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# Endoparasites of lizards (Lacertilia) from captive breeding and trade networks

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**Summary**

Parasitic infections are widespread among exotic lizards and cause serious problems in both private captive breeding and trade networks. Among 168 lizards obtained from captive breeding (Zoological Garden in Wrocław and private owners) and trade (pet shops and wholesale) the total prevalence of endoparasites was 42.35 %. We detected species of Protozoa, Cestoda, Trematoda – Digenea and Nematoda as well as pseudoparasites. The prevalence of endoparasites was higher in the reptiles obtained from captive breeding (59.5 %) than in those from trade network, however the parasite species spectrum was wider in the animals form pet shops and wholesales.
**Keywords:** exotic lizards; endoparasites; helminths: Cestoda, Trematoda – Digenea, Nematoda; Protozoa

## Introduction

According to literature information the level of helminth infection among lizards in the wild can be very high. Studies on house lizards (Gekkonidae): *Cosymbothus platyurus* and *Hemidactylus frenatus* from Thailand revealed infection levels of 94.4 % and 100 %, respectively. The nematode *Pharyngodon* sp. (Oxyuridae) was the most prevalent and abundant parasite (83.3 %) in both lizard species (Saehoong & Wonqsawad, 1997). The prevalence of parasites in the African lizard *Agama agama* from Lagos (Nigeria) was 97.6 % in females and 94.1 % in males. Two species of nematodes dominated among the helminths of *Agama agama*; the prevalence of *Strongyluris brevicaudata* was 82.3 % and of *Parapharyngodon awokoyai* – 74.5 % (Adeoye & Ogunbanwo, 2007). Likewise, high levels of parasitic infections were reported for exotic reptiles imported into European countries for breeding, for example Rataj *et al*. (2011) found 18 parasite taxa (mostly nematodes – 8 and protozoans – 6) in 331 specimens of lizards imported into Slovenia, with the prevalence of 76.1 %.

About 90 % of wild-caught reptiles die in the first year of captivity because of physical trauma prior to purchasing or because their owners cannot meet their complex dietary and habitat needs (Rataj *et al*., 2011). Perhaps parasites also contribute to their death.

Table 1. Species, number of specimens and origin of the examined lizards

| No. | Scientific Name<br>Common Name | Zoo | Private owner | Wholesale | Pet shop | Total |
|---|---|---|---|---|---|---|
| | AGAMIDAE | | | | | |
| 1. | *Acanthosaura capra*<br>Green Pricklenape | 1 | | | | 1 |
| 2. | *Agama agama*<br>Common Agama | 2 | | | | 2 |
| 3. | *Gonocephalus chamaeleontius*<br>Chamaeleon Anglehead Lizard | | | 7 | | 7 |
| 4. | *Physignathus cocincinus*<br>Chinese Water Dragon | 1 | | 47 | 1 | 49 |
| 5. | *Pogona vitticeps*<br>Bearded Dragon | 1 | | 2 | 2 | 5 |

