

Original papers

Morphometrical and ecological analysis of nematodes of the family Capillariidae (Neveu-Lemaire, 1936) in wild ducks (Anatinae) from the north-western Poland

Agata N. Stapf, Katarzyna M. Kavetska, Piotr P. Ptak, Izabella Rząd[1]

Laboratory of Biology and Ecology of Parasites, Faculty of Biotechnology and Animal Husbandry, West Pomeranian University of Technology, Doktora Judyma 20, 71-466, Szczecin, Poland
[1]Department of Ecology and Environment Protection, Faculty of Biology, University of Szczecin, Wąska 13, 75-415 Szczecin, Poland

Corresponding author: Piotr Ptak; e-mail: piotr.ptak@zut.edu.pl

ABSTRACT. West Pomerania is located on the migratory route of many species of birds. Among them are many representatives of wild duck species (subfamily Anatinae), which are often the primary hosts of many helminths due to the fact of living in two different environments: terrestrial and aquatic. However, until the end of the 90s, research conducted in Poland on the helminth fauna of wild birds, including nematodes of the family Capillariidae, did not include the north-western region of the country. These first studies performed in 1999, aimed at the identification of the nematodes of wild ducks from the West Pomerania region, revealed the presence of three species belonging to family Capillariidae, i.e. *Capillaria anatis* (Schrank, 1790) Travassos, 1915, *Eucoleus contortus* (Creplin, 1839) Gagarin, 1951 and *Pseudocapillaria mergi* (Madsen, 1945). The purpose of the current study was to perform a comprehensive ecological analysis of *C. anatis*, *E. contortus* and *P. mergi*, including such factors as intensity, prevalence, relative density, index of fidelity and dominance index. The experimental material comprised 811 nematodes isolated from the gastrointestinal tracts of 953 ducks. These 9 species of ducks belong to three different tribes of the Anatinae subfamily: Anatini (*Anas clypeata*, *A. crecca*, *A. platyrhynchos*), Aythyini (*Aythya fuligula*, *A. marila*) and Mergini (*Bucephala clangula*, *Clangula hyemalis*, *Mergus merganseri*, *Somateria mollissima*) and diverse in terms of their biology and ecology. The morphometric and morphological analyses fail to identify any significant differences in the body structures of nematodes of the species *C. anatis*, *E. contortus* and *P. mergi* of the West Pomerania region in comparison with those found in other regions of Poland and Europe. The ecological analysis of the Capillariidae family in the West Pomerania region revealed that ducks of the tribe Anatini (mainly *A. platyrhynchos*) are the most common hosts of *E. contortus* species, *C. anatis* is most commonly found in ducks of the tribe Aythyini, and *P. mergi* is relatively frequent in ducks of the tribe Mergini (mainly in *M. merganser*).

Key words: Capillariidae, *Capillaria anatis*, *Eucoleus contortus*, *Pseudocapillaria mergi*, wild ducks, ecology, north-western Poland

Introduction

The family Capillariidae (Neveu-Lemaire, 1936) is one of the five families belonging to the superfamily Trichinellidae and comprises more than 300 known species of parasitic nematodes of all classes of vertebrates around the world, including 121 species occurring in Europe [1,2]. In Europe, the range of the nematode species *C. anatis* and *E. contortus* encompasses 17 countries found in the central and southern parts of the continent, while the parasitic species *P. mergi* is observed only in Austria, Denmark, Germany, Poland and Russia [2]. The morphological diversity of the family Capillariidae and the lack of specialised knowledge of the morphology and morphometry of their constituents are the cause of many difficulties in structuring their phylogenetic tree [3,4]. The currently accepted taxonomy distinguishes 17 genera within the Capillariidae family, i.e.

Amphibiocapillaria, *Aonchotheca*, *Pseudocapillaria, Calodium*, *Capillaria*, *Echinocoleus*, *Eucoleus*, *Liniscus*, *Nematoideum*, *Paracapillaria*, *Pearsonema*, *Piscicapillaria*, *Pseudocapillaria*, *Pterothomnix*, *Schulmanela*, *Tenoranema* and *Trichosoma* [2]. The nematodes occurring in wild ducks belong to three of these genera, namely *Capillaria*, *Eucoleus* and *Pseudocapillaria* [3,4].

