STOMACH NEMATODES OF WILD DUCKS (SUBFAMILY ANATINAE) WINTERING IN THE NORTH-WESTERN POLAND

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Abstract

The purpose of this study was to present the structure of nematofauna community with particular emphasis on stomach (proventriculus and gizzard) nematodes in wild ducks wintering in large numbers in the North-Western Poland. Hosts (n=152) were represented by 17 species from eight genera belonging to three different ecological tribes: Anatini, Aythyini, and Mergini. Parasitic nematodes (n=14,396) were found in the digestive tract of 813 out of 1,052 birds (77.3%), with the vast majority of nematodes (93.9%) found in the gizzard (n=7,326) and proventriculus (n=6,198). Nematodes isolated from these organs represented 21 species from six families: Amidostomatidae, Acuaridae, Tetrameridae, Dioctophymatidae, Ascarididae, and Antiskidae. The most prevalent nematodes were from the genus Amidostomoides (n=6,686 individuals; 49.4%), and the most dominant species was A. monodon (5,013 nematodes).

Key words: ducks, gizzard, proventriculus, nematodes, Anatinae.

Interest in the helminthofauna of wild ducks (Anseriformes: Anatinae) results largely from the specific ecology of these birds. Wild ducks live in two environments - land and water, and hence have the greatest chance of contact with the invasive forms of parasitic worms. These birds are a very important part of aquatic ecosystems (both inland and marine ecosystems) throughout the entire northern provinces of the Eurosiberian region. The overwhelming majority of Anatinae changes their residence during the year, taking regular and often very long journeys between their breeding areas (tundra, taiga, banks of fjords) and wintering areas (Mediterranean basin and Eastern Africa) (12). Some species occur in Poland only during the flight, usually in March and April and again between August and November; while other, such as mallard (Anas platyrhynchos) and garganey (A. querquedula), nesting over almost all of Poland, are present in the territory throughout the year; still, many populations of these species also undertake long journeys (24, 26).

Some species of wild duck are now threatened with extinction. In Europe, the following breeding species are increasingly rare: wigeon (Anas penelope), pintail (A. acuta), garganey, ferruginous duck (Aythya nyroca) red-crested pochard (Netta rufina), and goosander (Mergus merganser). Researchers observe declining numbers of flocks of species that recently numbered many thousands wintering on the southern shores of the Baltic Sea: velvet scoter (Clangula hyemalis), common scoter (Melanitta nigra), and especially greater scaup (Aythya marila) (21, 24, 26). The causes of this phenomenon are not well understood. It seems that a comprehensive study of helminthofauna could help in better understanding the regulatory processes in the population of parasites, the role of parasites in regulating host populations, and consequently, biological factors involved in maintaining the biological balance of aquatic and terrestrial ecosystems.

Our previous studies have shown that parasitic nematodes represent approximately 11% of all helminths in the gastrointestinal tract of wild ducks (14-17). These parasites reside mainly in the proventriculus and gizzard, while flatworms, including tapeworms and flukes, occur almost exclusively in the intestines. The purpose of this study was to present the structure of nematofauna community with particular emphasis on stomach (proventriculus and gizzard) nematodes of numerous wild ducks wintering in the North-Western Poland.

Material and Methods

The material consisted of nematodes isolated from the digestive tract of 1,052 wild ducks (Anseriformes: Anatidae) wintering in the coastal zone of North-Western Poland, both on sea and inland
waters. The birds were collected for testing in 1999-2010. Hosts were represented by 17 species of ducks from eight genera belonging to three different ecological tribes: Anatini (Anas penelope, A. strepera, and A. crecca, A. platyrhynchos, A. querquedula, A. clypeata, a total of 236 specimens), Aythyini (Aythya ferina, A. fuligula, A. marila, a total of 379 birds) and Mergini (Somateria mollissima, Clangula hyemalis, Melanitta fusca, M. nigra, Bucephala clangula, Mergellus albellus, Mergus merganser; M. serrator, a total of 437 individuals). The study also included ducks hunted in Poland (A. platyrhynchos, A. crecca, Aythya ferina and A. fuligula, a total of 468 individuals), and protected species acquired dead from fishing nets (the remaining duck species, 584 birds in total).

