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HELMINTHS OF WILD RUMINANTS INTRODUCED INTO CZECHOSLOVAKIA

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Abstract. The paper contains results of helminthological studies on ruminants introduced into Czechoslovakia from other regions and continents. It is pointed out that introduction of wild ruminants is not only of theoretical importance in the adaptation of parasites to a new environment, but also of practical consequence in the mutual exchange of parasites between the imported and autochthonous game animals.

Studies on helminth fauna of introduced species of wild ruminants is of great practical importance because these game animals, as we could see previously in case of fascioloidiasis, may introduce into the new environment serious parasitoses spreading to autochthonous game or domestic animals.

For example, along with the sika deer, the species *Ashworthius sidemi* was imported to Czechoslovakia and adapted itself to moufflon and red deer in places of sika's contact with other game animals. The white-tailed deer *Odocoileus virginianus* introduced nematodes *Spiculopteragia odocoilei* and *Ostertagia mossi*, into its new environment.

And vice versa, under new conditions the introduced wild ruminants acquire local parasites. It was revealed that *Odocoileus virginianus* acquired palearctic nematode species such as *Spiculopteragia asymmetrica*, *S. spiculoptera*, *Rinaldia mathevossiani*, *Skrjabinagia kolchida*, *Artionema hartwichi* whose high numbers may be found in it as often as in autochthonous wild ruminants. In places where *Sika nippon* is being kept together with the white-tailed deer, it becomes the host of *Fascioloides magna*. In its places of contact with the red deer it acquires the species *Nematodirus roscidus*. Consequently, the research of parasitofauna of introduced wild ruminants is of great theoretical importance both, for the information about adaptation of parasites under new conditions of their existence, and in the studies of adaptation of endemic parasite species in organs of the newly imported hosts.

MATERIAL

The number of autopsies carried out according to particular species of wild ruminants was as follows: fallow deer (*Dama dama*) 725, sika deer (*Sika nippon*) 179, white-tailed deer (*Odocoileus virginianus*) 52, chamois (*Rupicapra rupicapra*) 82, moufflon (*Ovis musimon*) 308 animals. The wild ruminants came from free nature as well as from game reserves in Bohemia and Moravia.

RESULTS

A total of 44 species of worms parasitized the hosts listed above. The findings of individual species are represented in the following survey:

Dama dama — the following 31 species of parasitic worms were found: *Dicrocoelium*

dendriticum, Fasciola hepatica, Fascioloides magna, Moniezia benedeni, Cysticercus taeniae hydatigenae (Tenora and Vaněk 1969), *Bicaulus sagittatus, Dictyocaulus viviparus, Artionema altaica, Onchocerca flexuosa, Trichuris capreoli, T. globulosa, T. ovis, T. skrjabini, Capillaria bovis, Chabertia ovina, Oesophagostomum venulosum, O. radiatum, Haemonchus contortus, Nematodirus filicollis, Trichostrongylus capricola, Ostertagia leptospicularis, O. ostertagi, O. trifurcata, Skrjabinagia kolchida, S. lyrata, Spiculopteragia asymmetrica, S. schulzi, S. spiculoptera, Rinadia mathevossiani, Apteragia quadrispiculata, Cooperia pectinata.*

The archival records prove that breeding of this wild ruminant exclusively in reserves, dates back to the Middle Ages. It was not until the last century that the fallow deer was introduced into free nature and at present it occurs in about 45 localities and its number in Czechoslovakia is estimated to be 7000 animals.

The dominant parasite of the fallow deer, both in reserves and in free nature, is *Spiculopteragia asymmetrica*. We assume, that this species has been the original parasite of the fallow deer, as described from this host by Ware (1925) in England. Along with the fallow deer it later spread to other wild ruminants and due to the fact that the fallow deer is being kept primarily in reserves again, this parasite is encountered frequently in the white-tailed deer and the sika, and in the Lány reserve we found it in the red deer.

The next most frequent parasites of the fallow deer are *Oesophagostomum venulosum* and *Ostertagia ostertagi*. Our results showed that the species composition of parasites in the fallow deer differs from that in the red deer.

