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Cestoda and Nematoda Helminthiasis Effect on the Red Fox Demographics

Key words: Red fox, *Vulpes vulpes*, Cestoda, Nematoda, fertility, Kirov region, survival rate, Russia

Purpose of the research is to describe infection rate of the red fox (*Vulpes vulpes L.*) with some intestinal parasites and to evaluate Nematodes and Cestodes helminthiasis effect on such host's characteristics as fertility and survival rate.

Material

1400 fox carcasses collected during 20 seasons in the southern taiga zone (Kirov region) have been studied for the research purposes. The following parameters have been defined: sex, age, weight, number of placentary maculae, condition factor (in two methods), roundworms and cestodes helminthiasis occurrence and the number of roundworms in gastrointestinal tract.

Methods

Animal age was determined by registering structures in teeth (Klevezal, Kleinenberg, 1967). Fatness was determined in two ways: 1) ranked (rated) by means of visual evaluation and 2) by means of weighing kidney fat. Modified standard demographic methods were used in demographic parameters evaluation (Koly, 1979, Seber, 1973 and others). Population size was determined by means of cumulative tables of V.S. Smirnov (1964, 1967). This method is similar in meaning to virtual population analysis (Fry, 1949).

Results

Helminthes systematic category was determined to the accuracy of a class (Platyhelmintes, Cestoda) and type (Nematoda). We did not aim at precise determination of the parasite species. This research studies parasites' toxic effect on a host, rather its demographic parameters as intestinal parasites' toxic effect differs on large taxon level.

Infestation extensity (frequency index). Mean cumulative invasion extensity of red fox' intestinal tract with flatworms and roundworms reached 62,2 % (Table 1). Roundworms infestation is much higher than that with flatworms. 38,1 % of all material is infested with roundworms only (Combination 2, Table 1), while 16,2 % of all animals are infested with roundworms and flatworms (Combination 3). Total infestation with roundworms mounts to 54,3 % (Combination 3+2). 8,7 % are infested with flatworms (Combination 1) and 16,2 % in combination with roundworms (Combination 3). Total flatworms invasion equals 24,1 % (Combination 3+1).

Infestation extensity among dogs is higher than that among vixens in the majority of combinations (Table 2).

Infestation intensity (abundance index). Roundworms infestation intensity among dogs is on mean higher than among vixens. It was higher within four out of five studied age intervals (Table 3).

Table 1 Infestation extensity of red fox population with various combinations of intestinal parasites

Combination	Extensity (frequency index)
Flatworms (1)	0,079
Roundworms (2)	0,381
Flatworms and roundworms (3)	0,162
Total flatworms (3+1)	0,241
Total roundworms (3+2)	0,543
Total infested (1+2+3)	**0,622**
Uninfested	0,378

Infestation intensity among dogs is not only higher than among vixens but it also increases significantly together with animal age. While we can observe opposite process among vixens – infestation intensity decreases significantly together with age (Table 3).

Variation of infestation parameters in different sex and age groups. Infestation extensity (frequency index) in the population in general decreases with animal age (Figure 1).

In case of roundworms infestation we can observe a significant down trend of infested animals percentage with age increase. In case with flatworms however the trend is not so dramatic.

Decrease of roundworms infestation extensity is achieved only by reduction of the number of infested vixens from 49,9% at the age of 0+ down to 25,7% at the age of 4++. Roundworms infestation extensity among dogs remains practically the same within all age groups – at the level of 61% on mean.

Table 2 Infestation extensity (frequency index) among dogs and vixens

Combination	dogs		vixens	
	Sample fraction	n	Sample fraction	n
Flatworms (1)	0,075	59	0,084	50
Roundworms (2)	0,411	322	0,341	202
Flatworms and roundworms (3)	0,199	156	0,113	67
Total flatworms (3+1)	0,274	215	0,197	117
Total roundworms (3+2)	0,610	478	0,454	269
Total infested (1+2+3)	**0,685**	**537**	**0,538**	**319**

Table 3 Roundworms infestation intensity (abundance index) among dogs and vixens

Age	dogs		vixens	
	Mean	Error of mean	mean	Error of mean
0+	7,98**	0,44	6,25	0,42
1+	7,94	1,04	8,82	0,90
2+	10,00	2,90	6,89	1,13
3+	10,00*	1,84	5,67	0,63
4++	12,43**	2,29	3,44	0,63
Total	**8,27****	**0,41**	**6,77**	**0,35**
* $p < 0.05$ between dogs and vixens; ** $p < 0.01$				