In Poland, the available morphological and morphometric studies of the family Capillariidae were carried out in the Masovian Lowland, Lower Silesia and West Pomerania [5–7]. A study conducted in 1999 on the Western Pomerania region by the Laboratory of Biology and Ecology of Parasites of West Pomeranian University of Technology in Szczecin, revealed the presence of three species of nematodes of the family Capillariidae, belonging to the genera *Capillaria*, *Eucoleus* and *Pseudocapillaria* [6,8–10].

Nematodes of the genus *Capillaria* Zeder, 1800 (syn. *Trichocephalus*, *Trichosoma*, *Trichosomum*) are found in many avian hosts. A common host species of nematodes of this genus is the garganey (*Anas querquedula*), but they can also be found in teal (*A. crecca*), mallard (*A. platyrhynchos*) and the domestic duck *A. platyrhynchos dom.* [11]. Among most characteristic traits of the *Capillaria* genus are the presence of strongly sclerotised spicules in males, the lack of caudal lateral alae, the presence of a spiny spicular sheath and a rounded posterior end with two lateral or dorsolateral lobes [3,4,11–13]. A nematode species typical of this genus is *Capillaria anatis* (Shrank, 1790) Travassos, 1915. *C. anatis* most often settles in the body of the host in the caeca, and sometimes in the small intestine [11]. The life cycle is direct. The development of larvae in the egg lasts 11–12 days, and maturity in the host organism is obtained within 12–14 days after infection [3,4].

The genus *Eucoleus* Dujardin, 1845 (syn. *Thominx*) comprises parasitic nematodes of the respiratory and digestive systems of birds and mammals. The typical host species is the carrion crow (*Corvus corone*), but the nematode is also frequently found in the mallard, domestic duck, tufted duck (*Aythya fuligula*), scaup (*A. marila*) and common goldeneye (*Bucephala clangula*) [11]. The characteristic features of males of this genus are slender spicules, moderately sclerotised with a long spicular sheath densely covered with cuticular spines, the presence of lateral alae, two small laterally rounded lobes directed to the posterior which form pseudobursa, as well as a short pharynx, whereas in females, a vulva with a cuticular appendage, the epiptygmata, can be seen, and the egg shell has a porous structure [3,4,11–13]. Typical nematode species of this genus is *Eucoleus contortus* (Creplin, 1829) Gagarin, 1951. In the body of the host, this nematode forming a characteristic spiral is found in the mucosa of the oesophagus, the beak, the crop, and in the oral cavity. The life cycle may be direct, if the eggs are ingested by the final host, or indirect, involving earthworms as an intermediate host. The development of larvae in the egg lasts about 12 days and organism reaches maturity in the host approximately 24 days after infection [3,4,14].

The genus *Pseudocapillaria* Madsen, 1945 (syn. *Baruscapillaria*, *Ichthyocapillaria)* comprises parasitic nematodes of the gastrointestinal tracts of fish and birds. Nematodes belonging to this genus have been identified in the goosander (*Mergus merganser*) and common goldeneye (*Bucephala clangula*) [11]. Characteristic body features of this genus are a long, well sclerotised spicule, non-spiny spicular sheath, the absence of caudal lateral alae, with the pseudobursa supported from both sides by one rounded or elongated lateroventral appendage with papillae [3,4,11,12]. A typical nematode species of the genus *Pseudocapillaria* is *Pseudocapillaria mergi*, which can be found in the body of the host throughout all sections of the intestine, stomach, cloaca and the bursa of Fabricius [11].

Until now, there has been no comparative ecological analysis of the nematodes of the family Capillariidae isolated from ducks found in West Pomerania. Their presence has only been reported in our earlier studies [8–10].

Therefore, the aim of this paper is to present the ecological characteristics of the populations of nematodes of the species *C. anatis*, *E. contortus* and *P. mergi*, supplemented by their morphological and morphometric descriptions.

