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Gastrointestinal parasites of the fan-toed gecko, *Ptyodactylus ragazzi* (Squamata: Gekkonidae)

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Abstract
The geckos are common reptile of houses belonging to the family Gekkonidae; they distributed across all tropical and subtropical regions, and are well known to be carriers of different parasite species. This study investigated the gastrointestinal parasites fauna of the fan-toed gecko, *Ptyodactylus ragazzi* in Shendi, Sudan. A total of 37 *P. ragazzi* were collected and examined for gastrointestinal parasite infections. Four parasite species were identified: two species of nematodes, *Spauligodon* sp. (73%), *Parapharyngodon* sp. (5.4%) and two species of protozoans, *Nyctotherus* sp. (16.2%) and *Eimeria* sp. (2.7%). The overall prevalence of parasite infections was 81.1% and high prevalence of infections was in male geckos (85.7%) compared with females (75%). Older geckos tend to harbor more parasite infections when compared with younger ones. In conclusion, further investigations are required on the parasite fauna of the gecko, *P. ragazzi* in Sudan.

Keywords: *Ptyodactylus ragazzi*, Gastrointestinal, Parasites, Identification, Prevalence, Sudan.

1. Introduction
The geckos are common reptile of houses belonging to the family Gekkonidae. At present, the genus *Ptyodactylus* consists of 7 species, mainly distributed around the Mediterranean and dry areas of Africa [1, 2], and the genus *Hemidactylus* consists of 124 named species distributed across all tropical and subtropical regions [3-5]. Most of geckos are nocturnal and they prey on insects such as ants, termites and beetles [6, 7]. Several different parasites are reported to infect geckos, such as nematodes [8, 9], cestodes [9-11], protozoans [12, 13], and mites [14, 15]. The fan-toed gecko, *Ptyodactylus ragazzi* is widespread across northern parts of Africa, including Sudan; this species is well adapted to anthropogenic areas [1] and it has been classified as Least Concern (LC) in the Mediterranean region, according to the International Union for the Conservation of Nature (IUCN) Red List criteria [16]. In Sudan and to date, no studies exist on the parasite community of the house gecko species, therefore, the aim of the present study was to determine the following: (i) the gastrointestinal parasite species of the fan-toed gecko, *P. ragazzi*, from Shendi, a city located in the northern part of Sudan (ii) the prevalence of parasite infections in relative to the host age and gender.

2. Materials and Methods
A total of 37 *P. ragazzi* were collected between August and October 2014, utilizing a plastic net from their hiding places as the backs of boards on the walls and store rooms in the Faculty of Science and Technology Campus, University of Shendi, Sudan. The geckos were taken to the laboratory and they were sacrificed using a chloroform solution, their snout-vent length (SVL) and gender were recorded. The Hosts were grouped into two age classes on the basis of their SVL (juveniles: < 5 cm, and adults: 5-10 cm). The gastrointestinal tract organs; esophagus, stomach, small intestine and large intestine were removed, dissected and placed in a 0.9% saline solution in separate petri-dishes, and examined thoroughly under a stereo microscope for helminth parasite infections. Direct fecal smears from the stomach and intestine was also prepared and examined for protozoan infections using a compound microscope. Helminth Parasites isolated were cleaned and slide mounted with undiluted glycerol, then utilizing a microscope, they were identified based on the work of Hering-Hagenbeck et al. [17]. Prevalence of infections was calculated according to the host age and gender as (number of the infected host / number of the examined host ×100). All of the calculations were performed using Statistix (version 4, US) analytical software.

3. Results

Out of the 37 collected *P. ragazzi*, 30 (81.1%) were found infected with one or more of gastrointestinal parasite species. Four parasites were recovered from the examined geckos, namely; *Spauligodon* sp. (Nematoda) from the large intestine, *Parapharyngodon* sp. (Nematoda) from the large intestine, *Nyctotherus* sp. (Protozoa) from the large intestine and *Eimeria* sp. (Protozoa) from the small intestine.

Relatively higher prevalence of infections was observed in male geckos (85.7%) compared with females (75%) however, the difference was not significant (P > 0.05), (Table 1, Fig. 1).

