INTRODUCTION

In the past decade, zoos have played greater role in the promotion of animal biodiversity through the protection of endangered species (Kelly, English, 1997). Zoos are obligated to ensure the welfare and health of bred species. Accordingly, proper nutrition, effective husbandry procedures, and the treatment of disease-causing pathogens are extremely important (Malan et al., 1997). Indeed, parasitic diseases in zoo animals often represent major concern due to the maintenance of animals in confined areas (Geraghty et al., 1981; Citino, 2003) and stress brought on by captivity can also reduce their resistance to parasitic disease (Cordon et al., 2008).

There are relatively significant amounts of information regarding parasites of various cloven-hooved mammals – Artiodactyla, however, little is known about those concerning giraffes (Round, 1968; Pester, Laurence, 1974; Krecek et al., 1990; Fukumoto et al., 1996). One of the few known facts is that the wild giraffes are likely to die due to parasites that develop in water. Giraffes are known to consume large quantities of water, which is why they are so harshly affected by water-borne diseases. In captivity, animals are supplied with purified water which almost never causes illness or death of animals. Captive animals are also carefully monitored for any health issues.

Several studies found the following gastrointestinal parasites in captive giraffes throughout the world: unicellular parasites Blastocystis spp. (Parkar et al., 2010), Cryptosporidium spp. (Kodáková et al., 2010) and Eimeria spp. (Eid, Rawhia, 1996), nematodes Camelostongylus mentulatus (Fukumoto...

Giraffes (*G. camelopardalis*) belonging to the largest group outside Africa bred in a 25-acre grass enclosure in the Longleat Safari Park (Wiltshire, UK) were referred to be parasitized by a rather broad spectrum of parasitic organisms from various taxonomic groups (Melbourne, 1978). The giraffes lived together with camels and zebras and several species of nematode genera *Ostertagia*, *Cooperia*, *Haemonchus*, *Oesophagostomum*, and *Trichostrongylus* were diagnosed there.

Regarding wild giraffes in Africa, samples were collected from six animals (*Giraffa camelopardalis angolensis*) shot in three years in the Etosha National Park, Namibia; helminths recovered included nematodes *Parabronema skrjabini, Skrjabinema spp.*, *Haemonchus mitchelli*, and the hydatic cysts of the tapeworm *Echinococcus* sp. which, however, do not represent parasites of gastrointestinal tract in the case of the intermediate host animals (Kreeck et al., 1990). Protistans *Theileria sp.* and a *Theileria sp.* were diagnosed in a young giraffe (*Giraffa camelopardalis*) translocated from Namibia to South Africa (McCully et al., 1990). Another study from South Africa described originally three new sarcocyst species (Coccidia) in giraffes: *Sarcocystis giraffae, S. klasierensis*, and *S. camelopardalis* (Bengis et al., 1998). Additional parasitic infections were described in giraffes from various African regions were namely nematodes *Haemonchus mitchelli* (Sachs et al., 1973) and *Parabronema skrjabini* (Boomker et al., 1986), as well as the tapeworm *Moniezia expansa* (Pester, Laurence, 1974).

However, there is still little recent information available on parasites of giraffes, especially those bred in zoos. The aim of this study was to detect endoparasites occurring in captive giraffes at several zoos in the Czech Republic using coprological techniques.

### MATERIAL AND METHODS

Zoological gardens in the Czech Republic breed two subspecies of giraffes, namely the Rothschild’s giraffe (*Giraffa camelopardalis rothschildi*) and the Reticulated giraffe (*Giraffa camelopardalis reticulata*). Six Czech zoos were chosen for a parasitological study in giraffes: (1) Zoo Ostrava, (2) Zoo Dvůr Králové nad Labem, (3) Zoo Liberec, (4) Zoo Olomouc, (5) Zoo Praha, and (6) Zoo Plzeň. These zoological gardens implement similar antiparasitic measures. The majority of them (Zoos 1, 2, 3, 4, and 6) examine giraffe faecal samples twice a year. In the case that a parasitic infection is found, animals are treated with fenbendazole or macrocyclic lactones. Only in the Zoo Plzeň giraffes are treated preventively twice a year by using fenbendazole.

In autumn 2012 and spring 2013, 120 fresh faecal samples were collected from 21 giraffes; 55 samples in autumn 2012 and 65 samples in spring 2013. Out of them, 4 animals were young under one year of age, 11 giraffes were older females, and 6 were older males. Faeces were collected individually with the assistance of zoo keepers, stored in plastic bags, and refrigerated at 4°C until examination. The samples were divided into groups according to zoological gardens and gender of giraffes.

The samples were examined using the Concentrated McMaster method modified by Permin, Hansen (1998), which uses saturated sodium chloride and glucose as flotation solution and analytical sensitivity 20 eggs (oocysts) per g of faeces. The results of the coprology examination determine the overall prevalence of gastrointestinal (GI) parasites in captive giraffes and the prevalence of GI parasites according to gender of monitored captive giraffes. The prevalence was evaluated according to Bush et al. (1997).

