

Original papers

Epizootic situation of mouflon *Ovis aries musimon* in Lower Silesia on the basis of coproscopic examinations

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ABSTRACT. Coproscopic examinations of mouflons *Ovis aries musimon* from four forest districts of Lower Silesia performed in spring and autumn from 2012 to 2014 demonstrated the presence of pulmonary nematodes and intestinal parasites, including coccidia of the genus *Eimeria*. Prevalence of pulmonary nematodes (mainly *Muellerius capillaris*) amounted to 69.78%, intestinal nematodes – 56.11% and coccidia of the genus *Eimeria* – 44.6%. The number of oocysts, eggs of intestinal helminths and larvae of pulmonary nematodes was low. Most frequently the parasites occurred in mouflons from the Jugów forest district, which is related to contact with sheep grazed in the area.

Key words: *Ovis aries musimon*, mouflon, coproscopic examinations, pulmonary nematodes, intestinal helminths, *Eimeria* spp.

Introduction

European mouflon (*Ovis aries musimon* Schreber, 1782) is a wild mountain sheep endemic to the Mediterranean islands of Sardinia and Corsica, from where it was brought around 1902 into the Owl Mountains in the number of a few heads. Currently, the population is estimated at over 1 900 animals and inhabits the forests of the Sudeten Mountains, mainly the areas of the Owl Mountains, the Wałbrzyskie Mountains and the Kaczawskie Foothills. In the Owl Mountains mouflons occur in forest districts: Bardo, Jugów and Świdnica, and in the Kaczawskie Foothills in the Jawor forest district where the introduction took place in 1968–1969. In autumn and early winter the animals move from high mountain regions to low-lying areas, mostly meadows [1,2]. The description of these areas is included, inter alia, in „Management of mouflon population (*Ovis musimon* Schreber) in the Owl Mountains” [3]. In addition, mouflons are also scattered across 6 provinces and kept in several national hunting centers under semi-free conditions, among others, in Greater Poland [3,4].

During the harsh winter of 1987 numerous falls of mouflons were recorded in the Owl Mountains. Parasitological sections revealed gastrointestinal parasites and pulmonary nematodes in 100% of animals and in many lungs numerous helminths were observed. Since then, attempts have been made to reduce the occurrence of these parasites by administering anthelmintic drugs of the benzoimidazolylene group, initially in the feed, then in licks [1]. In order to protect mouflons, it has become necessary to control their health and monitor diseases, also parasitic, that often afflict these animals. The areas where mouflons live are also inhabited by roe deer and deer. Besides sheep and goats are being grazed on meadows, therefore this common environment is polluted with dispersive forms of parasites. Deer are very often infected with endoparasites and parasitoses are considered to be the most common diseases of cervids [5]. For example, a recent year-long coproscopic examinations of deer (*Capreolus capreolus*) from the area of the Henryków forest district in Lower Silesia revealed that 67.9% of the samples contained invasive forms of endoparasites

[6]. Also in sheep grazing on pastures in the summer parasitic infections are often recorded, and gastrointestinal nematodes were found, for example, in 30.59% of sheep from traditional farms and in 79.03% of sheep from ecological farms [7].

In addition to helminths, coccidia of the genus *Eimeria* are also common in sheep. For instance, 85.18% of lambs from a traditional farm in the Western Pomerania province and 55.32% of a large herd farm in the Lubuskie province were infected with *Eimeria* spp. [8]. Earlier studies conducted in Greater Poland [9] revealed that up to 96% of lambs were affected by the infection of coccidia, 5 species of the genus *Eimeria* were identified, and the vast majority of cases were multi-species infections. The same species of coccidia that infected sheep were also found in mouflons bred in a hunting centre in Greater Poland [3]. As is well known, the parasites of the genus *Eimeria* are characterized by host specificity, and mouflon and sheep are closely related.

The status of mouflon parasitofauna from the area of Lower Silesia was monitored several times over the years [10–12]. The first survey (1987) revealed that in the population of these animals in the Owl Mountains the prevalence of gastrointestinal nematodes amounted to 56.6%, and pulmonary nematodes up to 100%. Mouflons were provided with veterinary supervision and therapeutic treatments, which was systematically continued until 2011. Therefore, in consecutive years, fluctuations in the prevalence and the number of invasive forms of parasites in fecal samples were observed. After reduction of invasion, reinvasions followed owing to large concentration of dispersive forms of the parasites in the habitat of these animals [1,10]. Differences in the level of infection were also due to the introduction to the mouflon population of animals imported from the Czech Republic and Slovakia in 2006 [4]. The age structure of the herd was changed, the number of juveniles with immature immune system increased, which is conducive to acquiring and maintaining the parasitic infection.

