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Original papers

Gastrointestinal nematodes and the deworming of mouflon (*Ovis aries musimon*) from Goleniowska Forest in West Pomerania province, Poland

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ABSTRACT. Ruminants often live in environments where the natural balance has been disturbed by humans. As a result, there is a transfer of parasitosis to domestic animals and sometimes humans. The aim of the study was to determine the annual species composition and level of gastrointestinal nematode infection of mouflon (*Ovis aries musimon*) from the half-open breeding colonizing areas of the Goleniowska Forest, and to assess the effectiveness of deworming. The course of the parasitic infection of mouflon depends largely on geoclimatic and breeding factors. These diseases are caused by more than 17 species of nematodes with varying degrees of pathogenicity. Due to the high degree of parasitic infections in deer, both in Poland and abroad, it is necessary to develop specific preventive programs using preparations with a broad spectrum of action.

Key words: mouflon, gastrointestinal nematodes, infection, albendazole

Introduction

The mouflon (*Ovis aries musimon* Schreber, 1782), a wild mountain sheep endemic to the Mediterranean islands of Sardinia and Corsica, has been introduced in many countries of Europe. The species was brought to Poland for hunting in 1902. The mouflon initially could be found only in the provinces of Lower Silesia and Wielkopolska, but there has since been a significant expansion in their range. In Lower Silesia, they live in both free-ranging herds and on reservations [1].

The Polish Law Hunting mouflon is a species hunted to the period of protection. As an alien species, it has had a negative impact on native wildlife, and monitoring by Natura 2000 in Poland has found these animals to have a destructive effect on the local habitat. In these areas, herbaceous vegetation has sometimes completely disappeared and regeneration of woody species been interrupted by the erosion of slopes [2].

The ruminants live in an environment where the natural balance has been disturbed by human pressure. As they coexist and migrate with other animals, especially deer, and remain in close contact with them, they can take part in the transfer of parasitoses to domestic animals and sometimes humans [3]. This can result in large losses of livestock due to lowered resistance and consequent infection [4]. Mouflons were first introduced to the province of West Pomerania in autumn 2011, and one of the SPs.

The aim of the study was to determine the annual species composition and level of gastrointestinal nematode infection of mouflon living in the half-open breeding and colonizing areas of the

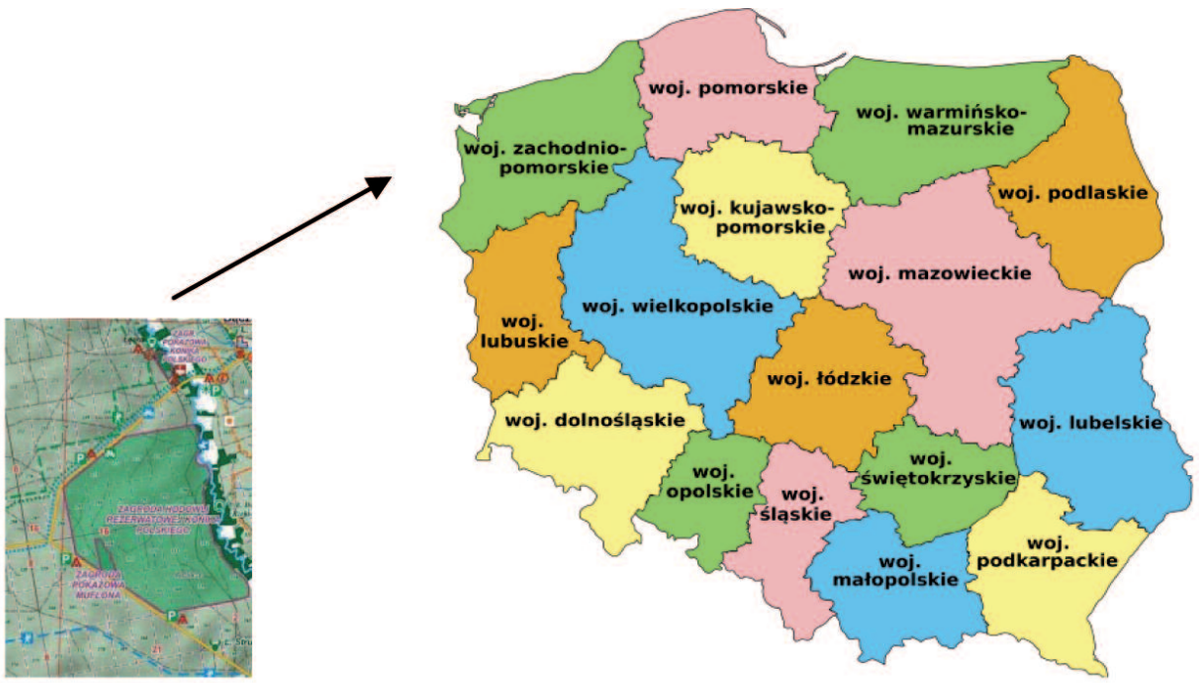

Fig. 1. The map of Goleniowska Forest, Poland

Goleniowska Forest; its second aim was to assess the effectiveness of deworming.

