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Composition and structure of the helminth community of *Columba livia* (Gmelin, 1798) (Aves, Columbidae), in the municipality of Juiz de Fora, Minas Gerais state, Brazil

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Abstract. The objective of the present study was to describe the composition and structure of the helminth community present in domestic pigeons, in the municipality of Juiz de Fora, Minas Gerais, Brazil. The helminthological survey of 35 hosts revealed the presence of two digenetic trematodes, *Tanaisia (Paratanaisia) bragai* (prevalence 51.42%, mean intensity 288.8 ± 403.86 and mean abundance 148 ± 320.9) and *T. inopina* (prevalence 2.85% and mean abundance 0.68 ± 4.05); five cestodes, *Raillietina allomyodes* (prevalence 34.28%, mean intensity 6.66 ± 9.14 and mean abundance 2.28 ± 6.11), *Raillietina* sp. (prevalence 37.14%, mean intensity 9 ± 10.68 and mean abundance 3.34 ± 7.7), *Skrjabinia bonini* (prevalence 20%, mean intensity 2.14 ± 1.21 and mean abundance 0.42 ± 1), *Skrjabinia* sp.(prevalence 5.7%, mean intensity 6 ± 7 and mean abundance 0.34 ± 7) and *Fuhrmanneta* sp. (prevalence 2.85% and mean abundance 0.028 ± 0.16) and four nematodes, *Baruscapillaria obsignata* (prevalence 51.42%, mean intensity 29.72 ± 44.2 and mean abundance 15.28 ± 34.7); *Ascaridia columbae* (prevalence 51.42%, mean intensity 60.55 ± 79.88 and mean abundance 31.14 ± 64.2); *Tetrameres fissipina* (prevalence 14.28%, mean intensity 346.3 ± 504.4 and mean abundance 49.42 ± 212.1) and *Synhimanthus* (*Dyspharynx*) *nasuta* (prevalence 2.85% and mean abundance 0.028 ± 0.16). Among the examined hosts, 97.2 % were found parasitized by at least one helminth species. In accordance with the prevalence of each species *T. bragai*, *A. columba*e and *B. obsignata* were considered secondary species and *T. inopina*, *T. fissipina*, *S. nasuta*, *S. bonini*, *Skrjabinia* sp., *R. allomyodes*, *Raillietina* sp. and *Fuhrmanneta* sp. were considered satellite species. All the species exhibited aggregate distributions, which is the most common distribution pattern in helminth populations.

Key words: aggregation, distribution, domestic pigeons, ecology, helminth fauna, prevalence.

Introduction

The knowledge on helminth fauna of *Columba livia* (Gmelin 1798) (Columbidae) in Brazil was initiated with the investigation of parasitism in domestic animals, which lead to the publication of lists of helmith species, their hosts and geographical distributions. Besides helminth fauna investigation, early studies focused on taxonomy, new species descriptions and occurrence and prevalence reports.

Costa & Freitas (1970) published a list of helminth parasites of domestic animals in Brazil, reporting, *Ascaridia columbae* (Gmelin, 1750) (Nematoda, Ascaridiidae), *Capillaria columbae* (Rudolphi, 1815) (Nematoda, Capilariidae), *Dispharynx spiralis* (Molin, 1858) (Nematoda, Acuariidae) *Tetrameres fissipina* Diesing, 1861 (Nematoda, Tetrameridae), *Raillietina bonini* (Megnin, 1899) (Cestoda, Davaineidae) and *Tanaisia bragai* (Santos, 1934) (Digenea, Eucotylidae) as parasites of *C. livia*. Carneiro *et al*. (1975) registered *A. columbae*, *T. bragai*, *C. columbae*, *Raillietina* sp. and *T. confusa* infecting domestic pigeons in the municipality of Goiânia, Goiás state. Costa *et al.* (1986) reported the presence of *C. columbae*, *A. columbae*, *Raillietina allomyodes* e *R. bonini*, in the intestine, and *T. bragai* in the urinary tract of *C. livia*, in most of the Brazilian states. Silva (1990) accounted for the parasitism in *C. livia* by *D. spiralis* (prevalence 2.8%), *R. bonini* (45.71%), *T. bragai* (42.85%), *C. columbae* (25.7%) and *A. columbae* (11.42%), in the municipality of São Gonçalo, Rio de Janeiro state.

Recently, the majority of the studies are related to either the pathology in the definitive host or the life cycles of the helminthes of columbiform birds.

Considering the lack of data on the helminth community ecology in *C. livia*, the objective of this study is to describe the helminth community structure in *C. livia* at infracommunity and component community levels.