| No. | Scientific Name<br>Common Name | Zoo | Private owner | Wholesale | Pet shop | Total |
|---|---|---|---|---|---|---|
| | CARPHODACTYLIDAE | | | | | |
| 6. | *Underwoodisaurus milii*<br>Thicktailed Gecko | | 1 | | | 1 |
| | CHAMAELEONIDAE | | | | | |
| 7. | *Chamaeleo calyptratus*<br>Veiled Chameleon | 2 | 5 | | 3 | 10 |
| 8. | *Trioceros melleri*<br>Meller`s Chameleon | 1 | | | | 1 |
| 9. | *Trioceros quadricornis*<br>Four-horned Chameleon | | | | 1 | 1 |
| 10. | *Furcifer pardalis*<br>Panther Chameleon | 1 | | | | 1 |
| | CORYTOPHANIDAE | | | | | |
| 11. | *Basiliscus vittatus*<br>Brown Basilisk | 1 | | | | 1 |
| | GEKKONIDAE | | | | | |
| 12. | *Eublepharis macularius*<br>Common Leopard Gecko | 1 | 1 | | 2 | 4 |
| 13. | *Gekko gecko*<br>Tokay Gecko | | | 1 | | 1 |
| 14. | *Gekko vittatus*<br>Lined Gecko | | | 4 | | 4 |
| 15. | *Phelsuma madagascariensis*<br>Madagascar Day Gecko | | | | 1 | 1 |
| | GERRHOAURIDAE | | | | | |
| 16. | *Gerrhosaurus major*<br>Sudan Plated Lizard | 1 | | | 2 | 3 |
| 17. | *Gerrhosaurus nigrolineatus*<br>Black-lined Plated Lizard | 1 | | | | 1 |
| | IGUANIDAE | | | | | |
| 18. | *Celestus warreni*<br>Giant Haitian Galliwasp | 3 | | | | 3 |
| 19. | *Cyclura cornuta*<br>Rhinoceros Iguana | 2 | | | | 2 |
| 20. | *Cyclura nubila*<br>Cuban Rock Iguana | 2 | | | | 2 |
| 21. | *Iguana iguana*<br>Green Iguana | 1 | | 43 | | 44 |
| 22. | *Sauromalus ater*<br>Northern Chuckwalla | 1 | | | | 1 |
| | LACERTIDAE | | | | | |
| 23. | *Gallotia galloti*<br>Gallot's Lizard | 2 | | | | 2 |
| 24. | *Timon lepidus*<br>Ocellated Lizard | 1 | | | | 1 |
| 25. | *Lacerta viridis*<br>European Green Lizard | 1 | | | | 1 |
| | PHRYNOSOMATIDAE | | | | | |
| 26. | *Sceloporus serrifer*<br>Blue Spiny Lizard | 1 | | | | 1 |
| 27. | *Sceloporus malachiticus*<br>Green Spiny Lizard | | | | 1 | 1 |
| | POLYCHROTIDAE | | | | | |
| 28. | *Anolis equestris*<br>Knight Anole | 1 | | 2 | | 3 |
| | SCINCIDAE | | | | | |
| 29. | *Eumeces schneideri*<br>Schneider's Skink | 1 | | 3 | | 4 |
| 30. | *Scincus scincus*<br>Sandfish skink | | | 3 | | 3 |

| No. | Scientific Name<br>Common Name | Zoo | Private owner | Wholesale | Pet shop | Total |
|---|---|---|---|---|---|---|
| | VARANIDAE | | | | | |
| 31. | *Varanus exanthematicus*<br>Savannah Monitor | 1 | | 1 | | 2 |
| 32. | *Varanus mertensi*<br>Mertens's Water Monitor | 1 | | | | 1 |
| 33. | *Varanus niloticus*<br>Nile Monitor | 1 | | | | 1 |
| 34. | *Varanus ornatus*<br>Ornate Monitor | 1 | | | | 1 |
| 35. | *Varanus salvadorii*<br>Crocodile Monitor | 2 | | | | 2 |
| | **TOTAL** | **35** | **7** | **113** | **13** | **168** |

**Material and Methods**

The total of 168 lizards representing 35 species and 11 families were examined. Forty-two of them came from captive breeding (35 from City Zoological Garden in Wrocław, 7 from private owners) and 126 specimens from trade networks (113 from wholesale, 13 from pet shops). The specimens obtained from wholesalers (113 animals of 10 species) were especially important, since probably some of them had been captured in the wild (Table 1).

Standard coproscopic methods: direct smear, flotation technique, sedimentation technique were used to detect parasite infections in 168 animals from the zoological garden (35), pet shops (13), private owners (7) and wholesale (113). Protozoans were identified by sodium-acetate acetic acid formaldehyde (SAF) method and modified Ziehl-Neelsen staining. Additionally, necropsy was performed on the dead lizards (105) recived from wholesale.

