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Ectoparasite fauna of rodents collected from two wildlife research centres in Saudi Arabia with discussion on the implications for disease transmission

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ABSTRACT

The majority of human pathogens are zoonotic and rodents play an important role as reservoirs of many of these infectious agents. In the case of vector-borne pathogens, rodent reservoirs not only act as a source of infection for vectors but also serve as hosts for the vectors themselves, supporting their populations. Current data on rodent-ectoparasite relationships is limited in Saudi Arabia, however, this is needed to assess disease risk and the relative importance of different hosts for the maintenance of vector-borne pathogen cycles. In order to provide baseline data for the region that could be used to assess zoonotic disease risk, we collected and identified 771 ectoparasite specimens (ticks, fleas and mites) from 161 rodents at two wildlife research centres in Saudi Arabia and discuss our results in the context of possible zoonotic disease risk based on the hosts and vectors present.

1. Introduction

Of 1415 human pathogens identified by Taylor et al. (2001), (868) (61%) are zoonotic and can be transmitted from animals to humans. Rodents are important reservoirs of zoonotic agents hosting a wide range of bacteria, protozoa and viruses of medical and veterinary importance. These pathogens can be transmitted either directly via exposure to rodent excreta (e.g. leptospirosis, hantavirus) or indirectly via arthropod vectors such as fleas, lice, mites and ticks (Meerburg et al., 2009). In the latter case, rodents propagate pathogen cycles both by being a source of infection for the vectors and by supporting vector populations themselves. Knowledge of specific host–ectoparasite associations in an area can provide important insights into disease transmission. Moreover, the identification of ectoparasites and rodents that are known vectors and reservoirs of pathogens in other locations suggests that the pathogen could be present in local systems. If a particular disease cycle of medical or veterinary importance is identified, quantitative data on specific host–ectoparasite relationships can be used to facilitate control measures (e.g. vaccination or vector/rodent control) and can be used in models to identify proximate drivers of disease transmission or predict risk.

A few older studies (Lewis, 1964, 1982; Al-Khalifa et al., 2006) have presented data on rodent-ectoparasite relationships in Saudi Arabia, however, little new data has been collected in the last 20 years. In order to provide baseline data that could be used to assess zoonotic disease risk, we identified host-ectoparasite<en dash not hyphen> relationships of rodents at two wildlife breeding and research centres in Saudi Arabia and discuss results with reference to the implications for disease transmission for the region.

2. Materials and methods

2.1. Rodent capture

We collected and analysed ectoparasite data from 161 rodents captured within the grounds of the National Wildlife Research

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Table 1
Species, sample size (n), sex ratio and mean body mass ± 1 standard error of the mean rodents captured at the King Khalid Wildlife Research Centre (KKWRC), Riyadh, and the National Wildlife Research Centre (NWRC), Taif, Saudi Arabia.

Site	Species	n	Male/female (proportion which are male)	Mean body mass males (g)	Mean body mass females (g)
KKWRC	*Acomys dimidiatus*	3	1/2 (0.33)	29.66 ± 0.00	27.66 ± 1.00
	Gerbillus nanus	16	6/10 (0.38)	19.46 ± 1.15	15.49 ± 1.80
	Meriones lybicus	41	21/20 (0.51)	130.16 ± 8.27	117.04 ± 6.30
NWRC	*Acomys dimidiatus*	34	19/15 (0.56)	40.94 ± 2.23	34.60 ± 1.47
	Gerbillus nanus	54	24/30 (0.44)	19.80 ± 0.45	18.98 ± 0.51
	Meriones rex	13	9/4 (0.69)	143.47 ± 26.87	129.55 ± 11.59

Centre (NWRC), Taif (21.253021, 40.699416) and the King Khalid Wildlife Research Centre (KKWRC), Riyadh (25.220649, 46.626471). Taif is situated at 1900 m altitude with a mild desert climate and average summer daily temperatures of 28 °C and average winter temperatures of 15 °C. Riyadh is at an altitude of 600 m with average summer temperatures of 33 °C and average winter temperatures of 15 °C. Both locations were dominated by bare, sandy substrate with sparse low level shrub vegetation, however, Taif had a large amount of rocky outcrops at trapping locations which were almost completely absent from the Riyadh site. Rodents were trapped using locally available live rat traps with a hook and bait trigger system. Thirty traps were baited with bread and a peanut butter and oat mix and placed 5 m apart near the entrances of rodent burrows located at the base of shrubs and also at the base of rocky outcrops. Traps remained set throughout the day and night and were checked every three hours from 6 am until 12 pm. Trap lines were moved to a new location ~50 m away from the previous line every 2 days in order to capture new hosts that had not yet been sampled. Traps were re-baited as required. Captured animals were removed from the trap, weighed, and the sex and species recorded. Rodent species were identified in the field based on morphological characteristics following Harrison and Bates (1991) and the identification of populations of *A. dimidiatus* and *G. nanus* found at the trapping locations were confirmed by genetic analyses (Bray et al., 2013). The body of each animal was searched by back-combing the fur and ectoparasites were removed with fine forceps and stored in 70% ethanol. After processing, a small amount of fur was clipped from the head of the animal as a mark to identify recaptures and then released at their point of capture. Animals that had already been captured and marked were not processed again. Traps were in place for a total of 28 days, from the 16th November until the 13th December 2011 with the first 10 days at KKWRC and the remaining 18 days at NWRC in Saudi Arabia. These centres employ numerous staff that come into immediate contact with animals and their enclosures during general animal husbandry and veterinary procedures. In addition, the centres are involved in captive breeding programmes for species of conservation concern including Arabian oryx (*Oryx leucoryx*), sand gazelles (*Gazella marica*), Arabian gazelles (*Gazella arabica*) and Nubian ibex (*Capra nubiana*). Therefore, both humans and species of conservation concern may be at risk from rodent and vector-borne diseases at these locations.