Material and methods

Thirty-five domestic pigeons (*C. livia)* from the municipality of Juiz de Fora were necropsied and examined for helminth parasites. All organs and corporal cavities were examined. The specimens found were collected and prepared according to the conventional helminthological techniques (Amato *et al*. 1991) and subsequently identified and quantified.

The ecological terminology employed in this study was that recommended by Bush *et al.* (1997). The following statistical procedures and ecological indexes were used to define helminth community structure: variance to mean ratio test for each species of helminth, to determine the distribution pattern of the infrapopulations; Simpson's index for concentration for dominance (dominance was assumed when c^3 0.25). The core-satellite species concept first utilized for helminth parasite communities by Bush & Holmes (1986a, 1986b) was applied. The components of the infra communities were classified in core species (present in more than two thirds of the hosts), secondary species (present in one to two thirds of the hosts) and satellite species (present in less than one third of the hosts).

The components were also defined by attributing importance values, based in abundance and prevalence of the species (Thul *et al.* 1985). Brillouin index (*H*) for diversity was calculated for each infracommunity, including the species with prevalence higher than 10% (Bush & Holmes 1986). Spearman coefficient of correlation ($p<0.05$) was calculated to determine the correlation between abundance of the species that occurred in the same organ.

Results

Component Community

Among the 35 hosts examined, 34 were parasitized by at least one helminth species, corresponding to a prevalence of 97.2%. A total of 8805 helminth specimens were collected, consisting of 225 cestodes, 3356 nematodes and 5224 digenetic trematodes.

We registered an average of 251.5 ± 401.5 parasites per infected host, with abundance amplitude of 1-1517. The infected hosts presented on average 8.3 ± 11.3 cestodes; 95.8 ± 214.1 nematodes and 290 ± 403.3 digenetic trematodes. The digenetic trematodes corresponded to 59.32 % of the total number of helminthes collected and thus it was the most important taxon, with mean abundance of 149.2 ± 320.9.

The cestodes corresponded to 2.55 % of the helminth specimens collected, with mean abundance of 6.42 ± 10.5 and the nematodes corresponded to 38.11 %, with mean abundance of 95.9 ± 214.1.

The identification of collected specimens revealed the presence of two digenetic trematodes, *Tanaisia (Paratanaisia) bragai* (Santos, 1934) (Eucotylidae) (prevalence 51.42%, mean intensity 288.8 ± 403.86 and mean abundance 148 ± 320.9) and *T. inopina* Freitas, 1951 (Eucotylidae) (prevalence 2.85% and mean abundance 0.68 ± 4.05); five cestodes, *Raillietina allomyodes* Kotlán, 1921 (Davaineidae) (prevalence 34.28%, mean intensity 6.66 ± 9.14 and mean abundance 2.28 ± 6.11), *Raillietina* sp. (prevalence 37.14%, mean intensity 9 ± 10.68 and mean abundance 3.34 ± 7.7), *Skrjabinia bonini* (Davaineidae) (prevalence 20%, mean intensity 2.14 ± 1.21 and mean abundance 0.42 ± 1), *Skrjabinia* sp. (prevalence 5.7%, mean intensity 6 ± 7 and mean abundance 0.34 ± 7) and *Fuhrmanneta* sp. (Davaineidae) (prevalence 2.85% and mean abundance 0.028 ± 0.16) and four nematodes, *Baruscapillaria obsignata* Madsen, 1945 (Capillariidae) (prevalence 51.42%, mean intensity 29.72 ± 44.2 and mean abundance 15.28 ± 34.7); *Ascaridia columbae* (Gmelin, 1790) (Ascaridiidae) (prevalence 51.42%, mean intensity 60.55 ± 79.88 and mean abundance 31.14 ± 64.2); *Tetrameres fissipina* Diesing, 1861 (Tetrameridae) (prevalence 14.28%, mean intensity 346.3 ± 504.4 and mean abundance 49.42 ± 212.1) and *Synhimanthus* (*Dyspharynx*) sp. (Acuariidae) (prevalence 2.85% and mean abundance 0.028 ± 0.16) (Table 1).

Table 1. Prevalence, community status, amplitude of the intensity, mean intensity, mean abundance and site of infection of helminths present in Columba livia (Gmelin), in Municipality of Juíz de Fora, Minas Gerais, Brasil.