Sika nippon — the following 20 species of parasitic worms were found: *Dicrocoelium dendriticum, Fascioloides magna, Cysticercus taeniae hydatigenae, Moniezia benedeni, Dictyocaulus viviparus, Bicaulus sagittatus, Artionema altaica, Trichuris globulosa, Capillaria bovis, Oesophagostomum venulosum, Chabertia ovina, Haemonchus contortus, Ashworthius sidemi, Trichostrongylus capricola, Spiculopteragia asymmetrica, S. spiculoptera, Ostertagia circumcincta, Nematodirus roscidus, Cooperia pectinata, Wehrdikmansia cervipedis.*

This species was introduced into many small game reserves and parks of our country from the Asian continent. Due to social changes the small game reserves and parks were gradually abolished and the wild ruminants were either shot or they fled to free nature. At present the sika deer lives in 11 localities in Czechoslovakia and its number is estimated to be 965 animals.

While evaluating the composition of helminthofauna of the sika deer in Czechoslovakia as regards its composition in a region where this host is autochthonous, we see that it is relatively poor. Also invasions are very mild. In most cases only few specimens, maximally several scores of worms are found.

Along with the sika also its specific parasite *Ashworthius sidemi*, has been introduced into this country and represents the dominant parasite in the reserves of Lány and Opočno (Kotrlá and Kotrlý 1973).

The next most frequent parasite of the sika in Czechoslovakia is *Spiculopteragia asymmetrica*. Of great interest is the finding of the nematode *Nematodirus roscidus* parasitizing *Cervus elaphus* in western Europe and so far undetected in this country. The species *Chabertia ovina, Haemonchus contortus, Spiculopteragia spiculoptera* and *Moniezia benedeni* are rare. Important is the occurrence of the trematode *Fascioloides magna* which the sika has acquired in Czechoslovak territory, thus becoming a new host of this trematode (Kotrlý and Kotrlá 1974).

Odocoileus virginianus — the following 25 species of parasitic worms were found: *Dicrocoelium dendriticum, Fasciola hepatica, Fascioloides magna, Cysticercus taeniae*

hydatigenae, Moniezia benedeni, Dictyocaulus viviparus, Elaphostrongylus cervi, Artionema hartwichi, Trichuris ovis, Chabertia ovina, Oesophagostomum venulosum, Haemonchus contortus, Trichostrongylus capricola, T. vitrinus, Spiculopteragia asymmetrica, S. spiculoptera, S. odocolei, Ostertagia circumcincta, O. lyrata, O. mossi, Marshallagia marshalli, Rinadia mathevossiani, S. kolchida, Cooperia pectinata, Nematodirus filicollis.

According to the archival records the first acclimatizing attempts with the white-tailed deer have been made since 1890 in the Mansfeld reserve at Dobříš. The animals were imported from Canada. After the abolition of reserves they were set free in nature and today they occur primarily in the submontane zone of Brdy and Hřebeny in Central Bohemia and their population is estimated to be about 200.

As in the sika likewise in the white-tailed deer the species representation of parasites is poor. From its original home country the white-tailed deer has introduced into the new territory 3 species of parasites, primarily the trematode *Fascioloides magna* and two nematodes: *Ostertagia mossi* and *Spiculopteragia odocoilei*. The white-tailed deer has become susceptible to the species which are current parasites of the roe deer in the Euro-Siberian subregion, such as *Spiculopteragia spiculoptera, Skrjabinagia kolchida, Ostertagia leptospicularis, Rinadia mathevossiani* and *Elaphostrongylus cervi*. Even *Spiculopteragia asymmetrica*, the parasite of the fallow deer, has become a dominant parasite of the white-tailed deer in the region of Brdy (Kotrlý and Kotrlá 1971).

Rupicapra rupicapra — the following 17 parasitic worms were found in the Jeseníky Mts., 19 species in the Lužické hory Mts.: *Echinococcus granulosus, Cysticercus taeniae hydatigenae, Moniezia benedeni, Spiculopteragia spiculoptera, Skrjabinagia lyrata, Ostertagia trifurcata, O. ostertagi, O. circumcincta, Trichostrongylus vitrinus, T. colubriformis, Nematodirus filicollis, Haemonchus contortus, Oesophagostomum venulosum, Chabertia ovina, Trichuris ovis, T. globulosa, Neostrongylus linearis, Muellerius tenuispiculatus, M. capillaris.*

Chamois was introduced into both localities 70 years ago from the Austrian Alps, from higher elevations to lower altitudes with quite different ecological conditions. At present its population in the Jeseníky Mts. is estimated to be over 300, in the Lužické hory Mts. 100 animals.

It is invaded here by a lesser number of nematode species than in the original biotopes of the Alps. Of the 3 specific lung parasites described in the Alps, in Czechoslovak territory only *Muellerius tenuispiculatus* has remained. Fasciolasis and dictyocauliasis, which are frequent in the Alps, do not occur either (Kotrlý and Erhardová-Kotrlá 1970).

