (1925) Versuch einer Monographie de Trematoden unterfamilie Harmostominae Braun. Zool. Jahrb., 51, 167 - 254.

__________ (1928) Notes on the Cyclocoeliidae. Ann. Mag. nat. Hist., ser. 10, 2, 410 - 417.

WOLFFHÜGEL, K. (1900) Beitrag zur Kenntnis der Vogel helminthen. Inaug. Diss. Basle.

__________ (1936) Fimbriariinae (Cestoda). Z. Infektionskr. u. Hyg. Haustiere 49, 257 - 291.

WU, L. Y. (1938) Parasitic trematodes of tree sparrows Passer montanus taiwanensis Hartert from Canton with a description of three new species. Lignan Sci. J., 17, 389 - 394.

YAMAGUTI, S. (1935) Plagiorchis maculosus (Rud., 1802) aus der Japanischen Schwalbe Hirundo rustica gutturalis (Scopoli). Zeitschr. Parasit., 7, 513 - 514.

__________ (1935 b) Studies on the helminth fauna of Japan. Part 6. Cestodes of Birds. I. Jap. J. Zoo., 6, 182 - 232.

__________ (1935 c) Studies on the helminth fauna of Japan. Part 12. Avain Nematodes, I. Jap. J. Zool., 6, 403 - 431.

YAMAGUTI, S. (1939) Studies on the helminth fauna of Japan. Part 25. Trematodes of birds. IV. Japan. J. Zool., 8, 129 - 210.

__________ (1940) Studies on the helminth fauna of Japan. Part 30. Cestodes of birds. II. Jap. J. Med. Sci., Part VI. Bact - Parasit., I, 175 - 211.

__________ (1941) Studies on the helminth fauna of Japan. Part 36. Avian Nematodes II. Japan. J. Zool., 9, 441 - 480.

__________ (1958) Systema Helminthum. Vol. I. The Digenetic Trematodes, New York. 1575 pp.

__________ (1959) Systema helminthum. Vol. II. Cestodes of Vertebrates. New Work and London. Interscience Publishers. 860 pp.

__________ (1961) Systema Helminthum. Vol. III. Nematoda. New York and London. Interscience Publishers. pp

__________ AND MITUNAGA, Y. (1943) Trematodes of Birds from Formosa. I. Trans. Nat. Hist. Soc. Taiwan. (241). 33.

YAMASHITA, J. (1937) Studies on the Echinostoma. Part II. A list of the family Echinostomatidae, Trematode parasites of Reptiles, Birds and Mammals, arranged systematically. Trans. Sapporo. Nat. Hist. Soc., 15, 82 - 95.

YEH, L. S. (1954) On two new species of the genus Serticeps (Nematoda:- Schistorophidae) from the Gizzard of Birds. J. Helm, 28, 165 - 170.

ZEDER, F. G. H. (1800) Erster Nachtrag zur Naturgeschichte der Eingeweidewürmer, von J. A. C. Goeze. Leipzig.

__________ (1803) Anleitung zur Naturgeschichte der Eingeweidewürmer. Bamberg. 432 pp.

ZELIFF, C. V. (1943) A new species of Cyclocoelum, a trematode from the Catbird. J. Wash. Acad. Sci., 33, 255 - 256.

ZELLER, E. (1974) Leucochloridium paradoxum Monographische Darstellung der Entwicklungs - Lebensgeschichte des Distomum macrostomum Bibliotheca Zool., Heft. 4, 66 pp.

ZSCHOKKE, F. (1903) Die arktischen Cestoden. Fauna Artica, 3, 20 - 24.