Materials and Methods

The material consisted of nematodes isolated from the digestive tracts of 953 wild ducks belonging to three tribes: dabbling ducks (Anatini), diving ducks (Aythyini) and sea ducks (Mergini). The entire gastrointestinal tracts were extracted during dissections of the birds. Each digestive tract was divided into nine sections: oesophagus,

proventriculus, gizzard, duodenum, jejunum, ileum, caeca, rectum and cloaca. The first three sections (oesophagus, proventriculus and gizzard) were directly examined for the presence of helminths by stereomicroscopy, while the decantation method was applied for the intestines. Isolated parasites were fixed in 70% ethanol.

To identify the nematodes, they were subjected to the action of lactic acid, or long-term glycerol clearing. Measurements were made using a light microscope equipped with a measuring eyepiece under phase contrast. *Capillaria* species were identified based on published keys and descriptions of the species available in the literature [15–17]. From the gastrointestinal tracts of examined birds, 16 321 nematodes were isolated, of which 811 (5%) were assigned to three species: *Capillaria anatis*, *Eucoleus contortus* and *Pseudocapillaria mergi*. Due to isolated nematodes being partially damaged, a group was selected for morphological studies. The group included 15 *C. anatis* specimens (4 males and 11 females), 10 specimens of *E. contortus* (2 males and 8 females), and 7 nematodes of *P. mergi* (4 males and 3 females).

Results

Nematode taxonomy is based on specific morphological elements, which in Capillariidae males, are the shape of the pseudobursa and the length and shape of the spicule, while in females, these are the shape of the vulva and eggs, and their dimensions.

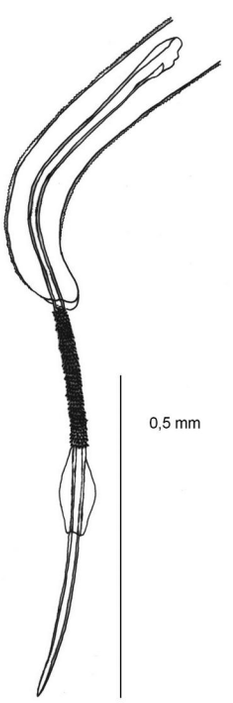

Fig. 1. *Capillaria anatis*, male rear body end

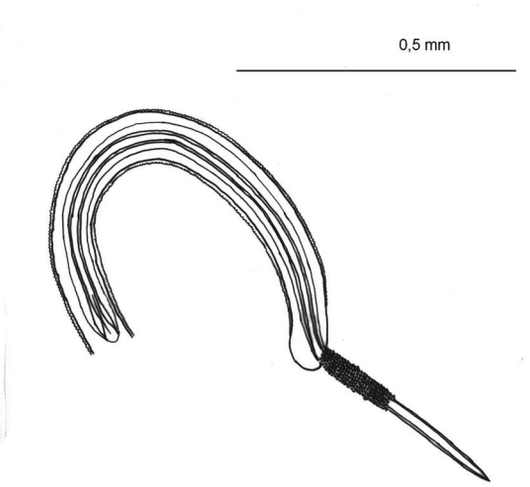

Fig. 2. *Capillaria anatis*, male rear body end

Nematodes of the species *C. anatis* settled mainly in the caeca, but a small number of them was also found in the ileum and rectum. These are parasitic worms with a filamentous body, milky white in colour; the males are 8–10 mm long while the females are 7–14 mm long. The dimensions of the body structures are shown in Table 1. The posterior end of the *C. anatis* male is equipped with two dorsolateral lobes. The spicule is long with thin walls, well sclerotised and pointed at the end, and expanded only in the proximal part (0.02 mm). Along its entire length, the spicule is hidden in a

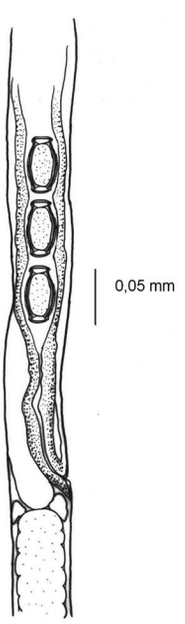

Fig. 3. *Capillaria anatis*, female vulva region

Table 1. Morphometric characteristics of three nematode species: *Capillaria anatis*, *Eucoleus concortus* and *Pseudocapillaria mergi*