Materials and Methods

The experimental material consisted of 11 infected mouflon (seven sheep and four rams) living in the vast Goleniowska forest complex (53°30'13"N 14°46'29"E), belonging to one of the forest districts in the West Pomerania province (Fig. 1). The main animal species occurring in this area are red deer, roe deer and wild boar. The mouflon were purchased for the purpose of conducting the education of nature and the forest. An enclosed corral area was created of about eight hectares of pine trees, spruce and recess (ultimately serving as a drinker), allowing the mouflon to remain throughout the year.

The animals had constant access to feed, water and mineral additives in the form of vitamin and mineral licks: a relatively inexpensive feed additive which provides many valuable microelements, such as magnesium, copper, zinc, manganese, cobalt and iodine, in addition to sodium and chlorine [5]. Coproscopic study was conducted in the years 2012–2014.

Parasitological monitoring was conducted on annual basis. Stool samples were collected regularly at monthly intervals. The study was based on a quantitative method (Fecal Egg Counts – FEC) using the McMaster technique, which allowed the number of eggs in 1 g of feces to be determined (EPG factor – Egg per gram) [6]. Parallel to the coproscopy tests, the larvae in the feces were cultured to identify the species of gastrointestinal nematodes (GIN). The cultures were incubated at 25°C for seven to ten days [7]. The invasive stages (L3) were obtained after isolation in coproculture [8].

The anti-parasite formulation of choice was Valbazen (active substance Albendazole), which has been routinely used for deworming ruminants in Poland for several years. Deworming is performed through the use of medicinal salt licks. The dose was estimated as the number of animals x average weight of the animal. The efficacy of this treatment was evaluated seven and 14 days after administration. Deworming was carried on in mid-May.

Results

Five species of nematodes were found in the gastrointestinal tract. The greatest prevalence was observed for the nematodes *Chabertia ovina* (prevalence 81.8%), *Nematodirus* spp. and *Ostertagia* sp. (prevalence 63.4%). The highest average rate of EPG of feces was 457 eggs/g for *Chabertia ovina*, while the lowest was five eggs/g, found for *Trichuris ovis*. Detailed results are presented in Table 1.

The parasitic profile changed depending on the

Table 1. Prevalence (%) and intensity (EPG) of infection with gastrointestinal nematodes in mouflons (N=11)

Species of nematodes	No. of infected	Prevalence	Intensity range	(EPG)
Chabertia ovina	9	81.8	0-5100	457
Nematodirus spp.	7	63.4	0-2400	377
Ostertagia spp.	7	63.4	0-900	231
Trichostrongylus sp.	3	27.3	0-350	24
Trichuris ovis	2	5.5	0-200	5

season. In the first quarter (January, February, March) EPG was low, ranging from 0–200 eggs/g. In the second quarter (April, May, June), a slow increase in the intensity of infection was observed, peaking at 5100 eggs/g in the middle of May. In the summer months, only slight fluctuations were observed, and a broad spectrum of parasites persisted until November. A slow decline in the intensity of infection was observed from December until January and February the following year (Table 1). Based on these results, deworming treatment was performed at the beginning of April the following year (Fig. 2). The extent of the nematode infection of the gastrointestinal tract was 72.77% after seven days, and 87.95% after 14 days.

The formulation used for deworming mouflon demonstrated mid- to high efficiency.

Discussion

Living animals have been the object of interest of many professional circles and scientific disciplines. They are an integral component of the natural environment and an important element in creating ecological structures.