**Results**

Out of the 168 examined specimens, 71 were infected. Infections were detected in 25 captive-bred individuals (prevalence 59.5 %) and in 46 specimens from trade network (36.5 %). The highest prevalence was recorded for the pet shop animals (13 examined and 8 infected individuals; 61.5 %) and for those captive-bred in the zoological garden (35 examined, 21 infected; 60.0 %). The sample from private owners was the smallest (7 examined, 4 infected), however the prevalence was rather high, i.e. 57.1 %. The smallest prevalence (33.6 %) was observed among the lizards derived from wholesale, where among 113 specimens 38 harboured at least one species of parasites. Table 2 summarizes the number of infected hosts and the of parasite infection in the examined host species.

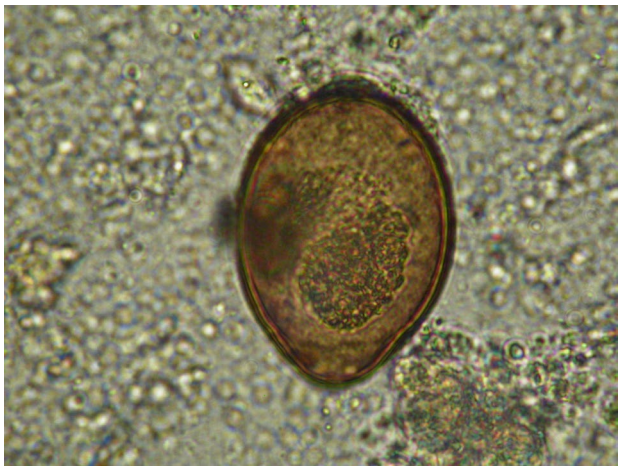

Fig. 1. *Nyctotherus* sp.

*Protozoa*

Protozoans were detected in faeces of 11 individuals (6.5 %) representing the families Agamidae, Chamaeleonidae, Gekkonidae, Scincidae and Varanidae, from both captive breeding and trade network. The parasites included coccidia of the genera *Isospora* and *Eimeria,* as well as representatives of Ciliophora: *Nyctotherus* sp. and *Balantidium* sp. (Table 2; Fig. 1).

*Digenea*

One digenean species was found in the autopsied Chinese Water Dragon. Mature trematodes of the family Plagiorchiidae were detected in five specimens of *Physignathus cocincinus* from wholesale. The intensity of infection was 3 – 5. The general morphological and morphometric features of these specimens corresponded with the descriptions presented by Sharpilo (1976), Roca and Navarro (1983) and Lewin (1992) *Metaplagiorchis molini* from *Lacerta* sp. The measurements (given in micrometers) of *Metaplagiorchis molini* (n=19) from our own material were the following: body length 2050 – 3675; body width 450 – 1025; diameter of oral sucker 200 – 375 x 225 – 350; diameter of ventral sucker 170 – 250; cirrus sac length 420 – 570; anterior testis 250 – 325 x 225 – 325; posterior testis 200 – 375 x 225 – 325; ovary 125 – 200 x 125 – 200; eggs 30 – 33 x 17 – 20. *M. molini* had not been reported previously in exotic lizards. (Fig. 2). Additionally, the analysis faecal samples of one Thicktailed Gecko *Underwoodisaurus milii* from a private owner revealed indeterminate trematode eggs with a characteristic operculum and 80 x 55 µm in size.

*Cestoda*

Eggs of a tapeworm of the genus *Oochoristica* (Anoplocephalidae) were found in faecal samples of two Green Iguana *Iguana iguana* from wholesale. The average size of the eggs was 55 x 35 µm and the hooks of the oncosphere were 15 µm long.