The whole gastrointestinal tracts of the birds were collected and frozen at -18°C. After thawing at room temperature, the tracts were divided into nine sections: oesophagus, stomach (proventriculus and gizzard), duodenum, jejunum, ileum, caeca, colon, and cloaca together with the bursa of Fabricius. The birds were collected and the birds were collected for testing in 1999-2010. Hosts were represented by 17 species of ducks from eight genera belonging to three different ecological tribes: Anatini (Anas penelope, A. strepera, and A. crecca, A. platyrhynchos, A. querquedula, A. clypeata, a total of 236 specimens), Aythyini (Aythya ferina, A. fuligula, A. marila, a total of 379 birds) and Mergini (Somateria mollissima, Clangula hyemalis, Melanitta fusca, M. nigra, Bucephala clangula, Mergellus albellus, Mergus merganser; M. serrator, a total of 437 individuals). The study also included ducks hunted in Poland (A. platyrhynchos, A. crecca, Aythya ferina and A. fuligula, a total of 468 individuals), and protected species acquired dead from fishing nets (the remaining duck species, 584 birds in total).

The vast majority of nematodes (93.9%) were found in the gizzard (n=7,328), with fewer nematodes occurring only in the proventriculus (n=7). We identified 21 species of nematodes which could be assigned only to a certain genus (Table 1).

Results and Discussion

Parasitic nematodes (n=14,396) were found in the digestive tract of 813 out of 1,052 birds (77.3%). These parasites represented seven families: Amidostomatidae (n=6,771), Acuaridae (n=3,854), Tetrameridae (n=2,634), Capillariidae (n=861), Dioctophymatidae (n=167), Ascarididae (n=91), and Anisakidae (n=7). We identified 21 species of nematodes from 10 different genera, two genus-level taxa (Epomidiostomum sp. and Tetrameridae sp.), three family-level taxa (Ascarididae gen. sp., Acuaridae gen. sp., and Capillariidae gen. sp.), and 11 individuals, which could be assigned only to a certain genus (Table 1).

The vast majority of nematodes (93.9%) were found in the gizzard (n=7,326) and proventriculus (n=6,198). The remaining parasites (n=872) represented the family Capillariidae (n=861), adult Porrocaecum crassum (n=7), and Contraecaeum rudolphii (n=4), where Capillariidae resided mainly in the oesophagus (n=429) and caeca (n=336). These nematodes were less numerous in the intestines: jejunum (n=46), ileum (n=18), colon (n=29), and cloaca (n=3). Two species, P. crassum (Ascarididae) and C. rudolphii (Anisakidae), were found in the jejunum. No nematodes were found in the duodenum of the examined birds.

**Topospecificity.** Nematodes in the proventriculus. In the proventriculus, typical nematodes were from the genera Tetrameres and Echinuria, along with fewer Streptocara crassicauda, Eustrongylides mergorum, and Hystrichis tricolor.

Genus Tetrameres, in addition to its distinct organ specificity, is characterised by strong sexual dimorphism. Females, relatively large in mature form, do not resemble nematodes. They are strongly shortened with a distended egg-containing uterus, their shape is almost spherical, with only slightly protruding, thin and conical ends of the body. This strong "distension" of the central part of the female body makes the nematode extremely difficult to isolate from the proventriculus - it breaks easily and is destroyed, especially when collecting from frozen material. In addition, it is difficult to define systematic affiliation of such formed females. In fact, it is only possible on the basis of the accompanying much smaller male with a stringy body shape, living in the surface layer of mucous membrane and mucus itself.

Echinuria nematodes also live in the proventriculus. E. hypogonatha embeds itself deeply in the pores of the epithelial tissue that lines the proventriculus on the inside, and E. uncinata forms distinct nodules in the wall of the proventriculus, usually containing dozens of individuals. E. hypogonatha nematodes locate themselves in the gland (in strong infections, there are 2-3 nematodes in one gland) so that the front of the parasite is located in the gland's interior, and the rear end is located in the lumen of the stomach.

