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Original papers

Endoparasites of exotic ungulates from the Giraffidae and Camelidae families kept *ex situ*

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ABSTRACT. Giraffes and camels are popular attractions at zoological gardens. In order to present the diversity of parasites infecting exotic ungulates from zoos, faecal samples from three giraffes and six camels from both the Silesian Zoological Garden in Chorzów, and Kraków Zoological Garden, were examined. The research was carried out over a ten-month period in 2013 and 2014. In total, 100 faecal samples from 18 animals were analysed with the use of the McMaster method. Moreover, coccidian oocysts were incubated to investigate their development and larvoscopic examination was conducted to detect the presence of nematode species. Giraffes were infected with coccidia from the genus *Eimeria*, and gastrointestinal nematodes from the Strongylida order, and *Trichuris* and *Aonhotheca* genera. One male giraffe was uninfected. The level of infection in giraffes was low when compared to camels kept in both of the zoos. Limited contact with other animal species contributed greatly to the lower level of infection in camels from Kraków Zoo than those from Chorzów, which were kept in the same enclosure as alpacas and Shetland ponies.

Key words: parasites, ungulates, Giraffidae, Camelidae, faecal examination, zoos

Introduction

The Giraffidae of Ruminantia, and Camelidae of the Tylopoda suborder are families placed in the taxonomy of ungulates close to Cervidae and Bovidae. From eight subspecies and one hybrid of the giraffe *Giraffa camelopardalis*, which naturally inhabits Subsaharan Africa, mostly two – *G.c. reticulata* and *G.c. rothschildi* – are kept in zoos in Europe. Camelidae, consisting of two species from the *Camelus* genus originating from the Horn of Africa (*C. dromedarius*) or from Central Asia (*C. baktrianus*) are widespread.

Thorough parasitic evaluations are made, especially with regards to camelids, which are important domesticated ungulates [1–2]. They may be infected with pathogenic specific coccidia (*Eimeria dromedarii, E. cameli*, *E. rajasthani*, *E. pllerdyi* and *E. bactriani*), and specific, or shared with sheep and goats, nematodes of *Haemonchus* spp., *Trichostrongylus* spp., *Ostertagia* spp., *Nematodirus* spp., *Marshallagia* spp., *Camelostrongylus mentulatus*, *Oesophagostomum venulosum*, *Trichuris* spp. As regards wild giraffes living in the nature, their parasitic fauna is not yet adequately recognized, but the animals are slightly infected with helminths, e.g., with hookworms *Monodontella giraffae*, trichostrongylid *Haemonchus mitchelli*, or *Parabronema skrjabini* and *Skrjabinema* spp. [3–4].

The present work focused on the parasitic infection of giraffes *G.c. reticulata* and *G.c. rothschildi*, and related camels *C. baktrianus*, kept *ex situ* in the zoological gardens of southern Poland. The main aim of this study was to determine the level of gastrointestinal parasite infections in giraffes during the first months following their introduction to both of the zoos.

Materials and Methods

The research was conducted at two zoos located in southern Poland: the Silesian Zoological Garden in Chorzów, and Kraków Zoo. Fresh faecal samples for coproscopic analyses were collected from giraffes and camels every month from September 2013 to June 2014. In Chorzów Zoo, three giraffes and six camels were kept during the experiment. Three giraffes up to eight years old, which had arrived at the zoo in September 2013, were held in a pavilion, on the floor with sawdust changed daily. The male giraffe was maintained separately and two females were housed together. From the spring of 2014, the animals were allowed to stay outside the pavilion, on grassland. De-worming treatment had not been applied since the arrival of the giraffes at the Silesian Zoo.

The six camels (one male and five females) were kept in individual boxes on straw litter, and a large paddock was used by all the animals throughout the year. The camels were dewormed regularly, several times during the study, with Vermitan 10%, Eqvalan Duo or Fenbenat 4%. Four young camels were born during the study.

At Kraków Zoo, three 3-year-old giraffe males arrived in October 2013 and occupied a newly built pavilion. The pavilion was equipped with large individual boxes and a place for walking, as well as an outdoor paddock, where the animals were kept from spring until late autumn. The animals were not dewormed.

In the case of the camels, six animals lived together in one building, spending all day outside, regardless of the season. During the research, the animals were not treated with any antiparasitic drug, and two young camels were born.

Faecal material was collected in the mornings. In Chorzów zoo, the male and two female giraffes were sampled separately each month, starting from September, and individual samples from six camels were also gathered. In Kraków zoo, from November 2013 individual faecal samples were collected monthly from giraffes, whereas from camels one

Table 1. The level of gastrointestinal parasite infection in the ungulate species examined coproscopically

Month of the year 2013 and 2014	Zoo in Chorzów				Zoo in Kraków			
	G. c. reticulata		*C. baktrianus*		*G. c. rothschildi*[1]		*C. baktrianus*	
	OPG[2]	EPG[3]	OPG	EPG	OPG	EPG	OPG	EPG
September		*20T*[4]	360	0	0	-	-	-
October		*20T* + *20A*[4]	2000	20 (20)*S*+20(20)*T*	0	-	-	-
November		*60S*[4] + *20T*	0	123 (20-640)*S* +23 (2040)*T*	0	0	0	460*S*
December		0	560 (500-620)	884 (80-2260)*S* +175(20-440)*T*	0	80 (60-160)*T*	0	1120*S*
January		0	0	1630 (40-4740)*S* +640 (120-1160)*T*	0	60 (60)*T*	40	970S+40*A*
February		0	0	796 (40-1920)*S* +590 (100-1180)*T*	0	20*T*	0	920S+80*T*
March	120 (100-140)	0	470 (20-1920)	580 (280-1120)*S* +296 (20-1200)*T*	0	20*S* + 80*T*	0	380*S*
April		20*S* + 40*T*	413 (40-1200)	488 (20-940)*S* +315 (20-760)*T*	0	20*S* + 40*T*	0	400*S*
May		0	40	212(40-460)*S* +25(20-40)*A* +320(280-360)*T*	0	60*T*	80	1080*S*+80*A*
June		0	1507 (20-8160)	372(160-740)*S*+140*A* +35(20-60)*T*	0	50(20-80)*S* + 40*T*	0	