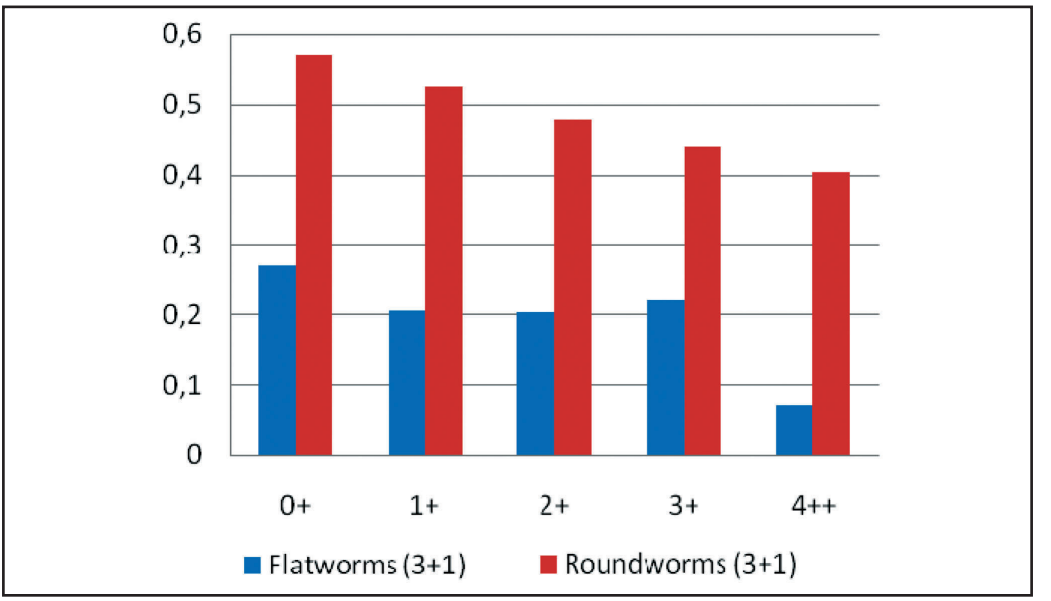

Fig. 1 Helminths infestation extensity at different ages

Thus general pattern of roundworms infestation shows fundamental gender difference. Dogs preserve the same level of infestation with age, while infestation intensity increases with age. Roundworms infestation extensity among vixens declines almost by half with age. Apart from extensity decline vixens show a considerable (over 50 %) decrease in roundworms infestation intensity (Table 3).

Fatness of infested and uninfested animals. Roundworms invasion hardly effects animals' fatness. Condition variances do not achieve reliable significance value when using both methods of condition evaluation. Significant condition differences can be observed between uninfested and flatworms infested animals (Combination 1) both via visual evaluation ($p < 0.05$) and kidney fat weigh ($p < 0.01$).

Fertility. Variation of the placentary maculae mean number is presented in Table 4. Placentary maculae mean among healthy animals equals 5,71. Difference between mean values of uninfested and roundworms infested animals is insignificant. Significant difference between placentary maculae mean values has been observed among healthy and infested animals in Combination 1 (flatworms) and in Combination 3 (flatworms and roundworms). The most significant fertility reduction is typical for the case when vixens are infested both with flatworms and roundworms.

Table 4 Mean number of placentary maculae in vixens infested with different combinations of helminthes

Combination	mean	error
Flatworms (1)	5,09*	0,21
Roundworms (2)	5,90	0,35
Flatworms and roundworms (3)	4,83	0,58
Total infested vixens (1+2+3)	5,59	0,27
Uninfested animals	5,71	0,21
* $p<0.05$		

Non-breeding animals sample fraction changes similarly to the change of placentary maculae mean value (Table 5). The biggest number of dry animals is presented in Combination 3, that is both roundworms and flatworms invasion. Non-breeding ratio in this Combination is twice as big as in healthy animals. Though roundworms invasion (Combination 2) does not effect mean values of placentary maculae non-breeding animals ratio is still higher than among uninfested animals.

Survival rate. Specific survival rate of infested animals is lower than the survival rate of healthy foxes. Survival rate of foxes infested with roundworms decreases insignificantly, approximately by 6 % compared to uninfested animals. Foxes infested with flatworms in different combinations have a much lower survival rate as compared to healthy animals. Not more than 5–6 % of flatworms invaded foxes live up to the age of three years.

Helminthiases and population size. Direct comparison of population size and infestation fluctuations shows relation only to roundworms infestation intensity (Figure 2) which is directly proportional to population size ($r=0,82$; $p<0.01$).

Correlation between population size and flatworms infestation extensity has proved to be insignificant, though the trend is inverse.

