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Comparision of helminth fauna of shrew (*Sorex araneus* and *Sorex minutus*) in ecosystems affected and non-affected by industrial immissions

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Summary

The study deals with changes of the helminthofauna in shrews (*Sorex araneus*, Linnaeus, 1766 and *Sorex minutus*, Linnaeus, 1766) in ecosystems of Krušné hory Mts. (NW Bohemia) affected by industrial immissions compared with ecosystem of Kaplice (S Bohemia) non-affected by industrial immissions. The pollution degree of environment by industrial immissions was ascertained on the basis of examination of shrew digestive tract. Data on helminths found in the common shrew (*Sorex araneus*) and lesser shrew (*Sorex minutus*) trapped live in ecosystems of Krušné hory Mts. (36 shrews) and in control (non-affected) ecosystem (32 shrews) during autumn 2001 – 2002 are presented. 72 % (26/36) shrews were infested with helminths in affected area and 46.88 % (15/32) shrews were infested with helminths in non-affected area. Nine and seven helminth species were ascertained in affected and non-affected area, respectively. The analysis of the material revealed that, in ecosystems of Krušné hory Mts. (NW Bohemia) affected by industrial immissions are hosts more infected by helminths ($P < 0.01$).

Key words: helminths; *Sorex araneus*; *Sorex minutus*; immission; Krušné hory

Introduction

In the past a large part of the Krušné hory Mts. (NW Bohemia) was affected by immisions. The helminths of small mammals appear to be elements that may serve as indicators of structural changes in ecosystem (Dorosz, 1968; Jirouš, 1984; Prokopič, 1973, Prokopič *et al.*, 1973; Tenora, 1980; Tenora & Staněk, 1994, 1995). Monitored area is located in the upper parts of the Krušné hory mountains. We describe here the patterns of helminth parasitism in *S. araneus* and *S. minutus* in ecosystems of Krušné hory Mts. transformed by industrial immissions. The analysis has purposes to compare the infection levels of helminths and changes in helminth fauna of shrews (*S. araneus* and *S. minutus*) from two areas (affected and non-affected by industrial immissions). A few authors were concerned with helminth fauna of shrews in Czech Republic, for example Prokopič and Tenora.

Material and Methods

The material was collected in the industrial immissions (SO_2, NO, NO_2, NOx, SPM suspended particulate matter) affected area in the Krušné hory Mts. (North West Bohemia) and from control (the industrial immissions non-affected) area in Kaplice (South Bohemia). The shrews were caught by snaptraps. In the affected area and from non-affected were caught 36 and 32 shrews, respectively. The animals were subjected to a helminthological dissection (especially the alimentary tract). Identification of shrew helminths was carried out with aid of Genov (1984) and Prokopič (1956), taking into consideration the synonyms of cestode species (Khalil *et al.*, 1994) and other helminth species of *Sorex* (Pojmanska, 1998).

The body cavity and liver were searched for encysted larvae of tapeworms and the alimentary tract (stomach, small intestine and caecum) for adult helminths. Alimentary tract and liver were stored in 4 % formaldehyd for later identifycation of helminthes.

From the each parasite species prevalence, abundance (number of helminths in trapped host), dominance (% helminth species in sum total of helmiths) and mean intensity of infection (number of helmiths in infected host) were calculated.

The dependence between the occurrence of helminths in host and the industrial immissions affected area was analysed by using SAS (SAS Institute, 2002). The level of significance was set at $P < 0.01$ and $P < 0.05$.

Quantitative and qualitative contains of industrial immissions in the organism of the host were monitored as heavy metals (cadmium, manganese, lead, copper, zinc, chromium and nickel) concentration in kidneys and livers of small mammals from industrial immission affected area and from industrial immission non-affected area.