The most frequent parasites of chamois in the Jeseníky and Lužické hory Mts. are the lung worms *Muellerius tenuispiculatus, M. capillaris* and *Neostrongylus linearis* which often occur together, the infection of the animals reaching as high as 50%.

Of the gastro-intestinal nematodes the most frequent are *Ostertagia circumcincta* and *Chabertia ovina* (45—48%) as well as *Haemonchus contortus* and *Spiculopteragia spiculoptera*. Outstanding is the high percentage of infection with cysticercosis (larva of the cestode *Taenia hydatigena*) reaching 22%.

Ovis musimon—the following 24 species have been found: *Fasciola hepatica, Dicrocoelium dendriticum, Moniezia benedeni, M. expansa, Cysticercus taeniae hydatigenae, Dictyocaulus viviparus, Muellerius capillaris, Protostrongylus kochi, Trichuris globulosa, T. ovis, Capillaria bovis, Chabertia ovina, Oesophagostomum venulosum, Haemonchus contortus, Nematodirus filicollis, N. spathiger, Trichostrongylus axei, T. capricola, T. colubriformis, T. vitrinus, Ostertagia circumcincta, O. leptospicularis, O. trifurcata, Spiculopteragia spiculoptera.*

Moufflon, originally an inhabitant of the Mediterranean region, was introduced into Bohemia more than 100 years ago from the Leinz reserve near Vienna. The first archival records date from 1858, from the reserve Hluboká, but moufflons are supposed to have been introduced into this country prior to this date. Statistical data show that 11,674 animals live in free nature and reserves in Czechoslovakia at present.

The helminth fauna of moufflon is not as rich in species as it is in closely related animals, the sheep. The intensity of invasion is much lower, too. The most frequent parasites of moufflons are the lung worm *Muellerius capillaris* and the parasite of the large intestine *Chabertia ovina*. The species *Dicrocoelium dendriticum* is more frequent than *Fasciola hepatica*.

It should be taken into account that the environment in which moufflon lives as well as its contact with other wild ruminants affect the species composition of nematodes in moufflon. This fact became manifest in the nematode *Ashworthius sidemi* occurring in joint biotopes with the sika and in *Spiculopteragia spiculoptera* which parasitized in moufflons in places where the contact with the red deer and fallow deer was becoming more intensive.

DISCUSSION

Czechoslovakia is well known for its rich wildlife, as 7 species of game animals of the cervine and bovine group are represented in a relatively small territory. Besides autochthonous wild ruminants, represented by the red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*) several exotic species were introduced into both free nature and reserves of this country from various geographical regions, namely the white-tailed deer (*Odocoileus virginianus*), sika (*Sika nippon*), fallow deer (*Dama dama*), moufflon (*Ovis musimon*) and chamois (*Rupicapra rupicapra*), introduced into the Lužické hory and Jeseníky Mts.

The populations of these introduced wild ruminants, as compared with the number of autochtonous ruminants are much lower, but they are not negligible. In 1974 their numbers in the Czech Socialist Republic reached 15,994, while the numbers of the red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*) exceeded 225,100.

Due to human interference, mainly in the last century, there was an incessant displacement of wild ruminants and only few biotopes exist today which would be original for these two autochthonous species and where they would not contact any other species. No less important factor contributing to the enrichment of the helminth fauna is the fact that many wild ruminants have been bought from the first zooparks, e.g. from the reserve Lainz near Vienna or from the firm Hagenbeck. Since these transfers had been taking place for many years, they became reflected in the present species representation of parasites and thus the differences between species typical of particular host became blurred. For example, the red deer and roe deer, whose typical parasites are *Ostertagia leptospicularis, O. ostertagi, Skrjabinagia kolchida, Spiculopteragia spiculoptera*, acquire the parasites of other wild ruminants with which they get into contact. The red deer, for instance, acquires the nematode *Spiculopteragia asymmetrica* from the fallow deer, the trematode *Fascioloides magna* from the white-tailed deer, *Ashworthius sidemi* from the sika deer. This applies also vice versa. The introduced wild ruminants acquire parasites of the autochthonous animals or of those which became assimilated to the new environment more than one hundred years ago. Thus the white-tailed deer acquires palearctic nematode species *Spiculopteragia asymmetrica* from the fallow-deer, *Rinadia mathevossiani, Spiculopteragia spiculoptera, Skrjabinagia kolchida, Elaphostrongylus cervi, Artionema hartwichi* from the red deer

and roe deer. The sika also acquires parasites in its new environment (*Fascioloides magna, Nematodirus roscidus, Bicaulus sagitattus, Spiculopteragia asymmetrica*).