Table 1: Prevalence of gastrointestinal parasite infections in *P. ragazzi* from Shendi, according to snout-vent length (SVL) and gender

SVL (cm)	Male			Female		
	No. examined	No. infected	Prevalence (%)	No. examined	No. infected	Prevalence (%)
5-10	16.00	14.00	87.50	12.00	10.00	83.30
< 5	5.00	4.00	80.00	4.00	2.00	50.00
Total	21.00	18.00	85.7	16.00	12.00	75.00

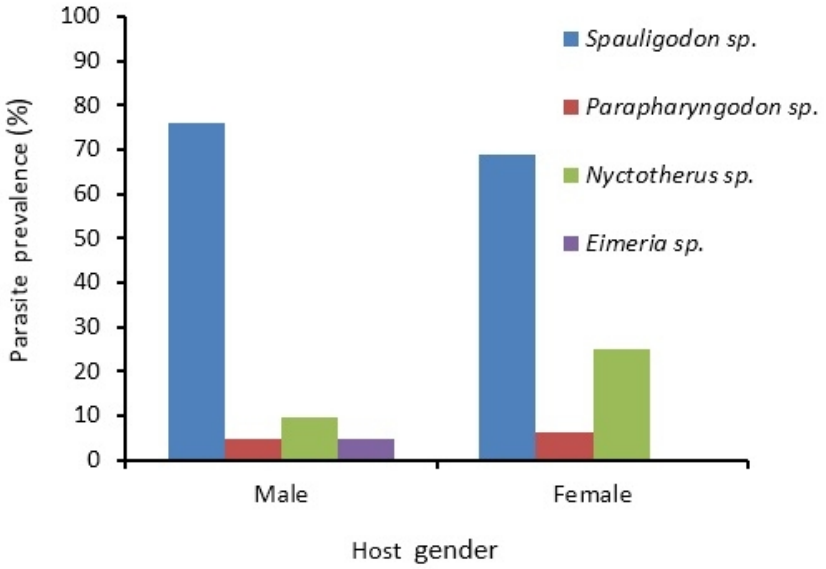

Fig 1: Prevalence of different gastrointestinal parasite infections in *P. ragazzi* from Shendi, relative to gender.

Since the gecko's snout-vent length (SVL) was used as a direct measurement of age, the highest prevalence of parasite species infections was in geckos of SVL range 5-10 cm (adults), compared with the SVL of less than 5 cm (juvenile), (Table 1, Fig. 2).

The dominant parasite species found were *Spauligodon* sp. (73%) followed by *Nyctotherus* sp. (16.2%) and the lowest were *Parapharyngodon* sp. (5.4%) and *Eimeria* sp. (2.7%), (Fig. 1, 2). Of the 37 samples examined, 23 (62.2%) found harbored single infection while 7 (18.9%) harbored mixed infection.