Nematode species/ Author	Czapliński 1960		Baruš et al.1978		Madsen 1945		Present study	
	m	**f**	**m**	**f**	**m**	**f**	**m**	**f**
C. anatis								
TL	7.0-16.1	8.4-24.8	8.2-12.2	18.0-20.7	7.0-12.2	8.4-14.9	7.71-10.55	6.83-14.04
BWGE	0.05-0.07		0.045-0.051	0.056-0.062			0.035-0.042	0.04-0.05
SL	1.22-1.86		0.91-1.59		1.22-1.83		0.63-0.925	
EL/W	0.050-0.065 × 0.027-0.032		0.055-0.061 × 0.023-0.031		0.049-0.065		0.4-0.052 × 0.022-0.025	
E. contortus								
TL	15.0-17.0	28.0-32.0	12.0-16.2	17.2-36.8	6.1-25.6	15.4-38.6	13.34	26.81-39.59
BWGE	0.05-0.7		0.052-0.078	0.090-0.120			0.05-0.09	0.05-0.14
SL	0.8-1.2		1.52-1.8				0.55	
SSL	0.8				2.02		1.78-2.08	
EL/W	0.048-0.055 × 0.021-0.028		0.050-0.069 × 0.025-0.029		0.046-0.063		0.05-0.57 × 0.02-0.025	
P. mergi								
TL			6.82-10.45	13.7-16.6	5.6-9.3	7.0-13.0	7.99-10.32	17.96-23.30
BWGE			0.048-0.057	0.055-0.068			0.2-0.04	0.025-0.055
SL			1.1-1.25		0.92-1.53		1.05-1.59	
EL/W			0.048-0.053 × 0.023-0.028		0.041-0.054		0.045-0.05 × 0.02-0.025	

Explanation: TL – total body length, BWGE – body width at glandular esophagus, SL – spicule length, SSL – spicule sheath length, EL/W – egg length/width, m – male, f – female

sheath that is densely covered with spines along its distal part (Figs. 1 and 2). The vulva of the females does not have any appendages and does not protrude beyond the line of the body. The shell of the egg possesses characteristic ornamentation and forms collar-like structures at the poles. The eggs also have bipolar plugs (Fig. 3).

E. contortus parasitises the mucosa of the oesophagus. Against the background of the sectioned organ they took the form of coiled springs, firmly attached to the walls. Their body is long, filamentous, and white in colour. The body length of the males is about 13 mm, while in females, it ranges from 27 to 40 mm. The dimensions of particular body structures are shown in Table 1. The caudal end of the male is provided with lobular appendages, 0.017–0.02 mm in diameter, forming pseudobursa 0.032 mm in diameter. Both appendages carry a single, minute papilla. The spicule is long and thin, weakly sclerotised and not always entirely visible (Fig. 4). The spicule of the male ranged in length from 1.78 to 2.08 mm, whereas the visible part of the spicule was measured only in one specimen (0.55 mm). The sheath of the spicule is mostly smooth, with some spines in the distal part. The tiny spines covering the sheath are more visible closer to the pseudobursa. In the preparations of the proximal spicules, a fray in the shape of a leaf innervation was noted. In females, the vulva is situated on a small protuberance (Fig. 5). The eggs have bipolar plugs. A characteristic feature in *E. contortus* females is an imbrication of the eggs, which have not yet descended to the uterus. Due to the quality of the slides, stichocytes were recognized and counted only in some specimens: 25 to 35 stichocytes in females and 15 to 25 in males.

The main locations of *P. mergi* parasites were caeca of the host, but as with *C. anatis,* they also infested the jejunum and ileum. The distal end of male's body ends with pseudobursa, composed of two appendages, each with one papilla, surrounded by a membrane (Fig. 6). The spicule is long, well sclerotised and smooth. The spicular sheath has a heterogeneous structure along its entire length. In the proximal part it appears to have folded edges, while annulation is present in the distal section. The vulva of the female possesses distinctive