The usual site for S. crassicauda is the space under the stratum corneum (cuticula gastrica) of the gizzard. However, in our previous studies, a significant portion of these nematodes were found in the mucus of the proventriculus, which is probably related to the life cycle of the parasite. Additionally, one C. rudolphii was located in the mucus, and the remaining nematodes (the relatively large E. mergorum and H. tricolor) penetrated the front of the body very deeply, down to the layer of smooth muscles of the proventriculus, resulting in local inflammations and large nodules.

**Nematodes in the gizzard.** Amidostomoides nematodes occurred only in the gizzard, and with a characteristic separation of the habitats: A. acutum was located under the soft mucus layer of the gizzard cardia, A. monodon under the hardest part of the stratum corneum in the middle section of the gizzard, and A. petrovi both in the cardia and pyloric antrum, bypassing the central part of the gizzard. Another pattern was also observed: nematodes A. acutum and A. petrovi were arranged under the stratum corneum of the gizzard in a straight form or as a gently curved sinusoid, and A. monodon was almost always present in the form of...
quite tightly-rolled wad. Other species (from genera *Epomidiostomum*, *Streptocara*, *Porroccaeum*, and *Paracuaria*) also favoured the area under the stratum corneum in the gizzard; *Streptocara formosensis* were notably arranged in a characteristic sinusoid.

**Taxonomic structure.**

**Family Amidostomatidae** Travassos, 1919. Family Amidostomatidae in the examined ducks was represented by two genera: Amidostomoides Petrova, 1987 (subfamily Amidostomatinae Travassos, 1919) and *Epomidiostomum* Skrjabin, 1915 (subfamily Epomidiostomatinae Skrjabin and Schulz, 1937). Four species were found for the genus *Amidostomoides*: *Amidostomoides acutum* (Lundahl, 1848) Lomakin, 1991, *A. auriculatum* Lomakin, 1988, *A. monodon* (Linstow, 1882) Lomakin, 1991, and *A. petrovi* (Shakhthaitinskaya, 1956) Lomakin, 1991; which has been reported in earlier studies (14-17). These species differ substantially in the structure and ecology as they have hosts from different trophic groups (18). *A. acutum* was observed only in Anatini ducks (*Anas penelope*, *A. crecca*, *A. platyrhynchos*, *A. querquedula*, *A. clypeata*), one specimen of *A. auriculatum* was isolated from its typic host *A. querquedula* (also tribe Anatini), *A. monodon* was found only in *Mergini* (Somateria mollissima, *Clangula hyemalis*, Melanitta nigra, *M. fusca*, *Mergus merganser*), while *A. petrovi* was reported in ducks of the genus *Aythya*: *A. ferina*, *A. fuligula*, and *A. marila* (tribe Aythyni) and in the species *Bucephala clangula* (tribe *Mergini*).

Out of 85 nematodes of the genus *Epomidiostomum*, 81 (more than 95%) belonged to the species *E. uncinatum* (Lundahl, 1848) Seurat, 1918, one specimen was identified as *E. ryzhikovi* Lomakin, Zinovjeva, and Suporova, 1985, and one as *E. anatinum* Skrjabin, 1915. *E. uncinatum* were detected in three species of ducks: *A. platyrhynchos*, *C. hyemalis*, and *M. nigra*, and nematodes *E. ryzhikovi* and *E. anatinum* in *M. nigra* and *A. clypeata*, respectively. For two nematodes, only genus was determined (Epomidiostomoid sp.). Parasites of the genus *Epomidiostomum*, are relatively common in ducks, although their importance in the community was not as large as the *Amidostomoides* (2, 3, 5, 8-10, 19, 28). It is worth noting that in the examined birds, the presence of mixed nematode infection, including *Epomidiostomum* and *Amidostomoides* nematodes, was confirmed, as previously suggested by Lomakin (19-20), Ali (1-2), and Kavetska (16).