[1]the male giraffe Malik, not infected thorough the study period, belonged to *G. c. reticulata* subspecies; [2]OPG – the mean (range) number of *Eimeria* oocysts excreted in 1g of host faeces; [3]EPG – the mean (range) number of nematode eggs excreted in 1g of host faeces; [4]*T* – *Trichuris* sp., *A* – *Aonchotheca* sp., *S* – Strongylida

bulk sample was obtained each month. Overall, from all the zoo animals we collected 100 faecal samples, i.e. 65 from Chorzów – including 20 from the giraffes, and 35 from Kraków – with 27 samples from giraffes.

A coproscopical study was performed using a modified McMaster method with centrifugation. Saturated NaCl with glucose solution was used as a flotation fluid, with a sensitivity of 20 eggs (EPG) or oocysts (OPG) per gram of faeces. To assess the presence of lungworm larvae the Vajda method was applied. To distinguish the gastro-intestinal strongylid genera or species, the larvae obtained from coprocultures [5] were recovered using Baermann technique [6], and then identified on the basis of the keys elaborated by van Wyk and Mayhew [7]. In the case of coccidia, the species were distinguished, after sporulation carried out in 2.5% solution of potassium dichromate [6], by means of their morphological features [8].

Results

In giraffes we found eggs of nematodes from the Trichuridae family (*Trichuris* sp., *Aonchotheca* (*Capillaria*) sp.) and some unspecified eggs of Strongylida (Table 1). The larval cultures performed did not succeed in obtaining any larvae of strongylid nematodes, which was probably due to the very low infection level with these nematodes observed among the animals. All of the detected parasites quickly spread amongst the animals after their introduction to the zoos (Table 1).

From camelid coccidia, *Eimeria bactriani* and *E. dromedarii* species affected the animals. Bactrians from Chorzów zoo were highly infected with coccidia, compared to very low infection rates observed in Kraków zoo (Table 1). Based on larvoscopy, we revealed the presence of two nematode genera in camels: *Trichostrongylus* and *Cooperia*. In general, nematode infection was higher in camels (despite the regular treatment performed in Chorzów zoo), compared to the giraffes in both zoological gardens.

Discussion

In both of the zoological gardens, giraffes had low rates of infection with coccidia and nematodes. Nevertheless, the parasites were present in the animals shortly after their introduction to the zoos. As – excluding one – all the animals came from abroad, this would indicate a lack of thorough parasitic quarantine at the border or might suggest a drug resistance already acquired by the parasites. Nowadays, anthelmintic resistance is a common phenomenon, and has recently been documented in the United States, in *Haemonchus contortus* infecting giraffes [9–10].

Parasitic infections of exotic ungulates kept in zoological gardens have rarely been studied [11]. According to some works, giraffes are usually infected with nematodes shared with other hoofed animals, or they harbour non-specific coccidian species, e.g., typical for cattle *Eimeria bovis* and *E. zuernii* [12], but the infection level is minimal or even not observed – unlike some other herbivorous species present in the same environment [13]. This might be related to the giraffe's feeding behaviour and its lack of contact with infective stages present on the ground. The other studies however show that – despite any clinical symptoms – zoo giraffes may harbour (apart from specific nematodes, like *Trichuris giraffae*), heavy infections with non-specific species, e.g., *Trichostrongylus axei*, *T. colubriformis*, *Ostertagia ostertagi*, *Teladorsagia circumcincta*, *T. trifurcata*, *Marshallagia marshalli*, *Spiculopteragia asymmetrica* or *Camelostrongylus mentulatus*, received from mouflons, fallow deer, red deer or camels [14–15]. Similarly, strongyle nematode eggs were detected in 38.4% of the giraffes sampled by Koch [16], and eggs of *Nematodirus*, *Trichuris* and *Capillaria* (*Aonhotheca*) sp. were found in 5.0 to 7.5% of the faecal samples, whereas most of the larvae obtained in faecal cultures belonged to the *Ostertagia*, *Trichostrongylus*, *Cooperia* and *Strongyloides* genera. In giraffes kept in Negara Zoo in Malaysia, intestinal nematodes such as whipworms *Trichuris* sp., and hookworms, were also found [17]. Some authors [16] declare that Trichuridae (*Trichuris* and *Capillaria* genera) are more prevalent in zoos than in the original habitats of the animals. This was also the case in our study.

According to Young et al. [9], and Garretson et al. [10], giraffes – although classified as browsers – are known to graze, especially in captivity, contributing to the acquisition of gastrointestinal parasites. Żuchowska [18] notes that zoological gardens can create very convenient conditions for parasitic infections in animals, which is caused by the high density of animals kept on relatively small grazing areas, or the high rotation of different species. From this point of view, the lack of any

parasite presence in one of the giraffes (Table 1) throughout the whole period of the study appears to be interesting.

The camels in both of the examined zoos were kept on their own pasturelands for a long time and showed a high level of nematode infection in particular. Limited contact with other animal species contributed greatly to the lesser degree of infection in camels from Kraków Zoo, as compared to the animals in Chorzów – which were kept in the same enclosure as alpacas and Shetland ponies. Since even regularly administered drugs were not able to combat the parasites, it indicates the need for better management and prophylaxy to be applied to control the parasitic diseases of exotic hoofstock kept in the zoos.

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