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Gastrointestinal parasites and their prevalence in the Arabian red fox (*Vulpes vulpes arabica*) from the Kingdom of Saudi Arabia

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ABSTRACT

The gastrointestinal parasites and prevalence of infestation in the Arabian red fox *Vulpes vulpes arabica* Thomas, were investigated at the King Khalid Wildlife Research Centre (KKWRC) in Thumamah, Riyadh Province, Saudi Arabia. Faecal samples were collected from 58 wild caught foxes while under anaesthesia and examined for gastrointestinal parasites stages. Male and female foxes were infected with three major groups of parasites; cestodes, nematodes, protozoa as well as an acanthocephalan. Faecal analyses revealed that 22 foxes (37.9%) were infected with two different *Isoospora* spp. and three (5.2%) with an undescribed *Eimeria* sp., 12 (20.7%). Nine individuals (15.5%) harboured hookworms, (*Trichosomoides* sp.), two (3.5%) were infected with *Trichuris* sp. (probably *Trichuris vulpes*) and one individual (1.7%) with *Taenia* sp. (probably *Taenia hydatigena*). Carcasses of five male and three female foxes were necropsied. Four of the necropsied carcasses yielded *Ancylostoma caninum*, two each harboured *Pterygodermatitis affinis*, *T. vulpes* and *Macracanthorhynchus catalinus*, in six foxes *Joyeuxiella echinorhynchoides* was found. Five and four foxes were infected with *T. hydatigena* and *Diplopylidium nölleri*, respectively. The possible role of the Arabian red fox as an intercalary host essential for the life cycle of *Trichosomoides* sp., common to the Libyan jird, *Meriones libycus*, in particular and the importance of this species as a vector for zoonotic infections and in the spread of other parasites to wild and domestic animals in general is discussed.

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1. Introduction

The Arabian red fox (*Vulpes vulpes arabica* Thomas) is the smallest of the red foxes, but is the largest and most common of the four species of foxes described from the Arabian Peninsula (Travaini and Delibes, 1995; Nader, 1990; Harrison and Bates, 1991; Macdonald et al., 1999; Lenain et al., 2004). Red foxes are primarily carnivores, but are considered as opportunistic omnivores since their food comprises invertebrates, small mammals, birds and fruits. In Thumamah area the preferred food for foxes consists of the Libyan Jird (*Meriones libycus*), spiny mouse (*Acomys*

dimidiatus), different gerbils (*Gerbillus* spp.), Lesser Jerboa (*Jaculus jaculus*), hare (*Lepus capensis*) and the eastern Skink, *Scincus mitranus* (Al-Sadoon, 1988; Al-Johany et al., 1997; Macdonald et al., 1999). The eastern Skink, *Scincus mitranus* is a favourite prey for the Arabian red fox in the Thumamah area where it is abundant (Al-Sadoon, 1988; Al-Johany et al., 1997).

The diet of the fox renders it a potential host for several gastrointestinal parasites which may be harmful to both man and animals (domestic and wild) alike (Willingham et al., 1996). Although common in Arabia, the role of the fox as a potential reservoir of human and animal diseases is yet to be documented. Macdonald et al. (1999) extensively investigated the behavioural ecology of the fox including the home range and food preference in the vicinity of Thumamah, Saudi Arabia (25°30'N, 46°30'E). The findings

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have raised concerns of the red fox as a possible reservoir of zoonotic parasitic diseases in this area harbouring such infestations as Ancylostomosis and Toxoplasmosis. Lenain et al. (2004) have studied the ecology and diet of the *Vulpes vulpes arabica* and *Vulpes rveppelli sabei* in the Mahazat as-Sayd protected area in western Saudi Arabia. Macdonald et al. (1999) live trapped foxes and fitted them with neck collars containing radio transmitters, these were subsequently released at in the vicinity of where they were trapped. In conjunction with this practice, we took the opportunity to collect faecal material from sedated foxes and performing necropsies on a small number of dead animals which were collected from Thumamah. The samples collected were examined in the laboratory in order to determine the identity and the prevalence of gastrointestinal parasites present in the Arabian red fox.

2. Materials and methods

This study was undertaken in Thumamah area (25°30'N, 46°30'E), an arid stone and gravel desert, 70 km north of the Riyadh City, Saudi Arabia. Within this area, the King Khalid Wildlife Research Centre (KKWRC) was established in 1986 to breed endangered antelopes species indigenous to the Kingdom for reintroduction into the wild where their numbers have decreased over the years.

Thirty-five male and 23 female Arabian red fox (*Vulpes vulpes arabica* Thomas), were anaesthetized using a combination of xylazine hydrochloride (Rompun®, Bayer, Leverkusen, Germany) at a dose of 2 mg/kg body weight and ketamine (Imalgène®, Rhône Mérieux, Lyon, France) at a dose of 5 mg/kg body weight. Fresh faecal samples were collected from the rectum of each fox and placed into numbered plastic bags.