**Family Anisakidae** (Railliet and Henry, 1912)

Skrjabin and Karokhin, 1945. Specimens from the family Anisakidae, Contraeccae to rudolphi Hartwich, 1964, were observed in two very piscivorous mergansers. This nematode is a typical parasite of another piscivorous bird, cormorant *Phalacrocorax carbo sinensis* (13). The possibility of such a parasite-host system in *M. merganser* was reported in Japan by Yoshino et al. (28). Moreover, two badly damaged nematodes, identified only as *Anisakidae* gen. sp were found in mallards. This duck occasionally eats fish, although its diet is dominated by herbaceous feed.

**Family Ascarididae Baird, 1853.** In the fauna of wild *Anatinae* from the Northwestern Poland, family Ascarididae was represented by *Porroccaeum crassum* (Deslongchamps, 1824). Out of 84 specimens of this species, 77 (nearly 92%) were juvenile nematode specimens, which were found in the mallard gizzard, and seven adult parasites were found in the jejunum of this species.

**Family Tetrameridae** Travassos, 1914. The family Tetrameridae was represented by five species, all from the genus Tetrameres. Because of the lower quality of material, which was associated with freezing, only 1,207 nematodes were assigned to a particular species, while the remaining (n=1,427) were classified only at the genus-level. The greatest frequency in the community of identified parasites (n=783) was *T. fissispina*, observed in most examined ducks. Frequency and host specificity of the remaining species were very different. *T. spinosa* (n=370) was observed almost exclusively in the tribe Aythyini; *T. rjikovi* (n=43) in five species of ducks from two tribes: Mergini and Aythyni; *T. pavonis* (n=10) in *Aythya marila*, and *A. fuligula* (*Aythyni*) and a single specimen of *T. somaterea* were found in *Melanitta fusca* (*Mergini*).

**Family Acuariidae** Railliet, Henry and Sisoff, 1912. Family Acuariidae was represented by five species belonging to the genera: *Echinuria* Soloviev, 1912, *Paracuaria* Rao, 1951, and *Streptocara* Railliet, Henry, and Sisoff, 1912. Two species from the genus *Echinuria*: typical species (*species-typus*) *E. uncinata* (Rudolph, 1819) Soloviev, 1912, and *E. hypognatha* Wehr, 1937 were found. It should be emphasised that *E. uncinata* (n=937) was a characteristic parasite only for Anatini ducks, and *E. hypognatha* (n=2,443) was a parasite of *Mergini* ducks.

One specimen of Paracuaria aduncia (Creplin, 1846) was found in goosander (Mergus merganser), which is probably its accidental host. This parasite has previously been recorded in piscivorous birds from different orders and genera: Ciconiiformes (Gavia), Charadridiformes (Larus, Rissa, Sterna), and Ciconiiformes (Egretta) (25, 27).

Two species from the genus Streptocara: *S. crassicauda*, Creplin, 1829 (n=64) and *S. formosensis*, Sugimoto, 1930 (n=378) were also found. Typical species (*species-typus*) *S. crassicauda* was observed in long-tailed duck, common scoter, mallard, velvet scoter, and goosander. It is regarded as a cosmopolitan parasite of birds living in marsh and water environments. It was noted not only in its typical host family Anatidae (Anderson, 2000), but also in birds from genera Gavia, Recurvirostra, Huematopodus, Tringa, Arenaria, Larus, Gelocheidon, and Gallus (25).

