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Endoparasites of exotic snakes (Ophidia)

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Summary

Exotic reptiles, among them snakes, are a novelty in the world of pets. A total of 28 snakes housed in the City Zoological Garden in Wrocław and 23 snakes from zoological wholesale were examined for the presence of endoparasites. Both parasitological sections of dead reptiles and coprological examination were done. Endoparasites were detected in a total of 13.7 % of snakes, including 21.7 % of those coming from the zoological wholesale and 7.1 % of the zoo-kept snakes. Two groups of protozoa were detected: *Choleoeimeria* sp. and Ciliata, as well as nematodes: *Kalicephalus* sp., Dioctowittidae and a pinworm (Oxyurida). The zoo snakes were also found to carry pseudoparasites.

Keywords: exotic snakes; helminths; Nematoda; Protozoa; pseudoparasites; zoological garden; zoological wholesale

Introduction

Reptiles, including exotic snakes, are becoming increasingly popular in amateur breeding in our homes. Some of them, as well as some of those kept in zoological gardens, acquired from private breeders or within amateur exchange, have been caught in the wild. Snakes kept in zoos are under veterinary supervision; they are subject to quarantine and anthelmintic treatments, but parasitoses occur also in zoos (Fernando & Udagama-Randeiya, 2009). There are few reports of parasites of domestic pet snakes. Veasy *et al.* (1994) report on lethal consequences of invasion of *Strongyloides* sp. in the Burmese python *Python molurus bivittatus* kept in a terrarium with other snakes in Louisiana. Examination of 72 exotic snakes of 18 species from amateur breeding in south-east Poland revealed that 19.4 % of them were infected by nematodes of the genus *Kalicephalus*, the invasion intensity being 3-157 (Szczepaniak & Sadzikowski, 2010). Carnivorous snakes in captivity are often fed rodents that may be infected with parasites such as tapeworms *Hymenolepis nana* and *H. diminuta.* They also hold Cryptosporidia: besides the snake-specific *Cryptosporidium serpentis,* they are infected with *Cryptosporidium parvum* (mouse genotype), which is not pathogenic for reptiles but only for humans (Schneller & Pantchev, 2008). Handling snakes may pose a risk to human health (Beck & Pantchev, 2006).

Internal parasites of exotic snakes caught in the wild are rarely studied and poorly understood; mostly, single individuals or small populations of snakes are examined. McAllister *et al.* (1992) found a tapeworm *Ophiotaenia ophiodex* and roundworms *Ophidascaris* sp. in two individuals of the spotted night adder (*Causus maculatus*) imported from Cameroon to the Zoological Gardens in Houston (USA). Examination of 20 snakes representing 10 species (families Colubridae, Elapidae, Viperidae and Typhlopidae) in South Africa revealed a nematode *Kalicephalus colubri* in only two individuals of the Cape cobra *Naja nivea* (Elapidae) (McAllister *et al*., 2010).

Some publications describe new species of nematodes obtained from snakes. In India, a new capillarid species of Paracapillaria (Ophidiocapillaria) was found in the Indian cobra *Naja naja* (Elapidae) (De, 1998), in Brazil *Ophidascaris durissus* was detected in the rattlesnake *Crotalus durissus* (Viperidae) (Panizzutti *et al*., 2003), and in the Amazon Estuary – a nematode *Dracunculus brasiliensis* was found in the green anaconda *Eunectes murinus* (Boidae) (Moravec & Santos, 2009).

Records of Protozoa in exotic snakes are rare. They include a paper on a new species of coccidia *Caryospora regentensis* found in the western green mamba *Dendraspis viridis* (Elapidae) from the Saharan regions of Africa (Daszak & Ball, 2001).

Several studies concern the occurrence of Pentastomida: *Armillifer armillatus*, *Porocephalus* sp. and *Raillietiella* sp. in large snakes (pythons, boas, rattlesnakes) (Almeida *et al.*, 2008). This creates a danger of pentastomiasis in ani-

mals and humans as a result of consumption of raw or half raw snake meat. Such cases of infection have been reported from China and Nigeria (Yao *et al.,* 2008; Ayinmode *et al*., 2010), where pentostomes of the genus *Armillifer* are often found in the ball python (*Python regius*) and *Porocephalus taiwana* in snakes of the genus *Boa.* A new pentastoma species – larval form of *Kiricephalus pattoni* - was recorded in the mountain wolf snake *Lycodon ruhstrati* (Colubridae) from Taiwan (Norval *et al*., 2009). One hundred twenty four snakes, obtained from food markets in Guanghou (China), were killed and examined for parasitic helminths. Plerocercoids of *Spirometra erinaceieuropaei* were found in 29.8 % of them (*Enhydris plumbea*, *Zaocys dhumnades*, *Elaphe radiate*, *E. taeniura*, *E. carinata*, *Ptyas korros*, *P. mucosus, Naja naja*, *Bungarus fasciatus*, *B. multicinctus*). The highest prevalence (100 %) was observed (Wang *et al.,* 2011) in the Chinese rat snake *Zaocys dhumnades* (Colubridae). Eating infected snakes, raw or half-cooked, creates a potential risk of human infection (sparganosis).