Table 5 Ratio of non-breeding vixens infested with different helminthes combinations

Combinations	mean	n
Flatworms (1)	0,46	13
Roundworms (2)	0,40	63
Flatworms and roundworms (3)	0,50	20
Total infested vixens (1+2+3)	0,40	102
Uninfested animals	0,24	136

Table 6 Specific survival rate of foxes infested with different helminthes combinations

Combination	Specific survival rate, p
Flatworms (1)	0,330
Roundworms (2)	0,451
Flatworms and roundworms (3)	0,354
Total flatworms (3+1)	0,335
Total roundworms (3+2)	0,425
Total infested (1+2+3)	0,416
Uninfested	0,512

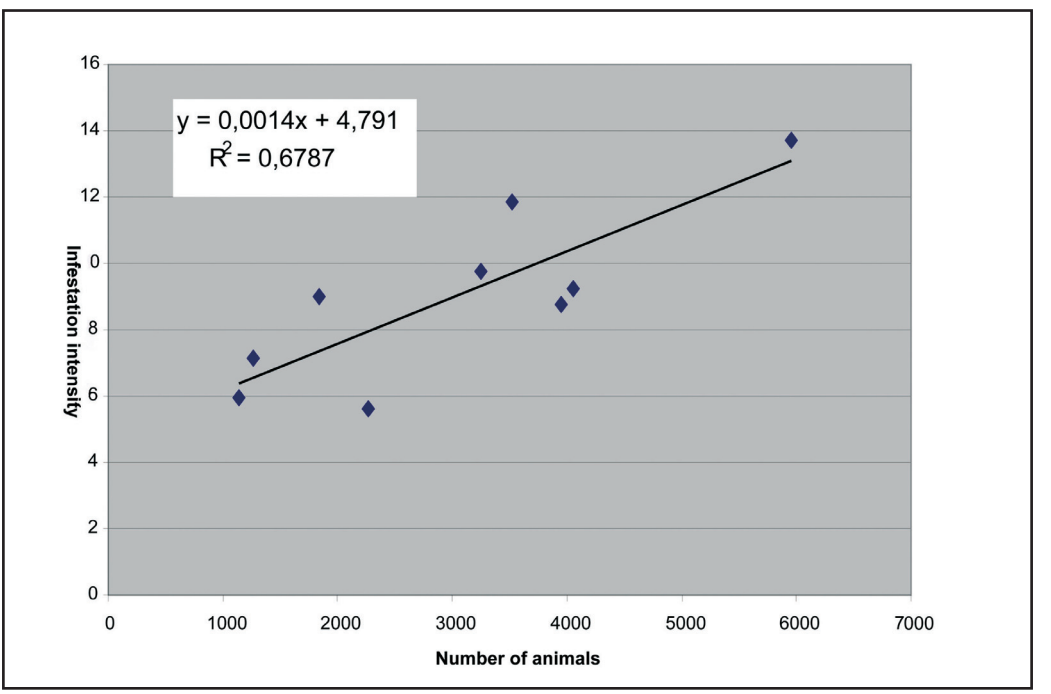

Fig. 2 Roundworms infestation intensity and population size correlation

Thus helminthiases caused by different parasite types vary significantly in their effect on red fox population. Roundworms infestation reduces the number of breeding vixens and has some effect on specific survival rate of animals. Overall toxic effect may be characterized as weak.
Flatworms infestation reduces average number of species, has significant effect on the number of fertile animals and a strong impact on the specific survival rate of infested animals.
Overall toxic effect may be characterized as strong. High mortality rate leads to a relatively moderate expansion extensity of this infestation in red fox population.

Summary

Various groups of red fox (*Vulpes vulpes L.*) populations have been studied in this research in relation to intensity and extensity of infestation with flatworms (Cestoda) and roundworms (Nematoda). Age-related difference between roundworm infestation of dogs and vixens has been studied. Roundworm infestation causes insignificant reduction of breeding vixens and mean value of placentary maculae, as well as decreases slightly specific survival rate of the animals. Flatworms infestation and infestation with both types of parasites lead to significant fertility and survival rate reduction.

Zusammenfassung

Einfluss des Helminthenbefalls auf die Rotfuchspopulation

Die Extensität und die Intensität der Invasion mit Bandwürmern (Cestoda) und mit Fadenwürmern (Nematoda) verschiedener Strukturgruppen der Fuchspopulation (*Vulpes vulpes* L.) wurden untersucht. Grundsätzliche Unterschiede der Intensität und der Einfluss der Fadenwürmerinvasion für Rüden und Fähen werden in Zusammenhang mit ihrem Lebensalter nachgewiesen. Die Fadenwürmerinvasion führt zu einer mäßigen Abminderung der Fruchtbarkeit (sowohl im Anteil trächtiger Weibchen, als auch der durchschnittlichen Anzahl der Embryonen) und des Überlebensindexes der Füchse. Die Bandwürmerinvasion oder kombinierte Invasion führt zu beträchtlichen Abminderungen der Fruchtbarkeit und des Überlebensindexes der Füchse.

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