Table 2. Prevalence of endoparasites infecting lizards

| Parasite (number and percentage of infected hosts) | Host species (number of examined individuals) | Number of infected hosts |
|---|---|---|
| **PROTOZOA** | | |
| *Eimeria* sp. (1; 0.6%) | *Gekko vittatus* (4) | 1 |
| *Isospora* sp. (3; 1.8%) | *Chamaeleo calyptratus* (10) | 2 |
| | *Pogona vitticeps* (5) | 1 |
| *Nyctotherus* sp. (5; 3.0%) | *Chamaeleo calyptratus* (10) | 2 |
| | *Eumeces schneideri* (4) | 1 |
| | *Varanus exanthematicus* (2) | 2 |
| *Balantidium* sp. (2; 1.2%) | *Iguana iguana* (44) | 2 |
| **DIGENEA** | | |
| *Metaplagiorchis molini* (5; 3.0%) | *Physignathus cocincinus* (49) | 5 |
| Digenea spp. (1; 0.6%) | *Underwoodisaurus milii* (1) | 1 |
| **CESTODA** | | |
| *Oochoristica* sp. (2; 1.2%) | *Iguana iguana* (44) | 2 |
| **NEMATODA** | | |
| **Enoplida** | *Acanthosaura capra* (1) | 1 |
| *Capillaria* sp. (3; 1.8%) | *Chamaeleo calyptratus* (10) | 1 |
| | *Varanus ornatus* (1) | 1 |
| *Raillietascaris varani* (13; 7.7%) | | |
| | *Physignathus cocincinus* (49) | 13 |
| *Meteterakis cophotis* (9; 5.4%) | *Physignathus cocincinus* (49) | 5 |
| | *Gonocephalus chamaeleontius* (7) | 4 |
| *Strongyluris* sp. (1; 0.6%) | *Agama agama* (2) | 1 |
| Ascarididae (1; 0.6%) | *Gonocephalus chamaeleontius* (7) | 1 |
| **Spirurida** | | |
| *Thubunaea pudica* (1; 0.6%) | *Scincus scincus* (3) | 1 |
| **Strongylida** | | |
| *Oswaldocruzia* sp. (1; 0.6%) | *Gonocephalus chamaeleontius* (7) | 1 |
| **Oxyurida** | *Physignathus cocincinus* (49) | 2 |
| *Parapharyngodon* sp. (3; 1.8%) | *Pogona vitticeps* (5) | 1 |
| *Pharyngodon* sp. (2; 1.2%) | *Eumeces schneideri* (4) | 2 |
| Pharyngodonidae (26; 15.5%) | *Agama agama* (2) | 1 |
| | *Basiliscus vittatus* (1) | 1 |
| | *Celestus warreni* (3) | 1 |
| | *Chamaeleo calyptratus* (10) | 3 |
| | *Cyclura nubila* (2) | 2 |
| | *Eublepharis macularius* (4) | 2 |
| | *Eumeces schneideri* (4) | 1 |
| | *Gallotia galloti* (2) | 2 |
| | *Gekko gecko* (1) | 1 |
| | *Gerrhosaurus nigrolineatus* (1) | 1 |
| | *Iguana iguana* (44) | 3 |
| | *Lacerta lepida* (1) | 1 |
| | *Lacerta viridis* (1) | 1 |
| | *Physignathus cocincinus* (49) | 2 |
| | *Pogona vitticeps* (5) | 3 |
| | *Underwoodisaurus milii* (1) | 1 |
| **PSEUDOPARASITES** | | |
| *Hymenolepis nana* (1; 0.6%) | *Varanus ornatus* (1) | 1 |
| Acari eggs (4; 2.4%) | *Varanus exanthematicus* (2) | 1 |
| | *Varanus mertenseni* (1) | 1 |
| | *Varanus salvadori* (2) | 2 |

*Nematoda*

As could be expected, nematodes were the most prevalent group of helminths detected in this study. Eggs of *Capillaria* sp. (1.8 %) were found in Green Pricklenape *Acanthosaura capra* and Ornate Monitor *Varanus ornatus* kept in the zoo, as well as in one Veiled Chameleon *Chamaeleo calyptratus* from a private owner.