Materials and Methods

Within a period of two years (from spring 2012 to spring 2014), 139 coproscopic samples of mouflons from forest districts: Silesian Bardo (19), Jawor (30), Jugów (44) and Świdnica (46) were examined (Table 1). In addition, 21 fecal samples of

sheep and 12 samples of goats from the Jugów forest district were investigated.

Samples were collected at dens of animals in the morning. The study used fresh and refrigerated material. The research was carried out using standard coproscopic methods: direct smears, flotation by Fülleborn and the modified Willis flotation method, decantation and larvoscopy according to Baermann [13]. The number of eggs was determined using a glass slide under a light microscope [14]. The detected parasites were identified based on their morphology and biometrics. Identification of coccidia species was performed using the key of Pellerdy [15].

Results

Among 139 fecal samples obtained from free-living mouflons, pulmonary nematode larvae were found in 97 (69.78%), eggs of intestinal nematodes in 78 (56.11%), and oocysts of coccidia of the genus *Eimeria* in 62 (44.6%). Also, eggs of *Dicrocoelium dendriticum* and *Moniezia* sp. were identified. In total, gastrointestinal helminths occurred in 81 (58.27%) fecal samples of mouflons (Table 1).

In 65 coproscopic samples (46.76%) dispersive forms of two groups of parasites were found. They were larvae of pulmonary nematodes and eggs of intestinal helminths (30.22%), larvae of pulmonary nematodes and oocysts of *Eimeria* spp. (12.95%), or eggs of helminths and oocysts of *Eimeria* spp. (3.6%). Co-infections of three groups of parasites were detected in 23 samples (16.55%), most of these infections (31.82%) were recorded in samples of mouflons from the Jugów forest district.

The detected pulmonary nematodes were mainly larvae of *Muellerius capillaris* and *Protostrongylus kochii* (Protostrongylidae), as well as *Dictyocaulus viviparus* (Dictyocaulidae). *M. capillaris* occurred most frequently in mouflons from the Jugów forest district (88.64%), less often in the areas of Świdnica, Jawor and Silesian Bardo forest districts (only 36.84%). *Protostrongylus kochi* was recorded less frequently – from 25.0% of the samples from the Jugów forest district to 10.52% of samples from the Silesian Bardo forest district. The larvae of *D. viviparus* were found only twice in the Jugów area (Table 2).

The intensity of pulmonary nematode infections varied depending on the time of year and was generally low; on average, between ten and twenty larvae in 1 g of feces. Maximum number of larvae

in 1 g of feces was detected in samples collected in autumn (130 in the Świdnica forest district) and in spring months (90 in the Silesian Bardo forest district and 72 in the Jugów forest district).

Among the helminths of digestive tract gastroenteric nematodes dominated from the family Trichostrongylidae: *Ostertagia* sp. and *Trichostrongylus* sp.; there were also *Chabertia ovina*, *Nematodirus* sp., *Trichuris ovis*, *Capillaria* sp. and *Strongyloides* sp. The greatest species richness of gastrointestinal helminths was recorded in the samples obtained from the Jugów forest district (Table 2). The number of helminth eggs in fecal samples was not high. It generally was scored as „+”, that is 1–5 eggs per microscopic field (magnification 5×10).

Based on the metric and morphological characteristics, up to five species of coccidia oocysts in the feces of mouflons were identified: *Eimeria bakuensis* (syn. *E. ovina*) – 32.76%, *E. ovinoidalis* – 27.34%, *E. parva* – 15.64%, *E. crandalis* – 12.23%, and *E. intricata* – 5.03%, some remained as unidentified *Eimeria* spp. Infections with these protozoa were in most cases low – in the field of view of the microscope single oocysts were detected, usually one or two, exceptionally three species of coccidia.

In fecal samples of sheep originating from the Jugów forest district mainly pulmonary nematodes were detected – 90.48% (*M. capillaris*, *P. kochii* and *D. viviparus*), also *Eimeria ovinoidalis* and *E. crandalis* – 57.14%; and in 28.57% – intestinal nematodes (Trichostrongylidae, *Chabertia ovina* and *Strongyloides* sp.). Even more parasites were present in the feces of goats because in 11 out of 12

tested samples (91.67%) there were larvae of pulmonary nematodes *M. capillaris* and *Dictyocaulus* sp., eggs of intestinal nematodes, mainly *Chabertia ovina* and *Strongyloides* sp., and not determined eggs of Trichostrongylidae. Coccidia *Eimeria* spp. were found in 9 samples (75%). Both in the feces of sheep and goats large numbers of parasitic invasive forms were observed, in particular of pulmonary nematodes, the number of which amounted to 450 larvae per gram of feces.