Comprehensive investigations of snake parasite fauna are few. An exception is the work carried out in Slovenia in 2000 – 2005 (Rataj *et al*., 2011): the number of examined individuals of exotic reptiles was 949, 55 of them being snakes of 21 species. Endoparasites of 10 taxa, including four types of Protozoa, were found in 43.6% of the snakes. Among them five species (11 specimens) originated from Slovenia, seven (23 specimens) were imported from different EU countries and nine (21 specimens) from Pakistan.

The aim of this study was to assess the occurrence of endoparasites in exotic snakes kept in the Zoological Garden in Wrocław and those obtained from zoological wholesalers.

Material and methods

The total number of examined exotic snakes was 51: 28 individuals, representing 22 species, came from the City Zoological Garden in Wrocław, and 23specimens of 11 species originated from zoological wholesale. The snakes represented the families Boidae, Colubridae, Elapidae and Viperidae (Table 1).

The methods used were standard coprological examination and parasitological section. In the case of snakes from the Wroclaw Zoo samples of faeces were taken, and one snake was subject to parasitological section: a Trans-Pecos rat snake *Bogertophis subocularis*. Thirteen dead snakes obtained from the pet wholesale (*P. guttatus* – 1; *P. regius* – 3*; M. spilota* – 1; *C. major* – 2; *L. getula* – 1; *L. triangulum* – 1; E. *murinus* – 3; *Ahaetulla* sp. – 1) were sectioned.

Table 1. Examined snake species, number of specimens, and their origin

Taxon	**Common name**	**Number of specimens**		
		Zoo	**Wholesale**	**Total**
BOIDAE				
Acrantophis madagascariensis	Madagascar ground boa	1		1
Boa constrictor	boa constrictor	3	2	5
Corallus hortulanus	garden tree boa	1		1
Epicrates cenchria	rainbow boa	4		4
Epicrates striatus	Spanish boa	1		1
Eryx johnii	sand boa		1	1
Eunectes murinus	green anaconda		3	3
Sanzinia madagascariensis	Madagascar tree boa	1		1
COLUBRIDAE				
Ahaetulla sp.			1	1
Bogertophis subocularis	Trans-Pecos rat snake	3		3
Cyclophiops major	great green snake		2	2
Elaphe obsoleta	black rat snake	1		1
Elaphe radiata	radiated rat snake	1		1
Elaphe taeniura	Beaty snake	1		1
Lampropeltis getula	common king snake		1	1
Lampropeltis triangulum	milk snake		1	1
Lamprophis fuliginosus	brown house snake	1	1	2
Morelia spilota	carpet python	1	2	3
Pantherophis guttatus	eastern corn snake	1	2	3
Pituophis melanoleucus	eastern pine snake	1		1
Python molurus	Indian python	2		2
Python regius	ball python	1	7	8
Python reticulatus	reticulated python	1		1
Rhynchophis boulengeri	rhinoceros snake	1		1
ELAPIDAE				
Naja mossambica	Mozambique spitting cobra	1		1
VIPERIDAE				
Trimeresurus albolabris	white-lipped pit viper	1		1
Total		**28**	**23**	**51**

Table 2. Number of snakes examined and infected with endoparasites

Origin	Number of examined individuals	Number of infected individuals	Prevalence %
Zoological garden	**28**	**2** (16)[1]	**7.1** (57.1)[1]
Wholesale	**23**	**5**	**21.7**
Total	**51**	**7** (23)[1]	**13.7** (45.1)[1]

1) including pseudoparasites

Faecal samples were collected from 10 live snakes from the wholesalers (*P. guttatus* – 1; *P. regius* – 4; *B. constrictor* – 2; *M. spilota* – 1; *E. johnii* – 1; L. *fuliginosus* – 1) and subject to coprological examination. Oocysts of *Cryptosporidium* sp. were detected with modified Ziehl-Neelsen method. Faecal samples of ball python and milk snake were tested for the presence of *Cryptosporidium* sp. based on PCR reaction and DNA electrophoresis.