The faecal samples were analysed using floatation and sedimentation techniques (Anonymous, 1986). Protozoan oocysts were sporulated in 2.5% potassium dichromate solution (K₂Cr₂O₇) in Petri dishes (Mohammed and Hussein, 1992). Faecal cultures were also examined using a Baermann apparatus (Anonymous, 1986) for the recovery of nematode larvae. Third stage larvae were identified using the criteria in Soulsby (1982) and Anonymous (1986).

Five male and 3 female Arabian red fox carcasses were recovered from their home ranges and near their dens and autopsied. The alimentary canal was removed from each animal. The oesophagus, stomach, duodenum, jejunum, ileum, colon, caecum and rectum were placed individually into a separate white enamel tray. Each was opened and thoroughly washed with physiological saline. The washings of each gut compartment was transferred to a Petri dish and examined under a stereoscopic microscope for parasites. Adult nematodes and cestodes were collected and subsequently preserved in 5% glycerin alcohol. The worms were cleared in lactophenol (lactic acid crystals 100 g, phenol crystals 100 g, glycerine 200 ml, distilled water 100 ml), examined microscopically and were identified according to Yamaguti (1959, 1961, 1963) and Schmidt (1986). The identification of the parasites was confirmed by the International Institute of Parasitology, St. Albans, UK.

The intestinal mucosa was scraped using a sharp scalpel blade for the release of protozoan and other parasitic

Table 1

Results of coprological investigations from 58 faecal samples collected from the Arabian red fox (*Vulpes vulpes arabica*) around Thumamah area, Saudi Arabia.

Parasite stage	Number of faeces with parasites	Percentage infestation (%)
<i>Isospora</i> sp. (17–22 µm) oocysts	17	29.3
<i>Isospora</i> sp. (46–50 µm) oocysts	10	17.2
<i>Eimeria</i> sp. oocysts	3	5.2
Hookworm eggs	12	20.7
<i>Trichuris</i> eggs	2	3.5
<i>Trichosomoides</i> eggs	9	15.5
Taeniid eggs	1	1.7

Table 2

Adult nematode and cestode helminths recovered from the Arabian red fox (*Vulpes vulpes arabica*) (n=8) autopsied at King Khalid Wildlife Research Centre and their level of infestation.

Worm species	Number positive	Worm infestation (range)
<i>Ancylostoma caninum</i>	4	7–11
<i>Pterygodermatitis affinis</i>	2	23–35
<i>Trichuris vulpes</i>	2	4–6
<i>Joyeuxiella echinorhynchoides</i>	6	5–17
<i>Diplopylidium nölleri</i>	4	3–7
<i>Taenia hydatigena</i>	5	5–14
<i>Macracanthorhynchus catalinus</i>	2	2–5

stages. Sporulated protozoan stages were identified with reference to Levine and Ivens (1981), Dubey and Beattie (1988) and Dubey et al. (1989).

3. Results

A total of 37 (63.8%) of the 58 faecal samples, contained helminth eggs or coccidian oocysts (*Isospora* spp. and *Eimeria* sp). Isosporan oocysts were detected in 22 (37.9%) of the samples and two types of such oocysts were observed (measuring 17–22 µm and 46–50 µm). Eimerian oocysts were detected in only 3 (5.2%) of the samples. The nematode eggs found were *Trichuris* sp. {in 2 (3.5%) of the samples}, hookworm eggs {in 12 (20.7%) of the samples} and fully embryonated *Trichosomoides* sp. eggs in 9 (15.5%) of the samples. Eggs of *Taenia* sp. were found in a single sample, but no trematode eggs were observed (Table 1).

The faecal cultures revealed third stage larvae of *Ancylostoma caninum*, and adults in 3 male and 1 female of the necropsied foxes. *Pterygodermatitis affinis* and *Trichuris vulpes* were found in a single male and female fox. The cestodes included *Joyeuxiella echinorhynchoides* (in 4 male and 2 female foxes), *Diplopylidium nölleri* (in 2 male and 2 female foxes) and *Taenia hydatigena* (in 3 male and 2 female foxes) and ranges of helminth infestation are shown in (Table 2). Acanthocephalan worms, *Macracanthorhynchus catalinus*, occurred in one male (3 worms) and a female fox (5 worms).

4. Discussion

The current study is the first comprehensive report to document the endo-parasites present in the Arabian red fox (*Vulpes vulpes arabica*) from Saudi Arabia, and the Arabian Peninsula as a whole. The Arabian red fox may well