**Family Dioctophymatidae** Railliet, 1915.

Family Dioctophymatidae was represented by two species from two genera: *Eustrongylides* Jägerskiöld, 1909 and *Hystrichis* Dujardin, 1845, found in the gizzards of the examined ducks. *E. mergorum* Rudolphi, 1809 (n=161) was found in the typical host, piscivorous *M. merganser*, and *H. tricolor* Dujardin, 1845 (n=6) was found in *A. platyrhynchos*. 
Table 1
Quantitative structure of the nematode groups (n=1,052) in the proventriculus and gizzard of wild duck subfamily *Anatinae*

<table>
<thead>
<tr>
<th>Nematode species</th>
<th>Frequency</th>
<th>Prevalence</th>
<th>Intensity</th>
<th>Relative density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n=13,524</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amidostomoides acutum</td>
<td>557</td>
<td>133</td>
<td>12.64</td>
<td>4.19</td>
</tr>
<tr>
<td>A. auriculatum</td>
<td>1</td>
<td>1</td>
<td>0.10</td>
<td>1.00</td>
</tr>
<tr>
<td>A. monodon</td>
<td>5,013</td>
<td>256</td>
<td>24.33</td>
<td>19.58</td>
</tr>
<tr>
<td>A. petrovi</td>
<td>1,115</td>
<td>233</td>
<td>22.15</td>
<td>4.78</td>
</tr>
<tr>
<td>Epomidiostomum anatinum</td>
<td>1</td>
<td>1</td>
<td>0.10</td>
<td>1.00</td>
</tr>
<tr>
<td>E. uncinatum</td>
<td>81</td>
<td>18</td>
<td>1.71</td>
<td>4.50</td>
</tr>
<tr>
<td>E. ryzhikovi</td>
<td>1</td>
<td>1</td>
<td>0.10</td>
<td>1.00</td>
</tr>
<tr>
<td>Epomidiostomum sp.</td>
<td>2</td>
<td>1</td>
<td>0.10</td>
<td>2.00</td>
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<tr>
<td>Contracaecum rudolphii</td>
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<td>1</td>
<td>0.10</td>
<td>1.00</td>
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<tr>
<td>Porrocaecum crassum</td>
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<tr>
<td>Tetracoccus fissispina</td>
<td>783</td>
<td>77</td>
<td>7.32</td>
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<tr>
<td>T. pavonis</td>
<td>10</td>
<td>2</td>
<td>0.19</td>
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<tr>
<td>T. somatiae</td>
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<td>1</td>
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<td>1.00</td>
</tr>
<tr>
<td>T. spinosa</td>
<td>370</td>
<td>45</td>
<td>4.27</td>
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<tr>
<td>T. ryzikovi</td>
<td>43</td>
<td>5</td>
<td>0.47</td>
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<td>1,427</td>
<td>128</td>
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<td>Echinaria hypognatha</td>
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<tr>
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<td>937</td>
<td>30</td>
<td>2.85</td>
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<tr>
<td>Paracuaria adunca</td>
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<td>1</td>
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<td>Streptocara crassicauda</td>
<td>64</td>
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<td>Eustrongylides mergorum</td>
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<td>39</td>
<td>3.71</td>
<td>4.13</td>
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<tr>
<td>Hystrichis tricolor</td>
<td>6</td>
<td>2</td>
<td>0.19</td>
<td>3.00</td>
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<tr>
<td>Nematoda gen. sp.</td>
<td>11</td>
<td>8</td>
<td>0.76</td>
<td>1.38</td>
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</table>
The quantitative structure of the community. The most frequent nematodes in the examined community were Amidostomoides (Table 1). This genus was represented by 6,686 individuals (49.4%), with distinctly dominant A. monodon (5,013 nematodes, dominance index 1.1600). Much fewer (only 557) nematodes were identified as A. acutum, a species typical for Amidostomoides (dominance<0.1). Nematodes from the genus Tetrameres were another group with exceptional importance in the grouping represented by 2,634 nematodes (19.5%) belonging to five species. The large importance of the types of genera Amidostomoides and Tetrameres confirms the observations of other authors (3-6, 10, 11, 20, 22, 25, 28).

The large share of genus Echinuria, especially E. hypognatha (2,443 individuals), is noteworthy. This parasite seems to be typical for Merigini ducks, including Melanitta nigra, M. fusca, and Clangula hyemalis, previously never tested on this scale. The importance of other species was much smaller, as their frequency did not exceed 3.0%.

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References