The origin of snakes obtained from the warehouse is not known, probably most of them were caught in the wild, in different parts of the world (North and South America, Africa, Australia, Asia), and only a small proportion came from a breeding station.

Results

Endoparasites were detected in 13.7 % of the snakes: 21.7 % of those from the zoological wholesale and 7.1 % of those from the zoo. The actual proportion of the zoo snakes diagnosed with parasites was much higher, but the vast majority were pseudoparasites which entered the gastrointestinal tract of these reptiles with parasite-infected food (mainly small rodents) (Table 2, Table 4).

The parasites included Protozoa *Choleoeimeria* sp. and Ciliata, as well as nematodes *Kalicephalus* sp., Dioctowittidae and pinworms (Oxyurida) (Table 3).

Coccidia were found in one sectioned ball python *P. regius* obtained from wholesalers. They were oocysts of oval shape, dimensions of 22.5 µm x 12 µm, located in the gall bladder mucosa and containing four sporocysts each, and were identified as *Choleoeimeria* sp. (Fig. 1) and perhaps which Ciliophora of a large size (60 µm x 40 µm) were found in the faeces smear of one ball python *P. regius*.

Nematodes of the genus *Kalicephalus* were isolated from snakes of two species kept in the zoo - green anaconda *Eunectes murinus* and Trans-Pecos rat snake *Bogertophis subocularis*. In the case of *E. murinus* the faeces contained characteristic oval eggs with thin, smooth envelopes and dimensions of 72 – 80 x 45 – 47 µm. The section of *B. subocularis*, which died at the zoo, revealed 12 adult females (Fig. 2) and four males of the genus *Kalicephalus* in the stomach and the mouth cavity. Unfortunately, the males were destroyed which made the species identification impossible. The measurements of the females were: body length 7.25 – 9.63 mm; maximum width 300 – 345 µm; buccal capsule 140 x 150 µm; nerve ring 470 – 475 µm from anterior body end; excretory orifice 600 – 670 µm from anterior end; vulva 2.99 – 4.65 mm from posterior end; tail length 340 – 360 µm. The eggs were 75 – 80 x 43 – 45 µm. Probably the two hosts contained the same species of the genus *Kalicephalus*.

Table 3. Endoparasites infecting snakes

Parasite	Host (number of examined individuals)	Number of infected individuals
Choleoeimeria sp.	*Python regius* (8)	1
Ciliophora	*Python regius* (8)	1
Kalicephalus sp.	*Bogertophis subocularis* (3)	1
	Eunectes murinus (3)	1
Dioctowittidae	*Cyclophiops major* (2)	2
Oxyurida sp.	*Lamprophis fuliginosus* (2)	1

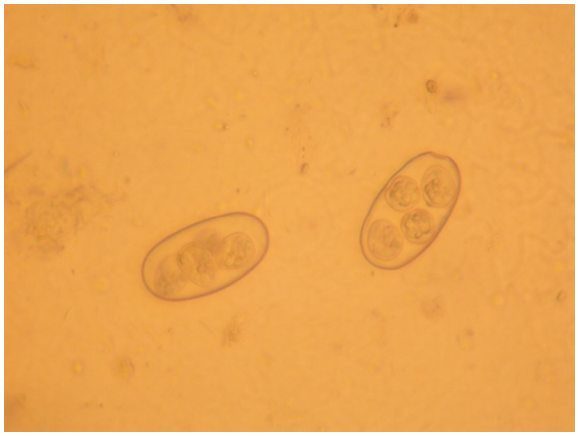

Fig. 1. *Choleoeimeria* sp. – sporulated oocysts from *Python regius*

Two dead specimens of the great green snake *Cyclophiops major*, obtained from the zoological wholesale, had filamentous nematodes in their body cavities. In the first case, it was a mature female 36.5 cm long, of the maximum width