Results

The total rates of infection of shrews by helminths were in affected area and from non-affected area 72.22 % (26/36) by 9 species of helminths and 46.88 % (15/32) by 7 species of helminths, respectively. The animals in affect-ed area were hosts 5 Cestoda: *Molluscotaenia crassiscolex* (Linstow, 1890), *Staphylocystis pistillum* (Dujardin, 1845), *Vigisolepis spinulosa* (Cholodkowsky, 1906), *Neoskrjabinolepis singularis* (Cholodkowsky, 1912), *Coronacanthus integra* (Baer, 1931); 1 Trematoda: *Pseudoleucochloridium soricis* (Soltys, 1952) and 3 Nematoda species: *Longistriata didas* (Thomas, 1953), *Parastrongyloides winchesi* (Morgan, 1928) a *Baruscapillaria kutori* (Ruchladieva, 1946) and 3 Cestoda: *Molluscotaenia crassiscolex* (Linstow, 1890), *Staphylocystis pistillum* (Dujardin, 1845), *Neoskrjabinolepis singularis* (Cholodkowsky, 1912), 1 Trematoda: *Brachylaima fulvum* (Dujardin, 1843), 3 Nematoda species: *Longistriata didas* (Thomas, 1953), *Baruscapillaria kutori* (Ruchladieva, 1946) a *Porrocaecum* sp. (Railliet et Henry, 1912) in non-affected area. The prevalence of trematodes, cestodes and nematodes in the affected area was 3 % (1/36), 63.89 % (23/36), 38.89 % (14/36), respectively, and 9.38 %, 28.13 %, 25 % from non-affected area (Fig. 1). New worm findings were not found out.

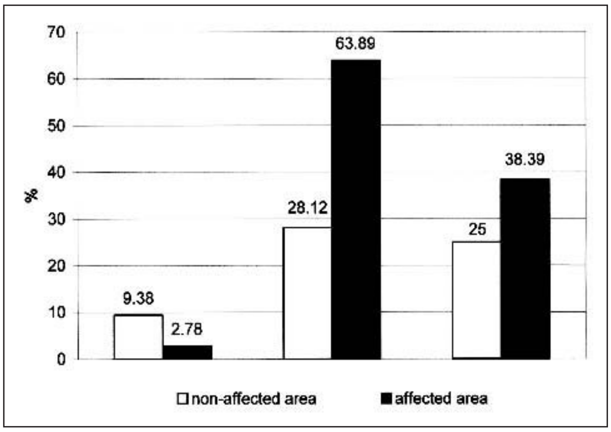

Fig. 1. Comparision of prevalence individual helminth groups (trematoda, cestoda, nematoda) in industrial imission affected and non-afected area

The cestode *Staphylocystis pistillum* (Dujardin, 1845) was the most frequently detected parasite with prevalence of 41.67 % in affected area, and *Molluscotaenia crassiscolex* (Linstow, 1890) with prevalence of 15.63 % only in non-affected area. Mean intensity of infection was the highest (5.04) in cestode *Staphylocystis pistillum* (Dujardin, 1845) in affected area and 2.07 in nematode *Porrocaecum* sp. (Railliet et Henry, 1912) in non-affected area. Results of the helminthological examinations are shown in Tables 1, 2 and 3.

The maximum intensity of cestodes was 25 (*Molluscotaenia crassiscolex*, Linstow, 1890), of trematodes 19 (*Pseudoleucochloridium soricis*, Soltys, 1952), and of nematodes 4 (*Longistriata didas*, Thomas, 1953) per shrew in affected area. In non-affected area was the maximum intensity of cestodes 5 (*Molluscotaenia crassiscolex*, Linstow, 1890), of trematodes 6 (*Brachylaima fulvum*, Dujardin, 1843) and of nematodes 30 (*Porrocaecum* sp. larvae, Railliet et Henry, 1912) per shrew. The nematode larvae of *Porrocaecum* sp. (Railliet et Henry, 1912) were the most dominant (40.79 %) in non-affected area. In affected area was the most dominant (48.16 %) cestode *Staphylocystis pistillum* (Dujardin, 1845).

In industrial immissions affected area dominated biohelminths 88.60 % (241/272), in non-affected area proportion biohelminths 51 % (39/76) and geohelminths 49 %. (37/76) was equable (Fig. 2, 3).

Table 1. Gastrointestinal helminths recovered from shrews (n=36) at industrial immissions affected area (Krušné hory. Mts., NW Bohemia)

Helminth species	Number of infected hosts	Mean intensity (±SD)	Range	Prevalence % (±SD)
Pseudoleucochloridium soricis	1	0.73	19	2.78
Σ Trematoda	1	0.73		2.78
Staphylocystis pistillum	15	5.04	1 – 20	41.67
Molluscotaenia crassiscolex	10	3.15	1 – 25	27.78
Vigisolepis spinulosa	1	0.15	4	2.78
Neoskrjabinolepis singularis	3	0.15	1 – 2	8.33
Coronacanthus integra	1	0.04	1	2.78
Σ Cestoda	23	9.65** (± 1.95)		63.89** (± 15.51)
				2
Longistriata didas	9	0.58	1 – 4	5.00
Parastrongyloides winchesi	5	0.34	1 – 3	13.89
Baruscapillaria kutori	1	0.27	7	2.78
Σ Nematoda	14	1.19 (± 0.13)		38.89* (± 9.07)
Total	26	10.46** (± 1.64)		72.22** (± 13.38)