The most common nematodes were species of Ascaridida, recorded in 24 (14.3 %) of the examined lizards. The autopsy of Chinese Water Dragon *Physignathus cocincinus* (13 specimens from wholesales) revealed medium-sized ascaridoid nematodes in the intestines (7.7 %), with the intensity of invasion 2 – 8 individuals mature and premature. The measurements and morphological

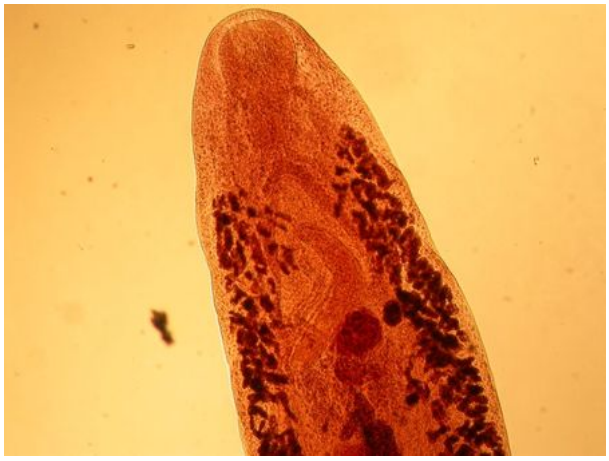

Fig. 2. *Metaplagiorchis molini*

features suggest that they are *Raillietascaris varani*, syn**.** *Ophidascaris varani* (Sprent 1985) (Fig. 3) a species reported from Varanidae (*Varanus monitor*, *V. swarlli*, *V. rudicollis*, *V. nuchalis*, *V. varius*, *V. gouldii*, *V. niloticus*) and also *Iguana iguanae* and *Physignathus cocincinus* from Thailand, India, Philippine Islands, Africa and Australia. The nematodes showed characteristic morphological features: lips with denticles all around the margins, oral groove present, median lobe absent. The interlabia and cervical alae were present, ventriculus was absent. The intestinal caecum was present. The vulva was situated in the anterior to middle body part. More than 20 precloacal papillae were present; the postcloacal papillae comprised subventrals and subdorsals. The spicules were alate. Measurements (in mm): male body length 17.4 – 29.0; maximum width 0.21 – 0.41; oesophagus length 1.72 – 3.00; spicule length 0.75 – 1.20; female body length 42.2 – 61.0; maximum width 0.48 – 0.87; oesophagus length 3.63 – 5.20; vulva from anterior end 12.5 – 26.8.

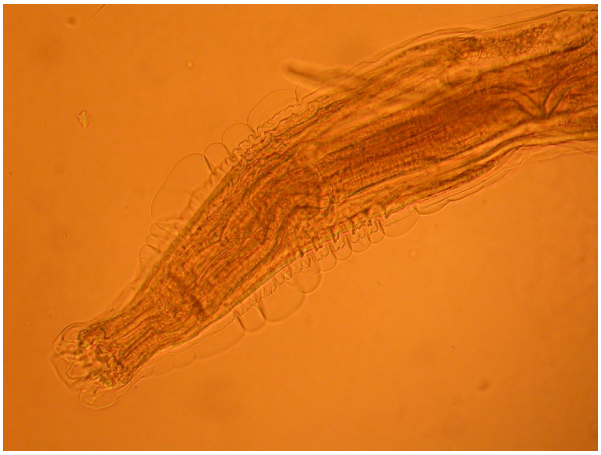

Fig. 3. *Raillietascaris varani*

The adult worms of *Meteterakis cophotis* (Heterakidae) were found in five Chinese Water Dragon *Physignathus cocincinus* and four Javan Humphead Lizard *Gonocephalus chamaeleontius* originating from wholesale**.** Both males and females (Table 2, Fig. 4) were located in the large intestine; the intensity of infection was 1 – 7 specimens. Nematodes of the genus *Meteterakis* are common in oriental and Neotropical lizards (Baker, 1984; Zhang & Zhang, 2011), besides, *M. cophotis* is regarded as typical of the family Agamidae (Reichenbach-Klinke, 1977).

One ascaridid female, approximately 7 cm long, was found in the Javan Humphead Lizard *Gonocephalus chamaeleontius*. Unfortunately, due to its bad condition the identification was impossible.

The analysis of faecal samples revealed a few eggs of *Strongyluris* sp. (70 x 50 µm) in Common Agama *Agama agama* from the zoological garden. Based on the presence of characteristic smooth, transparent and thick shell, the eggs were assigned to the genus *Strongyluris*. According to the literature data, *Strogyluris brevicaudata* is very common in *Agama agama*. The prevalence of this nematode in the lizard in Nigeria (Ibaden) was 87.5 % (Omonona *et al*., 2011).