Fig. 2. *Kalicephalus* sp. – female from *Bogertophis subocularis*

Fig. 3. Dioctowittidae – female from *Cyclophiops major*

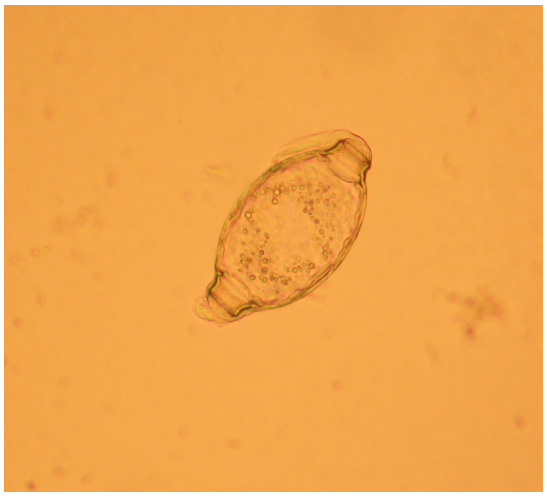

Fig. 4. Dioctowittidae – egg

of 410 µm (Fig. 3). The second female, found in the other snake, was immature (8 cm long and 250 µm wide); the specimen was seriously damaged during preparation. The body of the mature female contained a huge number of eggs measuring 95 – 105 x 40 – 65 µm, with characteristic cones (15 x 5 µm) and filaments 57.5 – 62.5 µm long (Fig. 4) on both poles. The eggs were not embryonated. The parasite (mature female) found in the snake morphologically corresponds to nematodes of the family Dioctowittidae Chabaud et Le Van Hoa, 1960; the characteristic features are the location in the snake's body cavity, very long body, stichosome formed by voluminous stichocytes of syncitial structure, intestine without terminal dilation, female body undivided, eggs lenticular with tufts of polar filaments. According to Moravec (2001) the family Dioctowittidae contains a single genus *Dioctowittus* Chabaud et Le Van Hoa, 1960. However, one feature is incompatible: the eggs not containing fully formed larvae. The size of the female far exceeded the dimensions of four previously known species of the genus *Dioctowittus* (Moravec, 2001; Mulder & Smales, 2006). The morphological characteristics are also slightly different and also make it difficult to identify the species in the lack of a male.

Description of female: nerve ring 95 µm from anterior end of body; 180 µm width at nerve ring; vulva 265 µm from anterior end. Oesophagus 18 mm long. Anus not visible. Tail rounded, almost smooth without cuticular formations.

Pinworm (Oxyurida) eggs, of characteristic shape, with average dimensions of 95 x 45 µm (Fig. 5) were found in the feces of one brown house snake *Lamprophis fuliginosus*, which came from zoological wholesale.

Discussion

The low proportion of parasite-infected snakes at the Wrocław Zoo (two out of 28 examined snakes; 7.1 %) is a result of veterinary supervision and de-worming. The examined snakes contained no *Cryptosporidium* sp. Rataj *et al.* (2011) detected the parasite in only 1 of 16 examined snakes. A pathogenic species, *C. serpentis*, causing cryptosporidiosis, is sometimes found in the gastric mucosa of those animals. There are also records of rodent-specific parasites in snakes, for example *C. parvum*, which however is not pathogenic for them (Greiner & Mader, 2006; Schneller & Pantchev, 2008).

In our study, coccidia of the genus *Choleoeimeria* were found in the gall bladder mucosa of one ball python. According to Schneller and Pantchev (2008) these parasites, found in lizards and snakes, disrupt the bile flow into the intestine and inhibit the action of digestive enzymes. The ciliates of the genus *Nyctotherus*, detected in the feces of another ball python specimen, are quite often noted in snakes. Rataj et. al. (2011) found them in *Platyceps karelini* (Colubridae). They are regarded as non-pathogenic.

Nematodes of the genus *Kalicephalus* (Diaphanocephalidae) are typical gastrointestinal parasites of snakes, less often found in lizards. They are blood-sucking parasites of low host specificity (Anderson, 2000). They have been recorded from snakes worldwide (North America, South and Central Africa, Asia, Europe and Australia) and the number of described species exceeds 50. In 1964 Schad revised the species of this genus and reduced their number