Parasites	Total number of specimens	Prevalence (%)	Community status	Amplitude of the intensity	Mean intensity	Mean abundance	Site of infection	Life cycle
Digenea								
Eucotylidae								
Tanaisia(Paratanaisia) bragai (Santos, 1934)	5200	51.42	S	15-1517	288.8 ± 403.86	148 ± 320.9	Kidney colector ducts	Indirect
Tanaisia inopina Freitas, 1954	24	2.85	Sa	-	-	0.68 ± 4.05	Kidney colector ducts	Direct
Nematoda								
Capillariidae								
Baruscapillaria obsignata (Madsen, 1945)	535	51.42	S	1-165	29.72 ± 44.2	15.28 ± 34.7	Midgut	Direct
Ascarididae								
Ascaridia columbae (Gmelin, 1790)	1090	51.42	S	1-328	60.55 ± 79.88	31.14 ± 64.2	Midgut	Direct
Tetrameridae								
Tetrameres fissipina (Diesing, 1860) Travassos, 1914	1730	14.28	Sa	1-1116	346.3 ± 504.4	49.42 ± 212.1	proventriculus	Indirect
Acuariidae								
Synhimantus (Dispharynx) sp.	1	2.85	Sa	-	-	0.028 ± 0.16	proventriculus	Indirect
Cestoda								
Davaineidae								
Skrjabinia bonini (Mégnin, 1889)	15	20	Sa	1-4	2.14 ± 1.21	0.42 ± 1	Midgut	Indirect
Skrjabinia sp.	12	5.7	Sa	1-11	6 ± 7	0.34 ± 7	Midgut	Indirect
Raillietina sp.	117	37.14	Sa	1-35	9 ± 10.68	3.34 ± 7.7	Midgut	Indirect
Raillietina allomyodes (Kotlán, 1921)	80	34.28	Sa	1-33	6.66 ± 9.14	2.28 ± 6.11	Midgut	Indirect
Fuhrmanneta sp.	1	2.85	Sa	-	-	0.028 ± 0.16	Midgut	Indirect

The helmith component community showed low concentration for dominance as demonstrated by Simpson's index (C=0.146). After calculating the value of importance of each species, *T. (Paratanaisia) bragai, Raillietina* sp., *B. obsignata*, *T. fissipina* and *A. columbae* were considered co-dominant species and *T. inopina*. *Synhimanthus* (*Dyspharynx*) sp., *S. bonini*, *Skrjabinia* sp., *R. allomyodes* e *Fuhrmanneta* sp. were considered unsuccessful species (Table 2).

Among the satellite species, *Synhimanthus* (*Dyspharynx*) sp. and *Fuhrmanneta* sp. were the less prevalent. Only one female specimen of this nematode and fragments of the gravid proglotids of this cestode were found and, for this reason, it was unfeasible to accomplish their identification at species level.

All helminth species of the community showed aggregated distribution (Table 3). There was no significant association among species of helminths.

Table 2. Importance value attributed to the components of the helminth infracommunities present in Columba livia, in Municipality of Juiz de Fora, Minas Gerais, Brasil.

Species	Importance value	Interpretation
Tanaisia (Paratanaisia) bragai (Santos, 1934)	0.7	co-dominant
Tanaisia inopina (Freitas, 1951)	0	unsuccessful
Baruscapillaria obsignata (Madsen, 1945)	0.07	co-dominant
Tetrameres fissipina (Diesing, 1860) Travassos, 1914	0.06	co-dominant
Ascaridia columbae Gmelin, 1790)	0.14	co-dominant
Synhimanthus (*D.*) sp.	0	unsuccessful
Skrjabinia bonini (Mégnin, 1889)	0	unsuccessful
Skrjabinia sp.	0	unsuccessful
Raillietina sp.	0.11	co-dominant
Raillietina allomyodes (Kotlán, 1921)	0	unsuccessful
Fuhrmanneta sp.	0	unsuccessful

There was no obvious separation of helminthes into core species. According to the classification proposed by Bush & Holmes (1986), *T. bragai*, *A. columbae* and *B. obsignata,* most prevalent, were considered secondary species and *T. inopina*, *T. fissipina*, *Synhimanthus* (*Dyspharynx*) sp., *S. bonini*, *Skrjabinia* sp., *R. allomyodes*, *Raillietina* sp. and *Fuhrmanneta* sp. were considered satellite species.

Helminth infracommunities

Infection by only one helminth species was detected in 10 hosts (29.41% of parasitized hosts). Infections by more than one helminth species were more frequent, occurring in 70.58% of the hosts.

Table 3. Aggregated distribution pattern of the helminth infrapopulations present in Columba livia, in Municipality of Juiz de Fora, Minas Gerais, Brasil as demonstrated by the dispersion index.