Fig. 4. *Metearakis copholis* – body end of male

Spirurida (Physalopteridae) were represented by one taxon. *Thubunaea pudica* was found in the esophagus of one Sandfish *Scincus scincus.* Moravec *et al*. (1987) reported *T. pudica* from many species of lizards in North Africa, including *S. scincus*. One specimen (female) of *Oswaldocruzia* sp. (Strongylida) was obtained from the intestine of Javan Humphead Lizard *Gonocephalus chamaeleontius.* The lack of male specimens made it impossible to identify the species. The genus *Oswaldocruzia* was reported from a few lizard genera, for example *Prionodactylus*, *Ameiva*, *Enyalius*, from Central and South America (Goldberg & Bursey, 2004, 2006; Durette-Desset *et al*., 2006).

Oxyurid nematodes (family Pharyngonidae) were frequent (18.4 %), especially among the lizards from the zoological garden (40.0 %) and pet shops (38.5 %), and less so among those from private owners (14.3 %) or wholesale (9.7 %). Using standard coproscopic methods proved to be less effective for detection of oxyurids at the generic level. Necropsy revealed a few females of *Pharyngodon* sp. (Figs. 5, 6) in the large intestine of two individuals Chinese Water Dragon *Ph. Cocincinus,* one Bearded Dragon *Pogona vitticeps* and two Schneider's Skink *Eumeces schneideri*. Infection with Oxyurida often shows high intensity.

Pseudoparasites – *Hymenolepis nana* and Acari – should also be mentioned. Their eggs were present in the faecal samples of Varanidae from the zoological garden, which is associated with the diet of these lizards (rodents). Probably these were the eggs of mites of the genus *Myobia* parasitic of eaten rodents.

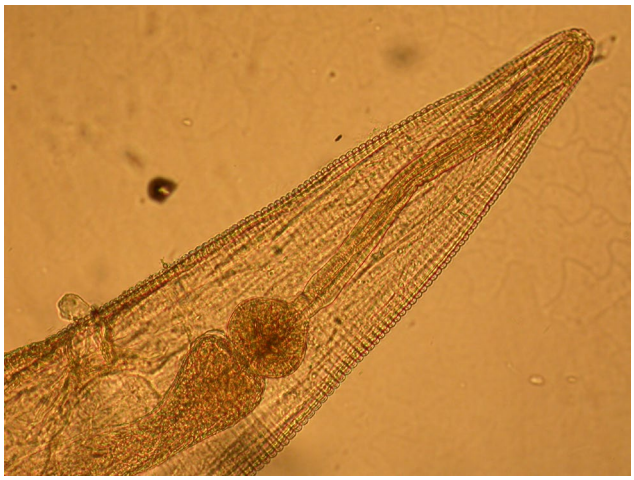

Fig. 5. *Pharyngodon* sp. – proximal part

Fig. 6. *Pharyngodon* sp. –distal part

## Discussion

Lizards, especially in the wild, are commonly infected with coccidia. Oocysts of *Eimeria* sp. were found in 68.7 % of *Agama agama* from Nigeria (Adeoye & Ogunbanwo, 2007). Ciliophora, such as *Nyctotherus* sp., with egg-shaped cysts and an operculum measuring 60 x 55 µm are common, and *Balantidium* sp. especially in herbivorous lizards and not regarded as pathogens. Rataj *et al*. (2011) found *Nyctotherus* sp. in 10 % and *Balantidium* sp. in 2.4 % of examined animals.

Finding adult *Metaplagiorchis molini* (Plagiorchiidae) in Chinese Water Dragon *Ph. cocincinus* is especially noteworthy. *M. molini* was previously reported from *Lacerta* sp. and *Podarcis muralis* (Lacertidae) in Europe, for example France, Germany, Ukraine, Spain and Poland (Lewin, 1992). The origin of the individuals of Chinese Water Dragon (native to East and Southeast Asia) that was examined in this study is not clear. Morphologically our fukes individuals are similar to previously described from Lacertidae, but a molecular characterisation is necessary to confirm this. A probable explanation would be a different species as a direct transfer is not possible due to the need of specific intermediate hosts.