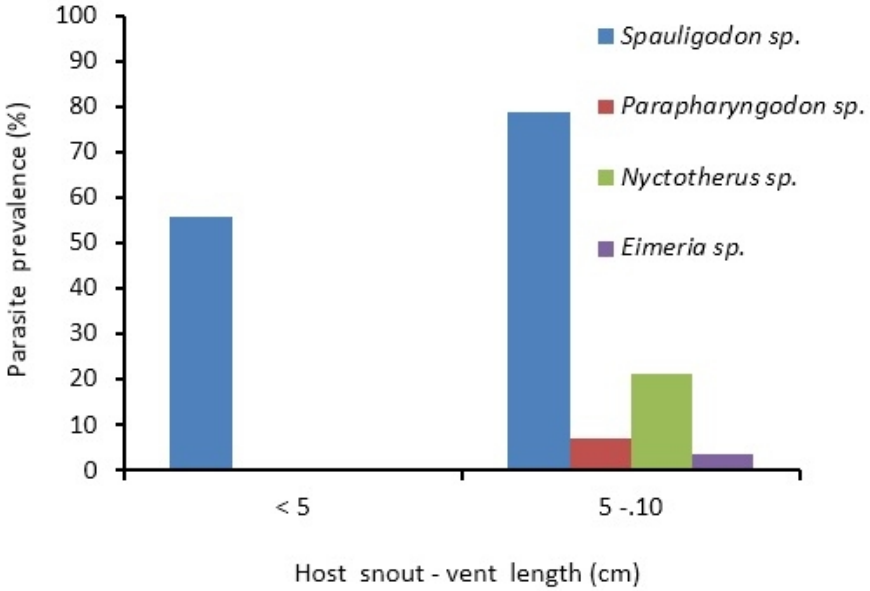

Fig 2: Prevalence of different gastrointestinal parasite infections in *P. ragazzi* from Shendi, relative to snout-vent length (SVL).

4. Discussion

In the present study, four gastrointestinal parasite species were identified from the examined gecko, *P. ragazzi* namely; *Spauligodon* sp. (Nematoda) from the small and large intestine, *Parapharyngodon* sp. (Nematoda) from the large intestine, *Eimeria* sp. (Protozoa) from the small intestine and *Nyctotherus* sp. (Protozoa) from the large intestine. Previously, many nematode species of the genus *Spauligodon* have been investigated, such as *Spauligodon molopoensis* from the large intestine of *Pachydactylus capensis* gecko, *S. blydeensis* from the large intestine of *Homopholis wahlbergii* lizard, *S. timbavatiensis* from the large intestine of *Pachydactylus turneri* lizard, *Spauligodon nicolauensis* from intestines of *Tarentola bocagei* and *Tarentola nicolauensis* geckos and *Spauligodon bintangensis* from the intestine of *Cyrtodactylus bintangrendah* gecko [17-20]. On the other hand, more than 30 *Parapharyngodon* species have been described, including *Parapharyngodon margaritiferi*, *P. gerrhosauri* and *P. rotundatus* [8, 17]. However, no studies exist on the parasites fauna of the house gecko, *P. ragazzi.*

Reptiles are hosts of different protozoan parasites including coccidian and ciliates. Recently, more than 15 species of the genus *Eimeria* (Apicomplexa: Eimeriidae) were reported to infect lizards of the family Gekkonidae [21-23]. In the present study, *Eimeria* sp. oocysts were detected in the intestinal contents of only one of the examined geckos. This is likely to be a new species since the host specificity of the parasite is strong; in addition to the fact that the description of *Eimeria* from lizard hosts as a new species is based mainly on the differences in hosts and their geographical distribution [24]. Of the *Nyctotherus* sp. protozoan, six samples (16.2%) from the examined geckos were found to be infected with this parasite. Previously, it was reported that *Nyctotherus* spp. and *Balantidium* spp. is commonly found in herbivorous lizards, turtles and snakes with transmission by ingestion of infective cysts [25, 26].

Out of the 37 collected *P. ragazzi*, 30 (81.1%) were found infected with one or more species of gastrointestinal parasites. The high prevalence of parasite infections observed in the examined geckos in Shendi city could be attributed to the geckos' food matter which consists of various arthropods such as insects that serve as intermediate hosts for parasite species. However, it has been reported that the high helminth infections in *Chalcides ocellatus* lizard were related to their foraging and feeding habits [27]. In addition, it has been suggested that small carnivorous reptiles harbor poorer helminth communities than herbivorous ones [28- 30]. Increasing in prevalence of parasitic infections with geckos' length in the present study seems to be just an indicator of their ages, hence, of time for parasite recruitment [29, 31-33]. There was no significant difference in the snout–vent length between adults, male and female nematode-infected geckoes; this result coincidence with a previous study finding of no correlation between the intensity of nematode infections and factors of body weight and snout–vent length of lizards[25]. Relatively higher prevalence of infections was observed in male geckos compared to females in the present study; however, the difference was not significant; this is likely that the older male geckos occupy more favorable areas where they come in contact with the parasites and their vectors. Moreover, it has been reported that male lizards are more susceptible to parasite infections probably due to the immune suppressive effects of testosterone, during the reproductive period [34].

5. Conclusion

Further investigations are required on the parasite community of the fan-toed gecko, *Ptyodactylus ragazzi* in Sudan, concerning their taxonomy to species level.

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