present a source of *A. caninum* infestation to domestic dogs, and of the subsequent zoonotic cutaneous larvae migrans caused by third stage larvae of this hookworm (Dunn, 1978; Soulsby, 1982). The fox may also be a potential source of *Cysticercus tenuicollis* (the larval stage of *T. hydatigena*, which has been reported in the present study) infestation which is common to Arabian gazelles (Mohammed, 1992) as well as sheep and goats in Saudi Arabia (H. S. Hussein, personal communication). Eggs belonging to *Taenia* were probably those of *T. hydatigena* which is a common parasite of dogs, the intermediate hosts usually being sheep, goats or ungulates. This cestode has recently been reported in dogs, foxes and golden jackals from Iran (Dalimi et al., 2006). The foxes could possibly become infected with this parasite as a result of scavenging the carcasses of sheep, goats, camels and wildlife common to Thumamah (Macdonald et al., 1999). *D. nölleri* and *J. echinorhynchoides* present new parasite records for the Arabian red fox. The eggs of *T. hydatigena*, *D. nölleri* and *J. echinorhynchoides* were not detected during coprological examination and this has similarly been documented by Willingham et al. (1996) and Criado-Fornelio et al. (2000) for Taenidae as they indicated that flotation technique can lead to underestimation of the infection. Likewise, the eggs of Dilepididae may not be detected easily during flotation technique.

Although, isosporan oocysts were found in 22 of the faecal samples examined, none of the foxes showed any ill effects. The species may be of low pathogenicity, however, *Isospora* infections are known to be severe, especially to fox cubs (Levine and Ivens, 1981). The measurements and morphological features of the two types of oocysts found were different from all of the *Isospora* species described from carnivores (Levine and Ivens, 1981). It is possible that these specimens may well belong to new and undescribed species. The eimerian oocysts detected in the present study are different to those of *Eimeria vulpes*, the only eimerian species currently described from foxes (Levine and Ivens, 1981). Again, this may well represent a new undescribed *Eimeria* species.

The fully embryonated eggs of *Trichosomoides* sp. are reported for the first time in the faeces of foxes. This intimates that the Arabian red fox could represent an intercalary or cannibalistic host that is necessary for releasing the entrapped passive eggs of that nematode, thus making them available to their rodent hosts. To our knowledge, such a situation is only known to occur in the life cycle of *Capillaria hepatica* of mice and rats, where the cat, and sometimes the dog is the intercalary host (Dunn, 1978). *Trichosomoides* sp. has been recorded in large numbers inside the stomach wall of Libyan jird (*Meriones libycus*) and sometimes inside that of the spiny mouse (*Acomys dimidiatus*) in Thumamah as well as other localities in Saudi Arabia. Interestingly, the eggs were neither seen in the lumen of the stomach, nor in the faeces of those rodents (H. S. Hussein, personal communication). *Capillaria hepatica* itself is known to be a very rare zoonosis, and has been considered by Dunn (1978) to be a false zoonosis, where man acts as an accidental intercalary host by eating the liver of animals in which the eggs are present. These animals include the peccary and some monkey species in Central America. A similar scenario is predicted for *Trichosomoides* sp. in Saudi Arabia

where several wild rodents are consumed as delicacies by local people.

The study is the first to report the infestation by the nematode, *P. affinis* in foxes in the Arabian Peninsula. This nematode has previously been reported from Egypt and Hungary (Yamaguti, 1961). Round (1968) and Rausch et al. (1983), have also reported it in wild carnivores in Africa and North America, respectively, and recently Schuster et al., 2009 have reported it from feral cats in the United Arab Emirates. This rictularioid spirurid has an optional three-host life cycle with insects as intermediate (tenebrinoid beetles and locusts) and reptiles as paratenic hosts. The paratenic host for this parasite may well be the eastern Skink, *Scincus mitranus* which is a favourite prey item of the Arabian red fox and is abundant in Thumamah (Al-Sadoon, 1988; Al-Johany et al., 1997). The absence of the eggs of this nematode from faecal samples may be an indication of its low prevalence in the foxes sampled. Alternatively, it might be explained by the speed at which the eggs are known to hatch rendering them undetectable during routine faecal examination (Yamaguti, 1961).

T. vulpes is a common parasite of foxes and dogs in many parts of the world (Soulsby, 1982). However, the presence of *T. vulpes* in the present study is the first record for Arabian red fox in the Arabia Peninsula. The occurrence of this parasite from the Arabian red fox in Saudi Arabia might also constitute a zoonotic threat as it is also known to infect man (Jacob and Prole, 1976; Kenny and Eveland, 1978). *M. catalinus* has been recorded in the small intestine of wolves, badgers, foxes as well as domestic dogs in several parts of the world (Soulsby, 1982). Macdonald et al. (1999) and Lenain et al. (2004) have identified a number of beetle species as preferred food items of the Arabian red fox, in addition to small mammals. These beetles may be important part in the life cycle of *M. catalinus*. Cystacanths have been found encysted in the muscles, peritoneal cavity and internal organs of mice, squirrels and woodchuck, which presumably act as paratenic hosts (Soulsby, 1982).

The general absence of trematode parasites from the Arabian red foxes sampled in the present study was not unexpected. This is because the very harsh and dry desert conditions prevailing in Thumamah are not conducive to the existence of their snail intermediate hosts. The current study has shown that the Arabian red fox is a host to a wide variety of endo-parasites some of which may well be new to science.

Conflict of interest statement

The authors of this paper have no financial or personal relationship with organizations that could inappropriately influence or bias the content of the paper.

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