According to some authors, Protocephalidea are more common in lizards than Cyclophyllidea (Gamil, 2012), but in our study only a member of Cyclophyllidea, genus *Oochoristica* was found. *Oochoristica* sp. were formerly reported from *Iguana iguana*, *Chamaeleo* sp. (Pasmans *et al*., 2008; Schneller & Pantchev, 2008) and also from Agamidae: *Pogona viticeps* and *Uromastyx dispar* (Rataj *et al*., 2011).

Nematodes are the most common helminths found in lizards and other reptiles. In this study nematodes were found in 35.7 % of the examined animals. The lizards from the zoological garden and private owners were mostly infected by Pharyngonidae. The reptiles form wholesale showed a large biodiversity of endoparasites, suggesting that those animals were most probably caught in the wild.

Two species of Ascaridida, *Meteterakis cophotis* and *Raillietascaris varani*, found in Chinese Water Dragon *Ph. cocincinus*, seem to be especially interesting. *Meteterakis cophotis* (Heterakoidea), reported from Agamidae in Sri Lanka, was previously found rather rarely. The morphological features and measurements of the specimens of *M. cophotis* found in this study correspond with the data presented by Skrjabin *et al*. (1961) and Reichenbach-Klinke (1977). *Raillietascaris varani*, found in *Physignathus cocincinus* in this study, was usually found in the stomach and intestine, mainly of Varanidae but sometimes also of other lizards, such as *Physignathus cocincinus* (Agamidae) and *Iguana iguana* (Iguanidae). This species is typical parasite of stomach and intestine for Varanidae family (Sprent, 1985).

Finding and identifying *Meteterakis cophotis* and *Raillietascaris varani* in exotic lizards seems to be valuable, because the presence of unidentified eggs of Ascaridida in faecal samples is often mentioned in the literature (e.g. Rataj *et al*., 2011).

Oxyuridae are most commonly found in geckos and agamas. Former studies showed high prevalence rates of up to 50 % (Beck & Pantchev, 2006) or 57.1 % (Rataj *et al*., 2011). In Varanidae these nematodes were reported quite rarely: Beck and Pantchev (2006) found them only in 4.7 % of the examined lizards. In this study no Oxyuridae were found in Varanidae. Lizards were reported as hosts for more oxyurid species of the family Pharyngonidae (Greiner & Mader, 2006), but it was impossible to identify those species based only on the measurements and morphological features of eggs. Although recent studies (Wolf *et al*. 2014) have shown that the use of flotation technique (CNF) allows differentiation of lizard species versus rodent species oxyurid eggs (Aspiculuris/Syphacia, e.g. in monitor lizard).

Finding eggs of *Capillaria* sp. in feaces of *Chamaeleo calyptratus* (Chamaeleonidae) is pretty unusual. This Veiled Chameleon came from private owner and is very likely that was kept together with some Lacertidae.

The helminth species richness was the highest in Chinese Water Dragon *Ph. cocincinus* (Agamidae). Helminths were found in 27 (55.1 %) out of the 49 examined specimens from wholesale and the following species were recorded: one digenean *Metaplagiorchis molini* (10.2 %) and nematodes: *Meteterakis cophotis* (18.4 %), *Raillietascaris varani* (26.5 %), *Parapharyngodon* sp. (4.1 %) and Pharyngodonidae (4.1 %).

## Conclusion

Lizards originating from captive-breeding (zoological garden and private owners) showed a higher level of infection than those form trade network (pet shops, wholesale), with the prevalence rate of 59.5 % and 36.5 %, respectively. The diversity of parasites among the captive-bred lizards was rather low, mostly Oxyuridae and Protozoa were recorded. In the animals from trade network we found the total of 13 species of endoparasites, some of them regarded as rare. We suspect that the high level of parasitic infections may have been the cause of death of some of the lizards from wholesale.

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