### RESULTS

The overall prevalence of parasites detected in 120 faecal samples from giraffes from six zoos in the Czech Republic was 1.7% of coccidian oocysts of the genus *Eimeria*, 25% of the nematodes *Trichuris* sp.,
Strongylids (Strongylida) were the most commonly occurring parasite being recorded from giraffe faeces in the Czech Republic, followed by eggs of the whipworms *Trichuris* spp., while exogenous stages – oocysts – of *Eimeria* spp. exhibited the lowest prevalence and low intensity, occurring solely in the Zoo Plzeň. Young giraffes served most often as hosts for *Trichuris* spp. This genus was observed also in adult animals, similarly as during an autopsy of two adult captive giraffes in Japan; four *Trichuris* species were found there, of which *T. giraffae* was the most abundant (Noda, 1955). Regarding strongylid-type nematodes, Gossens et al. (2005) reported their 14.3% prevalence in Kordofan giraffes (*Giraffa camelopardalis antiquorum*) from the Antwerp Zoo and Animal Park Planckendael in Belgium. Garjio et al. (2004) detected as much as 2724 adult nematodes in one dead female giraffe from the Aitana Zoo in Spain, and the majority of these nematodes belonged to various strongyles (*C. mentulatus, T. axei, O. ostertagi, T. circumcincta, T. trifurcata, M. marshalli, T. vitrinus, T. colubriformis*, and *S. asymmetrica*, see also Introduction).

In the condition of the Czech Republic, giraffes from three zoological gardens (Ostrava, Dvůr Králové nad Labem, and Olomouc) had the highest Strongylida prevalence (41.7%) and no infection was detected in Praha (5) and Plzeň (6). Considering recent results, regular medication appears to be effective as it likely eradicated also trichurid nematodes. However, it is important to consider the risk of anthelmintic resistance. A case of resistance was recorded in Florida, where a rigorous and long-time deworming schedule had been in place. A larval development assay showed resistance to three classes of anthelmintics currently used to treat (Garrisson et al., 2009). Unlike our results, van W y k et al. (2006) recommended the use of anthelmintics exclusively in

### DISCUSSION

<table>
<thead>
<tr>
<th>Prevalence (%)</th>
<th>autumn</th>
<th>spring</th>
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<tbody>
<tr>
<td>Strongylida</td>
<td>29</td>
<td>23</td>
</tr>
<tr>
<td><em>Trichuris</em> spp.</td>
<td>21.8</td>
<td>27.7</td>
</tr>
<tr>
<td><em>Eimeria</em> spp.</td>
<td>3.6</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2. Prevalence of nematodes from the order Strongylida, nematodes *Trichuris* spp., and coccidia of the genus *Eimeria*, samples/positive samples numbers (*n*) in individual zoological gardens

<table>
<thead>
<tr>
<th>ZOO</th>
<th>Prevalence (%)</th>
<th>Number of samples</th>
<th>Positive samples (autumn/spring)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ostrava (1)</td>
<td>27.2</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Dvůr Králové nad Labem (2)</td>
<td>37.5</td>
<td>33.9</td>
<td>0</td>
</tr>
<tr>
<td>Liberec (3)</td>
<td>11.8</td>
<td>35.3</td>
<td>0</td>
</tr>
<tr>
<td>Olomouc (4)</td>
<td>41.7</td>
<td>16.7</td>
<td>8.3</td>
</tr>
<tr>
<td>Praha (5)</td>
<td>0</td>
<td>11.1</td>
<td>0</td>
</tr>
<tr>
<td>Plzeň (6)</td>
<td>0</td>
<td>0</td>
<td>16.7</td>
</tr>
</tbody>
</table>

Table 3. Prevalence of the nematodes from the order Strongylida, nematodes *Trichuris* spp., and coccidia of the genus *Eimeria* according to year season

According to the age and sex distribution, 52.6% of samples from young animals were tested positive for parasites; older females had higher percentages of infection than did males (56.9% and 44.4% positive samples respectively) (Table 4). The nematodes from the order Strongylida predominated in both males and females, while *Trichuris* spp. was the most prevalent in young animals. Coccidia of the genus *Eimeria* were found only in males.

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individual animals requiring treatment as opposed to treating the entire herd.

A comparison of infections in the year seasons showed the prevalence of the order Strongylida and the genus *Eimeria* was higher in autumn (29% and 3.6%, respectively) than in spring (23% and 0%, respectively). With respect to *Trichuris* spp., the situation was reversed and the prevalence of trichurids increased from 21.8% in autumn to 27.7% in spring. In fact, seasonal differences are not very high and might be caused by a combination of weather and breeding conditions. Breeding management is apparently a very important factor for the occurrence of parasites in captive giraffes. For example, infection levels were significantly lower at the Antwerp Zoo than in the Planckendael Animal Park (Belgium); this was most likely due to the zero grazing and daily dung removal carried out at the Antwerp Zoo (Goossens et al., 2005). No parasites were found in giraffes at Italian zoological parks Zoosafari Fasanolandia and Giardino Zoolologico (Pistoria). Indoor enclosures were cleaned on a daily basis at these zoos, and the animals were treated twice a year with an anthelmintic drug and routine faecal analyses were performed monthly by the zoo veterinarians (Fagioli et al., 2010).

Another major factor is likely based on an opportunity of cross infections in common breads of giraffes and other ungulate animals in the same enclosures. According to Garjo et al. (2004), cross-infections of different species of wild ruminants with nematodes are common. The same context was referred by Garjio et al. (1998): Three new *Sarcocystis* species, *Sarcocystis giraffae*, *S. klaseriensis* and *S. camelopardalis* (Protozoa: Sarcocystidae) from the giraffe (*Giraffa camelopardalis*) in South Africa. The Journal of Parasitology, 84, 562–565. doi: 10.2307/3284724.

CONCLUSION

Gastrointestinal parasites of giraffes from six zoos in the Czech Republic were coprologically identified. The parasite prevalence detected in our study was not extremely high and the parasite compound did not significantly differ from that referred by other European studies. Nevertheless, zoo management in the Czech Republic might be improved.

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REFERENCES


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