The parasitic infection of mouflon has been investigated in many countries of the world. The use of coproscopy allows the prevalence of endoparasite infection to be monitored non-invasively. Mouflon inhabit mountainous forest areas around the world and in Europe, and are typically used as wild game. However, their health requires regular monitoring

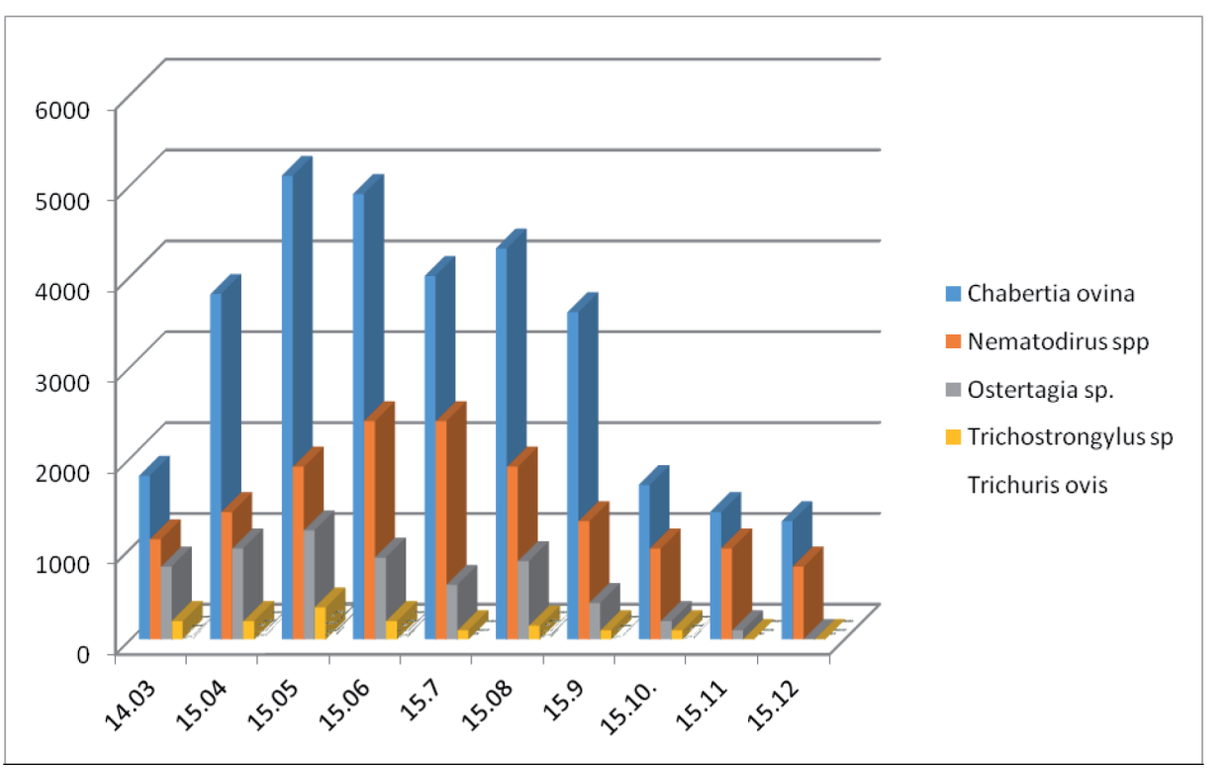

Fig. 2. Results after treatment against parasites at the beginning of April in a next 8 months

with regard to the occurrence of infectious diseases and parasite invasion. To develop an effective strategy to combat endoparasite infection, a detailed knowledge of the seasonal dynamics of the course of parasitic infections is required. In mouflon, these diseases are caused by more than 17 species of nematodes with varying degrees of pathogenicity. In the ecology and climate of Poland, most of the larvae of the fall do not reach sexual maturity until the spring of next year, remaining in the mucous membranes. These so-called dormant larvae (inhibition phenomenon) are activated in the spring (February, March) when they reach maturity and start producing eggs. This rise in the excretion of eggs observed in the spring is known as the *spring jump* or *spring rise* [9].

These processes are influenced by both climatic factors, mainly related to temperature and humidity, and the physical characteristics of the infected animal itself: age, health and immune suppression, anemia, detuning hormone-related pregnancies, lactations and location of the parasite. Research conducted in the Monti Livornesi Park region of Tuscany showed a correlation between the state of infestation of mouflon and climatic conditions, with six species found in the gastrointestinal tract. Egg output was analyzed with regard to seasonal variations in temperature and rainfall, the life-cycle and survival strategy of the parasites and the health condition of the hosts on an annual basis. The greatest extent of infection was observed the month of July, when the average temperature was 27.4°C and the average monthly rainfall was more than 120 mm [10].