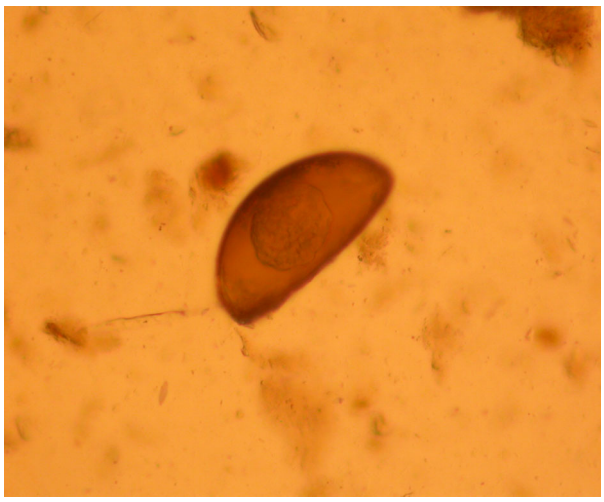

Fig. 5. Oxyurida - egg from *Lamprophis fuliginosus*

Table 4. Pseudoparasites found in faecal samples of zoo snakes

Pseudoparasite	Host (number of examined individuals)	Number of infected individuals
Hymenolepis nana (eggs)	*Acrantophis madagascariensis* (1)	1
	Boa constrictor (3)	1
	Bogertophis subocularis (3)	1
	Epicrates cenchria (4)	2
Aspiculuris tetraptera (eggs)	*Epicrates cenchria* (4)	1
	Epicrates striatus (1)	1
Nematodes (larvae)	*Elaphe radiata* (1)	1
	Bogertophis subocularis (3)	1
	Epicrates cenchria (4)	1
Acari (eggs)	*Acrantophis madagascariensis* (1)	1
	Boa constrictor (3)	3
	Epicrates cenchria (4)	2
	Epicrates striatus (1)	1
	Pituophis melanoleucus (1)	1
	Python molurus (2)	1
	Sanzinia madagascariensis (1)	1

to 23. *K. viperae*, also occurring in Europe (Bulgaria, France, Spain, Poland, Italy), is often found in snakes of the genera *Vipera*, *Elaphe* and *Coluber*. Nematodes of the genus *Kalicephalus* are also frequent in amateur-bred exotic snakes in our country. Szczepaniak and Sadzikowski (2010) found them in 19.4 % of the examined 72 individuals of 18 species of snakes, the invasion intensity being 3 – 157 individuals. Due to the parasite's simple life cycle autoinfection and superinfection occur among captive-bred snakes. Rataj *et al*., (2011) found nematodes of the genus *Kalicephalus* in six species of exotic snakes and emphasised that they were the most common parasites of these reptiles (prevalence 20.4 %). Examination of snakes caught in the wild (indigo snake *Drymarchon corais couperi* in Florida) shows that the invasion of parasites of the genus *Kalicephalus* can be very high, as high as 83 % of the population (Foster *et al*., 2000).

According to the literature, only two helminths are known so far to infect the Asian green snake *Cyclophiops major*: one is the nematode *Paracapillaria kuntzi*, probably located in the intestine and found by Moravec and Gibson (1986) in Taiwan. According to Moravec (2001) this capillaria is a specific parasite of *C. major*.

One mature female found in our material morphologically corresponded to the nematodes of the family Dioctowittidae. The family includes only one genus: *Dioctowittus*. So far (Moravec, 2001) four species have been described: *D. wittei* Chabaud et Le Van Hoa, 1960 occurring in snakes of the genus *Psammophis* (Colubridae) in Africa, *D. chabaudi* Bain et Ghadirian, 1967 in *Leioheterodon* (Colubridae) from Madagascar; *D. denisoniae* Jones, 1978 recorded from species of the family Elapidae in Australia and recently described *D. hughjonesi* Mudler et Smales, 2006 from the python *Liasis fuscus* (Boidae) in tropical Australia. Besides, an unidentified species of *Dioctowittus* sp. Jones, 1978 has been recorded on the basis of a single female found in *Morelia amethistina* (Boidae) from Australia. In the wild the great green snake *C. major* occurs in south-eastern Asia: China, Hong Kong, Vietnam, Laos and Taiwan. Hence its other name – the Hongkong green snake. It inhabits damp forests at altitudes up to 2 000 m where it lives in trees. The history of the two dead individuals in which the nematodes were found is unknown; it is not known how they got to the wholesale – caught in the wild or from a breeding station in another part of the world. According to Mulder and Smales (2006) the absence of records of *Dioctowittus* in snakes from south-eastern Asia results from insufficient studies.

Oxyurida are very rarely noted in snakes, and are more common in lizards and especially tortoises (Buńkowska *et al.,* 2011). The list of nematodes recorded in South African snakes does not contain single information about Oxyurida (Hering-Hagenbeck & Boomker, 2000); there are no records of these parasites from Costa Rica (Bursey *et al.,* 2011). Eggs identified as pinworm eggs were found in the faeces of one brown house snake *L. fuliginosus* from a warehouse. Oxyurid eggs were also found during the studies conducted in Slovenia (1.9 %), in *Platyceps karelini* (Colubridae). Earlier literature (Skrjabin *et al.,* 1960) contains information on the occurrence of *Spauligodon* = *Pharyngodon auziensis* and *Ph. limnodynastes* (Pharyngonidae) in snakes of the genera *Echis, Cerastes* and *Notechis*. These nematodes are regarded as non-pathogenic for reptiles (Greiner & Mader, 2006).

Detection of pseudoparasites – invasive forms of parasites of snake prey animals, most often rodents – in samples of snake faeces is a well-known phenomenon. Wright (2009) provides information on how to distinguish between oocysts and eggs of reptile parasites and pseudoparasites (mouse parasites or cricket eggs, often laid in reptile faeces).

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