2.2. Ectoparasite identification

Ectoparasites were identified by taxonomic specialists in their respective fields, either mounted or in ethanol, with reference to appropriate keys, descriptions and their own reference material. Mites were identified by E.U. (using Till, 1963; Baker, 1999), fleas by G.N.R. and M.W.H (using Hopkins and Rothschild, 1953; Lewis, 1982) and ticks by D.A.A. (using Filippova, 1997; Walker et al., 2000; Apanaskevich and Horak, 2009). Only generic identifications were possible for some ectoparasite specimens and although lice were also collected, they were not available for identification.

3. Results

3.1. Rodents

A total of 161 rodents were captured that belonged to four taxa consisting of 37 *Acomys dimidiatus*, 70 *Gerbillus nanus*, 41 *Meriones lybicus* and 13 *M. rex*. The majority of host species captured at KKWRC were *M. lybicus* (68.3% = 41/60 of the animals caught), followed by *G. nanus* (16, 26.7%) and *A. dimidiatus* (3, 5.0%). At NWRC, the majority of individuals captured were *G. nanus* (54, 53.4% of 101 animals), followed by *A. dimidiatus* (34, 33.7%) and *M. rex* (13, 12.9%). The mean mass of males and females ± 1 standard error of the mean and the proportion that are male for each species at KKWRC and NWRC are presented in Table 1.

3.2. Ectoparasites

A total of 771 ectoparasites were collected and identified that comprised 151 mites in two taxa (*Androlaelaps tateronis* and *Ornithonyssus* spp.), 413 fleas in seven taxa (*Nosopsylla iranus theodori*, *Parapulex chephrensis*, *Synosternus cleopatrae cleopatrae*, *Synosternus cleopatrae* spp., *Xenopsylla conformis mycerini*, *Xenopsylla nubica* and *Xenopsylla* spp.) and 207 ticks in three taxa (*Hyalomma impeltatum*, *Rhipicephalus camicasi* and *Rhipicephalus* spp.). Host–ectoparasite data for KKWRC and NWRC are summarised in Tables 2 and 3, respectively.

3.3. Mites

The genus *Meriones* was the predominant host for the mite *A. tateronis* with all stages found on *M. lybicus* comprising 92% of the 24 mites collected at KKWRC (Table 2). This mite species was not found on any other host at KKWRC. In contrast, mites of the genus *Ornithonyssus* were only found on *A. dimidiatus* which hosted the remaining 8% of mites collected at KKWRC. A similar pattern existed at the NWRC (Table 3) with *M. rex* hosting all stages of *A. tateronis* (92.1% of 127 mites collected) but no *Ornithonyssus* spp. A single specimen of *Ornithonyssus* spp. was found on *A. dimidiatus*. Small numbers of juveniles of *A. tateronis* were also found on *G. nanus* and *A. dimidiatus* accounting for 7% of the mites collected.

3.4. Fleas

Meriones lybicus hosted the majority of fleas at KKWRC (93.5% of 167 fleas collected), followed by *G. nanus* (5.4%) and *A. dimidiatus* (1.2%) (Table 2). *Nosopsyllus iranus theodori* (29.9% of fleas collected) and another flea which could only be identified to the genus *Xenopsylla* (2.4%) were found only at KKWRC. *N. iranus theodori* was predominantly found on *M. lybicus* with smaller numbers found on *G. nanus*. Only three specimens of the flea identified as *Xenopsylla* spp. were found on *M. lybicus* and a single specimen on *A. dimidiatus*. The remaining flea species from KKWRC, *S. cleopatrae cleopatrae*, *Xenopsylla conformis mycerini* and *X. nubica*, were also found at NWRC (Table 3). *S. cleopatrae cleopatrae* was generally scarce, found in small numbers (4.8% of fleas) on *M. lybicus* with

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