On the other hand, the introduced wild ruminants coming to a completely new environment, lose their specific parasites. This is evident primarily in biohelminths of the genera *Protostrongylus, Odocoileostrongylus, Elaphostrongylus, Parelaphostrongylus, Leptostrongylus*. Likewise the great majority of specific geohelminths (Mityushev et al. 1950), although their development is direct, have not been imported along with the introduced animals (e.g. *Pygarginema cervi, Schulzinema miroljubovi, Spiculopteragia panticola*). They have been found neither in this country, nor in Poland (Dróżdż 1963), where the sika had been also introduced. Only a small percentage of two specific nematode species parasitizing the white-tailed deer, *Spiculopteragia odocoilei* and *Ostertagia mossi*, occurring in America (Walker and Becklund 1970), was also found in the white-tailed deer in Czechoslovakia, but otherwise these parasites have not been adopted by other wild ruminants. In contrast to Poland where it does not occur, the nematode *Ashworthius sidemi*, a specific parasite of the sika, was brought in along with its host to this country and in joint places of contact transferred even to unspecific hosts (moufflon, red deer).

It should be noted that in all mentioned species of introduced wild ruminants in the territory of Czechoslovakia the helminth fauna as far as species composition is concerned is much poorer than in their original home country, the intensity and extensity of infection being low as well. This phenomenon cannot be univocally explained by the fact that the animals are very well cared for due to a highly developed wildlife management; both for parasitic germs and hosts an important role here is primarily played by the new environment. It remains to be seen if this new environment should be considered as optimal for the wild ruminants or not. According to Prokopič (1972, 1974) who worked out Thienemann's rule in cestodes parasitizing rodents and insectivores, animals in optimal environment are invaded by a larger number of species represented by a smaller number of individuals, while in an unfavourable biotope they harbour a small number of helminths with a high extensity.

The introduction of wild ruminants into different continents is not only of practical and epizootological importance, but it also involves many other problems as mentioned above, including the taxonomic ones. The parasites that must adapt themselves to different conditions, as well as their germs adapting themselves to different species of intermediate and definitive hosts, often happen to undergo many changes. Therefore, larger or smaller metric and morphologic changes take place in them due to new environment. There is a change of the whole life cycle, of the length of intramollusc phase, of the number and size of individual stages, of the length of praepatent period in the invaded host, of the invasive cycles etc. as we could see in *Fascioloides magna* and in *Ashworthius sidemi* as well (Erhardová-Kotrlá 1971, Kotrlá et al., in press).

These changes may become more or less manifest, and this is often misleading in the determination and description of new species.

CONCLUSION

Research of parasites and invasive diseases in introduced wild ruminants is important both from the theoretical and the practical aspect. It points out that imported parasites may and are able to exist in a new environment and to become members of the original biocenosis, in which their germs can accomplish their development and find optimal conditions for invading new hosts.

This theoretical conclusion shows that prevention of parasitoses, in our case

helminthoses of wild and domestic ruminants, is possible and necessary. The species composition and populations of wild ruminants in individual hunting areas and reserves should be considered with utmost care. In each area or reserve it would be profitable to choose a suitable group of wild ruminants and thus to assemble species harbouring relatively more specific and less adaptive parasite species. Groupings of those species of wild ruminants among which an active parasite exchange during massive invasions by helminths is possible, should by avoided. Therefore, all species of wild ruminants should not be kept in one biotope which cannot offer optimal conditions to them.

Future planning and elaboration of methods for the utilization of reserves and open hunting areas in the organized economic regions of particular species and groupings of wild ruminants should fully respect this information to the benefit of effective wildlife management.

ГЕЛЬМИНТЫ ДИКИХ ЖВАЧНЫХ, ИМПОРТИРОВАННЫХ В ЧЕХОСЛОВАКИЮ

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Резюме. В работе обсуждаются гельминтологические исследования по диким жвачным, которые были привезены в Чехословакию из других областей и континентов. Обращено внимание на тот факт, что интродукция диких жвачных имеет не только теоретическое значение при адаптации паразитов в новой среде, но также важна на практике при взаимном обмене паразитами между привезенными и аутохтонными животными.

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