Discussion

The presented data show that mouflons currently living in the wild in Lower Silesia are largely infected with parasites: helminths of gastrointestinal tract (58.27%) and coccidia (44.6%), especially pulmonary nematodes (69.78%). Since 1988, an attempt has been made to reduce the number of parasites by administering anthelmintics. For example, Fenbesan used in the Bardo forest district caused a reduction of the prevalence of pulmonary nematodes from 100% to 31.3% and gastrointestinal nematodes from 56.6% to 13.3%. Whereas Mebendazol administered in licks in the Jawor forest district resulted in a decrease of the prevalence of *Muellerius capillaris* infection from 100% to 20% [1].

It is believed that long-term use of these formulations contributed to the almost total elimination in the mouflon population of pulmonary nematodes *Dictyocaulus viviparus* and *D. filaria* which are characterized by a simple development cycle. These species were found in mouflons in the years 1988–1990 [11], but re-examinations (2006–2007) did not reveal the presence of nematode

Table 1. Parasitic infections in mouflons

Forest District	Number of samples	Number and prevalence of gastrointestinal helminths (%)	Number and prevalence of intestinal nematodes (%)	Number and prevalence of <i>Eimeria</i> spp. (%)	Number and prevalence of pulmonary nematodes (%)
Silesian Bardo	19	9 (47.37)	8 (42.11)	8 (42.11)	7 (36.84)
Jawor	30	12 (40.0)	11 (36.67)	13 (43.33)	20 (66.67)
Jugów	44	31 (70.45)	31 (70.45)	26 (59.09)	39 (88.64)
Świdnica	46	29 (63.04)	28 (60.87)	15 (32.61)	31 (67.39)
Total	139	81 (58.27)	78 (56.11)	62 (44.6)	97 (69.78)

Table 2. Prevalence of helminths in mouflons in the surveyed forest districts

Parasites	Jugów forest district (44) number (%)	Świdnica forest district (46) number (%)	Silesian Bardo forest district (19) number (%)	Jawor forest district (30) number (%)
<i>Muellerius capillaris</i>	39 (88.64)	32 (69.56)	7 (36.84)	17 (56.67)
<i>Protostrongylus kochii</i>	11 (25.0)	9 (19.56)	2 (10.52)	7 (23.33)
<i>Dictyocaulus viviparus</i>	2 (4.54)	–	–	–
Trichostrongylidae	19 (43.18)	26 (56.52)	6 (42.11)	10 (33.33)
<i>Chabertia ovina</i>	10 (22.73)	–	2 (10.53)	–
<i>Nematodirus</i> sp.	7 (15.91)	–	2 (10.53)	–
<i>Trichuris ovis</i>	1 (2.27)	1 (2.17)	1 (5.26)	–
<i>Capillaria</i> sp.	4 (9.09)	–	–	4 (13.33)
<i>Strongyloides</i> sp.	1 (2.27)	4 (8.69)	–	–
<i>Dicrocaelium dendriticum</i>	5 (11.36)	4 (8.69)	–	–
<i>Moniezia</i> sp.	–	1 (2.17)	–	–

larvae of the genus *Dictyocaulus* [12]. While the persistence of *M. capillaris* and *P. kochii* infections results from parasite circulation in the environment and abundance of terrestrial gastropods (from the families of Succineidae, Limacidae, Ariophonidae, Helicidae), which are intermediate hosts of these nematodes. Despite a 3-year break in the human intervention and not administering anthelmintics, currently small numbers of gastrointestinal nematode eggs and lower numbers of pulmonary nematode larvae have been observed compared to previous years [1,11]. Coproscopic samples in these examinations revealed most frequently a few to 30 larvae per 1 gram, which, according to the literature [16] indicates a weak intensity of infection.

The data presented in Tables 1 and 2 show that mouflons inhabiting the Jugów forest district are the most infected. Here the highest prevalence was reported of pulmonary nematodes (88.64%), gastrointestinal nematodes (70.45%), coccidia of *Eimeria* spp. (59.09%), the highest richness of helminths species and the most frequent parasite co-infections. Such a high incidence of infection in mouflons in these areas probably results from sharing meadows with sheep which are not always dewormed, as results from our pilot studies. This applies especially to the infection with pulmonary nematodes *M. capillaris*, *P. kochii*, *D. viviparus*, also *Chabertia ovina* and coccidia *Eimeria ovinoidalis*, *E. crandalis*. According to our unpublished research, coccidiosis occurred in a flock of sheep grazed on Falcon Pass, in which 80%

prevalence of *E. ovinoidalis* was found in coproscopic samples.