As mentioned above, the protection of animals involves monitoring them for the presence of infectious and invasive disease. In order to determine the species of parasites involved in such invasions, 104 mouflon from nine hunting areas in Thuringia (Germany) were studied. The prevalence of nematodes in the abomasum, small intestine and large intestine was found to be 100%, 85% and 82%, respectively. The most prevalent species in the gastrointestinal tract were *Ostertagia circumci - ncta* (96.1%), *Trichostrongylus axei* (92.2%), *Haemonchus contortus* (60.8%), *O. pinnata* and *Oesophagostomum venulosum* (56.7% each) [11]. Similar studies were conducted in 2005 in the Orecchiella Natural Reserve (Tuscany, Italy) on flocks of mouflon. A greater proportion of captive mouflons (73.17% and 814.6 +/– 1297.2 OPG) were born with the *Eimeria* protozoan than wild mouflons (36.73% and 112.7 +/– 268.7 OPG) [12]. A similar study in Spain examined 10 mouflons living in El Hosquillo National Wildlife Reserve (Cuencal). Pretreatment fecal examinations (day 0) found all animals to be infected. The mean (±SE) number of trichostrongylid eggs shed before treatment was 230±115 eggs/g from *Trichostrongylus axei*, *Ostertagia circumcincta* and *Marshallagia* spp. Six mouflons were also shedding *Nematodirus* spp. eggs, with intensities ranging from five to 100 eggs/g (mean ±SE, 63±15) [13].

In the province of Salamanca (Spain) wild animals have been epidemiologically linked to ruminants in livestock farms. The prevalence in mouflon was found to be 37%, with seven species of endoparasites identified. The most common species were found to be *Trichostrongylus axei* and *T. circumcincta* (medium 1300) *N. spathiger* (medium 250), *Cooperia oncophora* (medium 200). The authors found a close relationship between infection with parasites in wild animals and in domestic ruminants [14].

The Sudeten Mountains in Lower Silesia in Poland are the home of the largest mouflon population in Poland, constituting about 80% of the total population. A review of the literature reveals that parasitological research has been carried out on these mouflon on a regular basis. Standard coproscopy was used to establish the species composition and prevalence of animal infection. The prevalence of nematodes in the gastrointestinal tract was fairly uniform and ranged from 29.9 to 58.27% depending on the position of the forest district and the date of the study. A total of five species of nematodes were described, with most of these being in the Trichostrongylidae. The parasites most frequently occurred in mouflons from the Jugów forest district, which is related to contact with sheep grazed in the area [15,16]. The prevalence in a herd of mouflon consisting of 27 animals in a hunting facility in Wielkopolska was found to be 100%.

Deworming is the most effective method of combating parasites. However, the choice of a suitable antiparasitic preparation, which will help reduce the size of parasitic infections in animals and reduce their proliferation in the environment is sometimes difficult. The drug should be characterized by high efficiency and a broad spectrum of action against both forms of adult and larval (including dormant larvae – L4) high therapeutic index and low toxicity to the host. In addition, the developmental forms of the parasites should be eliminated from the environment.

As living animals are difficult research subjects, especially in the context of intravital research, the number of papers on this subject is limited. In addition, most publications generally address the subject of infestation. While the effectiveness of parasite control in game animals has often been assessed, the findings usually apply to closed systems. Such work is mostly carried out in animal breeding.

Many possible formulas can be used to combat parasites, with the most common being moxidectin, bamectin, eprinomectin, ivermectin, oxfendazole, albendazole, levamisole, doramectin, fenbendazole and febantel [17–21]. Goossens et al. [18] report fenbendazole to have high efficiency (90%) in the control of gastrointestinal nematodes in wild ruminants held in closed systems. Other studies carried out under similar conditions confirm the effectiveness of fenbendazole to be between 89% and 84% depending on the dose applied [19]. Yang et al. found a combination of fenbendazole/levamisole to have the best deworning effect in wild ruminants kept in captivity.

An important element is the choice of the season when deworming is performed. Goossens et al. [17] found the optimal term to be the period of early spring before the eggs become available for infection. However, many authors in Poland propose that the deworming of free-living animals should be carried out during winter feeding (late spring), as larval development is inhibited during this period and the peak excretion of eggs in the spring has yet to occur [21]. Deworming treatment during this period prevents environmental contamination by invasive forms, which in consequence reduces the risk of reinfection [22].

Conclusions

When managing populations of game animals, any system for preventing invasive diseases should be preceded by a thorough diagnosis of the parasite. Due to the high degree of parasitic infections in deer, both in Poland and abroad, it is necessary to develop specific preventive programs using preparations with a broad spectrum of action.

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