*, ** – if the number of infected hosts differs between the areas, the higher value is marked with asterisks (t-test): * $P < 0.05$; ** $P < 0.01$

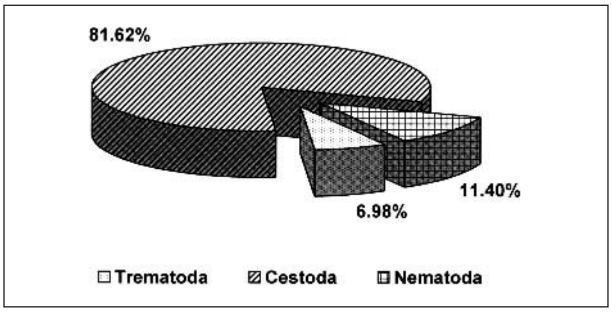

Fig. 2. Dominance of helminth groups (trematoda, cestoda, nematoda) from affected area

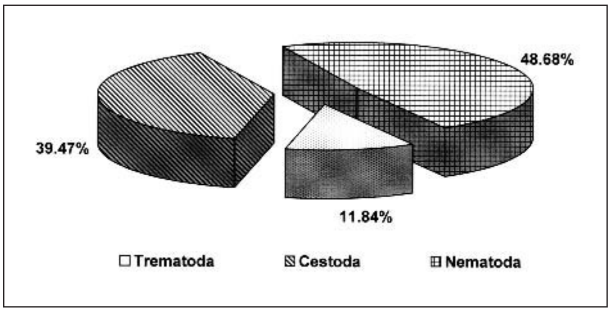

Fig. 3. Dominance of helminth groups (trematoda, cestoda, nematoda) from non-affected area

Table 2. Gastrointestinal helminths recovered from shrews (n=32) at industrial immissions non-affected area (Kaplice, S Bohemia)

Helminth species	Number of infected hosts	Mean intensity (±SD)	Range	Prevalence % (±SD)
Brachylaima fulvum	3	0.60	1 – 6	9.38
Σ Trematoda	3	0.60		9.38
Staphylocystis pistillum	1	0.67	10	3.13
Molluscotaenia crassiscolex	5	0.73	1 – 5	15.63
Neoskrjabinolepis singularis	2	0.60	1 – 5	6.25
Σ Cestoda	9	2.00 (± 0.05)		28.13 (± 5.31)
Longistriata didas	3	0.20	1	9.38
Baruscapillaria kutori	3	0.20	1	9.38
Porrocaecum sp.	2	2.07	1 – 30	6.25
Σ Nematoda	8	2.47* (± 0.88)		25.00 (± 1.47)
Total	15	5.07 (± 0.58)		46.88 (± 3.63)

*, ** – if the number of infected hosts differs between the areas, the higher value is marked with asterisks (t-test): * $P<0.05$; ** $P<0.01$

Table 3. Comparision of affected and non-affected areas for occurrence and number of helminthes

Helminth species	Affected area			Non-afected area		
	number of helminths	dominance (%)	abundance	number of helminths	dominance (%)	abundance
Pseudoleucochloridium soricis	19	6.96	0.53	0	0	0
Brachylaima fulvum	0	0	0	9	11.84	0.28
Total trematoda	19	6.96	0.53	9	11.84	0.28
Staphylocystis pistillum	131	48.16	3.64	10	13.6	0.31
Molluscotaenia crassiscolex	82	30.15	2.28	11	14.47	0.31
Vigisolepis spinulosa	4	1.47	0.11	0	0	0
Neoskrjabinolepis singularis	4	1.47	0.11	9	11.84	0.28
Coronacanthus integra	1	0.37	0.03	0	0	0
Total cestoda	222**	81.65	6.17	30	39.47	0.94
Longistriata didas	15	5.51	0.42	3	3.95	0.09
Parastrongyloides winchesi	9	3.31	0.25	0	0	0
Baruscapillaria kutori	7	2.57	0.19	3	3.95	0.09
Porrocaecum sp.	0	0	0	31	40.79	0.97
Total nematoda	31	11.4	0.86	37*	48.68	1.16
Total helminths	272**	100	7.56	76	100	2.38