Parasitic infection in mouflons living in natural conditions in the Lower Silesia is not a unique phenomenon. According to data of Movsesyan et al. [17], 10–72% of sheep in Poland are currently infected with nematodes of the Protostrongylidae family, 46.1–67.6% of fallow deer (*Dama dama*), 37% of moose (*Alces alces*) and 7.4–18.5% of mouflons. Such low numbers recorded for mouflons result from the fact that the authors took into account also the animals located on farms in closed conditions in different parts of our country. Mouflons kept in farms under semi-wild conditions with other ungulates acquire parasites from them. For instance, in Latvia in such farms the rate of their infection was significantly higher (87.5%) than of red deer (73.3%) and fallow deer (63%). Pulmonary nematodes *Protostrongylus* sp. were found in 20–59.5%, *Dictyocaulus* sp. in 2.3–62.5% and gastrointestinal nematodes Trichostrongylidae in 29.2–90% of the examined animals [18]. Previous studies reported a 100% infection with gastrointestinal nematodes in mouflons kept together with fallow deer in the hunting center in Greater Poland [3].

In addition to helminths, mouflons are frequently infected with coccidia which are sometimes overlooked in coproscopic studies. Information about obtaining *Eimeria* spp. from fecal samples of these animals from the Silesian Bardo and Jawor forest districts come from reports of Pacoń [11]. In

the current study coccidia were present in 44.6% of samples; from 32.61% in Świdnica to 59.09% in Jugów forest district (Table 1). The following species were identified: *Eimeria bakuensis* (syn. *E. ovina*), *E. ovinoidalis*, *E. parva*, *E. crandalis*, *E. intricata* and *Eimeria* spp. Most common were *E. bakuensis* 32.76% and *E. ovinoidalis* 27.34%. In comparison with studies from the years 1988–1990 [11] the degree of infection of mouflons with these protozoa significantly increased, in the Silesian Bardo forest district from 15.9 to 42.11% and in the Jawor forest district from 16.4 to 36.67%. Subsequent research conducted in the years 1987–1992 showed that in several forest administration regions of the Silesian Bardo forest district among the coccidia occurred: *E. parva* – 20.8–65.0%, *E. intricata* – 10.5–30.0% and *Eimeria* spp. – 4.1%, and in the Jawor forest district – *E. intricata* – 20.0% (according to unpublished data of Bartczak). However, in mouflons from semi-wild farms in Greater Poland the dominant species of coccidia were *E. bakuensis* – 63.0% and *E. ninakohlyakimovae* – 44.4% [3].

Research conducted in mouflons in south-western Europe showed that these animals are often infected with coccidia, the species composition of which is varied. In mouflons living in the wild in southern Europe, the dominant species is *E. bakuensis* – 66.7% and *E. ninakohlyakimovae* – 40.4% (Bulgaria), and in Spain the most common are *E. bakuensis*, *E. ovinoidalis*, *E. crandalis* and *E. caprovina* [19,20]. A similar species composition of coccidia was identified in the natural reserve of mouflons in Italy, and most frequently reported were: *E. parva*, *E. ovinoidalis*, *E. bakuensis*, *E. ahasata* and *E. intricata* [21].

Species of coccidia of the genus *Eimeria* belong to host-specific parasites. The review work of French authors [22] showed that characteristic species for sheep in Europe are *E. ovinoidalis*, *E. crandalis* and *E. weybridgensis*, whereas for goats *E. ninakohlyakimovae*, *E. arloingi*, *E. alijeivi*. These species in sheep and goats were recorded in different regions of Slovakia in many farms, and the prevalence was almost 100% with high intensity [23]. And the mouflons tend to be infected with coccidia typical for both sheep and goats.

The problem of coccidiosis also applies to animals living in protected areas. For example, in roe deer (*C. capreolus*) living in Kampinoski National Park the prevalence of coccidian ranged within one year from 20% to 70%, with mean value

47.5% [24]. Whereas coproscopic examinations of bison (*Bison bonasus bonasus*) in the Białowieża Forest revealed the presence of 11 species of *Eimeria* spp. in these animals. The average prevalence was 33.5%, while the juveniles were infected even in 93.3% [25].

Conclusions

Despite veterinary supervision, constant state of infection in mouflon population inhabiting the Owl Mountains is the result of an exchange of parasites between cervids and domestic ruminants (sheep and goats) and contamination of the environment with dispersive forms of parasites.

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