Species	Dispersion index
Tanaisia (Paratanaisia) bragai (Santos, 1934)	693.37
Tanaisia inopina (Freitas, 1951)	24.19
Baruscapillaria obsignata (Madsen, 1945)	78.82
Tetrameres fissipina (Diesing, 1860) Travassos, 1914	911.06
Ascaridia columbae Gmelin, 1790)	132.74
Synhimanthus (*D.*) sp	1
Skrjabinia bonini (Mégnin, 1889)	2.40
Skrjabinia sp.	10.17
Raillietina sp.	17.89
Raillietina allomyodes (Kotlán, 1921)	16.39
Fuhrmanneta sp.	1

Five hosts (14.7%) were infected by two helminth species; seven hosts (20.58%) by three species; five (14.7%) by four species and seven (20.58%) by five helminth species.

Infections by only one nematode species were more frequent (50%) than infections by one cestode species (25%) or one digenetic species (25%). The presence of nematodes was registered in 80%, 87%, 100% e 100% of the infra communities composed by two, three, four and five helminth species, respectively.

Co-infection by two nematode species was more frequent (60%) than co-infection by cestode and digenetic species (20%) or by cestode and nematode species (20%).

Cestodes were present in 40%, 57.1%, 100% e 100% of the infra communities composed by two, three, four and five helminth species, respectively. Digenetic trematodes were present at 20%, 57.1%, 80% e 100% of the infra communities composed by two, three, four and five helminth species, respectively.

The helminth community showed low species richness (5). The number of species in the infracommunities varied between 1 to 5 species, 2.8 ± 1.5, in average. The mean diversity was 0.33 ± 0.34 and maximum diversity was 1.06.

Discussion

The component community was characterized by the co-dominance between *T. bragai*, *Raillietina* sp., *B. obsignata*, *T. fissipina* and *A. columbae*, the most prevalent and abundant species, and by the presence of unsuccessful or pioneer species: *T. inopina*, *Synhimanthus* (*Dyspharynx*) sp., *S. bonini*, *Skrjabinia* sp., *R. allomyodes* and *Fuhrmanneta* sp.

Among the unsuccessful species were *S. bonini* and *Synhimanthus* (*Dyspharynx*) sp., helminthes that were previously reported in *C. livia* (Foggie 1933; Freitas 1946, 1957; Giovannoni 1946; Giovannoni & Kullak 1947; Hwang *et al.* 1961; Martins & Freitas 1975; Rolas 1976).

The low prevalence of these species probably is related to a low ecological opportunity for infection, since these helminthes use intermediate hosts and thus the conclusion of their life cycles depends on the presence and abundance of these hosts in the environment. The biology of such parasites is influenced by complex ecological interactions and infecting the definitive host may be less favored in specific contexts.

The success of transmission by *T. bragai*, which also presents indirect life cycle, is enhanced by the capacity of the larval forms, present in the intermediate hosts, to reproduce asexually. The proliferation of the larva enhances the success of the infecting forms in colonizing the definitive host , resulting in an aggregated pattern of distribution of the sexual forms, favoring the genetic diversity and increasing the potential for adaptation to the host.

Helminth species previously described from other hosts, such as *R. allomyodes* and *T. inopina*, were also classified as unsuccessful or pioneer species. *Raillietina allomyodes* was described by Kotlán (1921), infecting *Psittaculirostris salvadorii*, in New Guinea.

Rolas (1976) reported this cestode species parasitizing *C. livia* in Brazil, however this author did not provide data on the prevalence or intensity of infection. Probably, *R. allomyodes* is a pioneer species in *C. livia* typical of infracommunities of other host species, since it was described in other continent, in a host phylogenetically distant of *C. livia* (Livezey & Zusi, 2007).

Tanaisia inopina was described by Freitas (1951) from specimens recovered from *Passer domesticus*, previously identified by Almeida (1936) as *T. zarudinyi*. Later, *Sterna* sp., *Icterus chrysocephalus* and *Coturnix japonica* were registered as new hosts for this species by Freitas (1959), Franco (1965) and Pinto *et al.* (2005), respectively.

The parasitism by *T. inopina* in *C. livia* was not previously registered in the literature. This trematode probably is a pioneer species in *C. livia*, once it was found in low prevalence (only one host infected) and utilizes land snails as intermediate hosts, which also participate in the biological cycle of *T. bragai* (Maldonado, 1945; Brasil & Amato, 1992; Keller & Araújo, 1992; Brandolini *et al.* 1997).

The present work register for the first time the occurrence of *T. inopina* in Minas Gerais State and is the first account for the co-occurrence between *T. bragai* and *T. inopina* in the same individual host.

From the 140 adult trematodes found in the kidney collector ducts of one individual host, 116 were identified as *Tanaisia (Paratanaisia) bragai* and 24 as *Tanaisia inopina*.

All the *T. inopina* specimens showed the uterus completely filled with eggs, indicating that its biological development was not harmed and thus this species probably presents potential for colonizing this new host species.

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