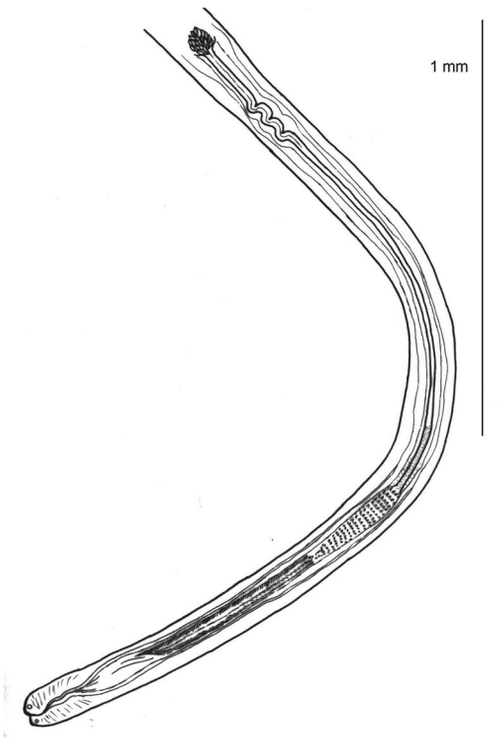

Fig. 4. *Eucoleus contortus*, male rear body end

epiptygmata, making it appear to be covered with a cap (Fig. 7). The eggs have plugs at both poles, and their shell is granular with chitinous collars surrounding the plugs.

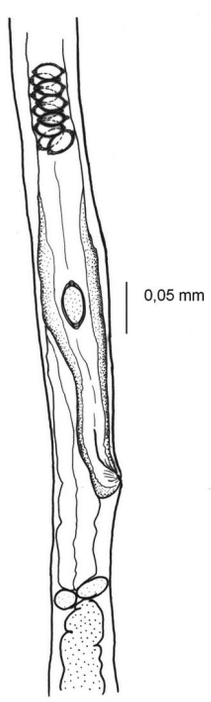

Fig. 5. *Eucoleus contortus*, female vulva region

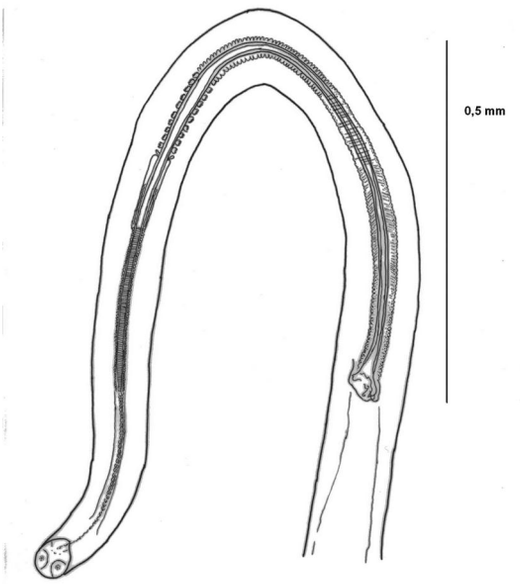

Fig. 6. *Pseudocapillaria mergi*, male rear body end

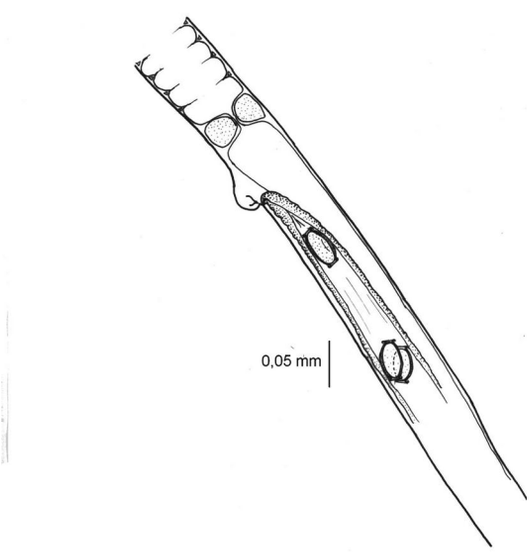

Fig. 7. *Pseudocapillaria mergi*, female vulva region

C. anatis was found in specimens of tufted duck, scaup, mallard, oldsquaw (*Clangula hyemalis*), common goldeneye, goosander and common eider (*Somateria mollissima*). Nematodes of the species *E. contortus* were observed in the mallard, scaup, tufted duck, northern shoveler (*Anas clypeata*), common teal and common goldeneye. Among the examined birds, only three species (*Mergus merganser*, *Clangula hyemalis* and *Anas platyrhynchos*) were infested with *P. mergi* nematodes. The ecological profile of the studied population of parasites is shown in Table 2.