*, ** – if the number of helminths differs between the areas, the higher value is marked with asterisks (t-test): * $P < 0.05$; ** $P < 0.01$

Table 4. Gastrointestinal helminths recovered from both shrews (*Sorex araneus, S. minutus*)

Helminth species	Area	Prevalence (%) in *S. araneus*	Prevalence (%) in *S. minutus*
Staphylocystis pistillum	A	44.83 (13/29)	28.57 (2/7)
	B	5.56 (1/18)	-
Molluscotaenia crassiscolex	A	34.48 (10/29)	-
	B	22.22 (4/18)	14.29 (2/14)
Longistriata didas	A	27.59 (8/29)	7.14 (1/7)
	B	16.67 (3/18)	-
Baruscapillaria kutori	A	3.45 (1/29)	-
	B	5.56 (1/18)	14.29 (2/14)

A = industrial immission affected area; B = industrial immission non-affected area

Majority of helminths (Table 3) were found in common shrew (*Sorex araneus*). The large-sized *Sorex araneus* had significantly higher overall infection levels than the smaller species *Sorex minutus*. Similarly, most helminth species were significantly more prevalent in *Sorex araneus* than in *Sorex minutus*. *Sorex minutus* harboured only four helminth species: cestodes *Staphylocystis pistillum* and *Molluscotaenia crassiscolex* and nematodes *Longistriata didas* and *Baruscapillaria kutori* in industrial immissions affected area (A) and industrial immissions non-affected area (B), respectively (Table 4).
Our results demonstrated elevated accumulation of manganese ($P \geq 0.05$) at the polluted area in Krušné hory Mts. in contrast to industrial immission non-affected area. In this area, the maximum concentrations of 4.86 mg/kg wwt of manganese were found in the liver of *Sorex araneus*.

Discussion

The parasites can be indicators of structural changes in ecosystems. Studies by Tenora and Staněk (1994, 1995) deal with long-termed investigations on parasitic worms in rodents in localities changed by human activities (affected intensively by agrotechnics and chemical treatments and dried successively by ameliorations). The authors registerred the decrease of the number of helminthic species and their prevalence in all host species. The chemization of environment affects negatively the development of the helminthofauna (Murai, 1974). The landscape entities changed by water management modifications, so-called ameliorations, affect the structure of helminths in rodents living there (Tenora & Staněk, 1995).
In our case, we captured shrews (*Sorex araneus, S. minutus*) in area affected by industrial immissions and in control (immissions non-affected) area. The helminth faunas of *Sorex araneus* were in both areas more various in contrast to *S. minutus* helminth faunas (Tab. 4). The common shrew *Sorex araneus*, which has high burdens of gastrointestinal helminths, is expected to be more severely affected than other species of *Sorex* (Haukisalmi *et al.*, 1994).
We recorded the significant increase of the number of prevalence and infection intensity of helminths ($P < 0.01$) in the immissions affected area (Tab. 1). The biological and taxonomical structures of the helminths found also reflect the habitat diversity of their host. In industrial immissions affected area (area without agrotechnical and agrochemical interferences) dominated biohelminths 88.60 % (241/272), in non-affected area (with some agrotechnical and agrochemical interferences) proportion biohelminths 51 % (39/76) and geohelminths 49 % (37/76) was equable (Figs. 2 and 3). The decrease of helminth species in area with agrotechnical and agrochemical interferences was more marked in the species developing via intermediate hosts (Trematoda, Cestoda, Acanthocephala), the least decrease occurred in Nematoda (Tenora & Staněk, 1995). Also absence of intermediate hosts' predators and industrial immissions affected soil unfits for geohelminths development be the cause of biohelminths prevalence in affected area.
The prevalence of helminths was significantly ($P < 0.01$) higher in the industrial immissions affected area (72.22 % prevalence), than in the immissions non-affected area (46.88 % prevalence only). Hörweg (2000) found out 92.9 % and Shimalov (2001) 95.3 % prevalence of helminths in shrews from the environment of Vienna and from ecosystems of Belorussian Polesie transformed by reclamation, respectively.
There are very numerous factors that participate in forming the structure of helminths in small mammals (shrews and rodents) in the monitoring industrial immissions affected area. Although the reasons for the increase of parasite numbers in immission affected area are not clear, possible factors that could affect prevalence and intensity of infection include absence of intermediate hosts predators, industrial immissions affected soil unfits for geohelminths development, host immunity weakening against parasites etc.

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