Table 2. Ecological characteristics of population of nematode species from present study

Nematode and host species	Number of examined hosts	Number of hosts infected	Prevalence (%)	Intensity		Relative density	Dominance index
				Range	Average		
C. anatis							
Anas platyrhynchos (Mallard)	246	3	1.21	1-56	31.33	0.38	0.0046
Aythya fuligula (Tufted Duck)	242	14	5.78	1-16	4	0.23	0.0130
A. marila (Scaup)	151	17	11.25	1-26	8.76	0.99	0.1110
Bucephala clangula (Common Goldeneye)	42	2	4.76	1-6	3.5	0.16	0.0039
Clangula hyemalis (Oldsquaw)	146	1	0.68	9	9	0.06	0.0004
Mergus merganser (Goosander)	106	1	0.94	5	5	0.05	0.0004
Somateria mollissima (Common Eider)	4	1	25	38	38	9.5	2.3750
E. contortus							
Anas clypeata (Northern Shoveler)	5	2	40	1-8	4.5	1.80	0.7200
A. crecca (Teal)	11	1	9.09	2	2.0	0.18	0.0165
A. platyrhynchos (Mallard)	246	60	24.39	1-30	6.58	1.65	0.4045
Aythya fuligula (Tufted Duck)	242	1	0.41	1	1.0	0.004	0.00001
A. marila (Scaup)	151	1	0.66	6	6.0	0.03	0.0002
Bucephala clangula (Common Goldeneye)	42	1	2.38	4	4.0	0.09	0.0022
P. mergi							
Anas platyrhynchos (Mallard)	246	1	0.41	1	1	0.004	0.00001
Clangula hyemalis (Oldsquaw)	146	1	0.68	1	1	0.006	0.00004
Mergus merganser (Goosander)	106	8	7.54	1-6	2.44	0.19	0.0140

Ducks of the tribe Anatini, i.e. the mallard and northern shoveler, displayed the highest prevalence of *E. contortus* infections. The prevalence of this parasitic species in mallards was 24.0%, while in the shovelers, it reached 40.0%, however, due to the number of examined hosts, the latter value may be considered accidental. Of all nematodes isolated from mallards and shovelers, *E. contortus* appeared to be a subdominant species. In the helminth fauna of the remaining host species, the low dominance index (D<0.1), which determines the role played by a given species in the parasite community, indicates that this parasite is a rare specimen.

The analysis of environmental indicators associated with the *C. anatis* population shows that it is a typical parasite of ducks of the Aythyini tribe. Its prevalence in examined hosts was 5.8% in the tufted duck and 11.0% in scaup. *C. anatis* was found to be a dominant species in the nematode community of common eider (D=2.3750). However, due to the fact that this parasite infected only one of four tested eiders, the obtained dominance value cannot be considered as valid. The presence of *C. anatis* in three mallards, one oldsquaw and one goosander can suggest that these birds are accidental hosts of this parasite. Based on the dominance index, it was found that *C. anatis* is an intermediate species in the helminth fauna of scaup (D=0.1110), while it was rare in the nematode fauna of remaining species of ducks (D<0.1).

The highest incidence of *P. mergi* was reported for goosander (7.5%), whereas the lowest was noted in mallards (0.4%). The presence of only one parasite in one infested oldsquaw and one mallard suggests that for this host species, the *P. mergi* parasite is non-specific. Although this parasite was an accessoric species in the nematode fauna of the examined birds, it can be concluded that, in West Pomerania, *P. mergi* is a typical species in the Mergini tribe.

Conclusions

Although the results of the morphometric and morphological analyses fail to identify any significant differences in the body structures of nematodes of the species *C. anatis*, *E. contortus* and *P. mergi* of the West Pomerania region in comparison with those found in other regions of Poland and Europe, further research based on a larger group of nematodes is needed. The ecological analysis of the Capillariidae family in the West Pomerania region revealed that ducks of the tribe Anatini (mainly *A. platyrhynchos*) are the most common hosts of *E. contortus* species, *C. anatis* is most commonly found in ducks of the tribe Aythyini, and *P. mergi* is relatively frequent in ducks of the tribe Mergini (mainly in *M. merganser*).

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