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# A New Coccidian Parasite (*Eimeria farasanii* n. sp.) Indicates Parasite-Host Specificity in Endemic Farasan Gazelle

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## ABSTRACT

The aim of this study was to describe a new species of *Eimeria* from Farasan gazelle which has not been described before. Faecal examination of 24 Farasan gazelles, *Gazella gazelle farasani* collected on Frasan Kebir (Farasan Islands, Saudi Arabia) yielded oocysts of an undescribed coccidian parasite, *Eimeria farasanii* n. sp. Eleven out of the 24 faecal samples (45.8%) were infected with the parasite. Sporulated oocysts of *Eimeria farasanii* n. sp., are ellipsoidal, flattened at micropylar end, measured 20.8±1.8×19.5±1.6 µm (19-25×18-23 µm), length/width ratio 1.07±0.05 (1.04-1.15), with smooth, double-layered oocyst wall, the inner yellow, the outer bluish green, with micropyle 3.6 µm but without a micropylar cap. Sporocyst elongate, measured 8.2±1.1×3.2±0.7 µm (7-10×2-5 µm) length/width ratio 2.6±0.5 (2-4). Stieda body present, substieda body absent. Sporocyst residuum present, consists of diffuse, coarse, refractile granules. Sporozoites elongate, measured 6.5±1.2 µm (6-8 µm), each with a small refractile body at wide end. Sporulation time 7-8 days at 25±2°C. In the present investigation *Eimeria farasanii* n. sp., was described from Farasan gazelle based on the morphological differences with previously described species from the genus *Gazella*.

**Key words:** Coccidia, *Gazella gazella farasani*, Saudi Arabia, Farasan Islands, *Eimeria*, oocyst

## INTRODUCTION

*Eimeria* infections are common in both domestic and wild artiodactyls in Saudi Arabia (Ghandour, 1988; Alyousif *et al*., 1992; Kasim and Al-Shawa, 1985a, b; Mohammed, 1997; Toulah, 2007). Several species were reported from camels (Kawashmeh and El-Bihari, 1983; Kasim *et al*., 1985; Hussein *et al*., 1987), sheep (Kasim and Al-Shawa, 1985a; Toulah, 2007), cattle (Kasim and Al-Shawa, 1985b), the Arabian oryx (Kasim and Al-Shawa, 1988), the Arabian sand gazelle (Hussein and Mohammed, 1992) and the Mountain gazelle (Mohammed and Hussein, 1992). Antelopes indigenous to Saudi Arabia include the Arabian oryx (*Oryx leucoryx*), the Sand gazelle (*Gazella subgutturosa marica*) and the Mountain gazelle (*Gazella gazella* ssp.). The latter species was reintroduced from a captive stock held at King Khalid Wildlife Research Centre (KKWRC) of the Saudi Wildlife Commission (SWC) into two protected areas in the Kingdom, i.e., Ibex Reserve and Uruq Bani Ma-Arid (Dunham, 1995, 1997; Dunham *et al.*, 1993). Other populations are persisting in small numbers in several remote areas along the Mountain ranges of western Saudi Arabia (Magin, 1996; Thouless *et al.*, 1997). The Farasan gazelle (*Gazella gazella farasani*, Thouless and Al-Bassri, 1991) is endemic to the Farasan Archipelago, off-shore the Red Sea coast of Saudi Arabia. The population is still believed to number around 1100 animals (Cunningham and Wronski, 2009). Although, the IUCN Red List classification of vulnerable is based on a population estimated to number <1000 mature individuals (Mallon and Kingswood, 2001), the population of this insular gazelle is characterised by an acute restriction in the number of locations (three islands) and is thus threatened by human nuisance, by stochastic events and devastating disease outbreaks (Flamand *et al.*, 1988; Dunham *et al.*, 2001). During the course of a systematic survey of gastro-intestinal tract parasitic infections in goats and Farasan gazelles and a possible cross-infection between domestic life stock and wild gazelles (Apio and Omer, unpublished data), oocysts of an unknown *Eimeria* species were detected in the faeces of gazelles.

This parasite is different from that infecting main-land mountain gazelles (*Eimeria idmii*; Mohammed and Hussein, 1992) and parasite-host specificity seems to be in place between endemic *Gazella gazella farasani* and the newly described *Eimeria* species. Data from the literature suggest that the phylogenetic backgrounds, body sizes and morphology and feeding behaviors of animal species serve to promote parasite-host specificity. Differences in these factors among coexisting animal species appear to result in hosts with parasite faunas characteristic of their species. There is laboratory and field evidence that suggests parasites may constitute barriers to sympatry of host species with similar parasite susceptibilities. Taxonomically related host species are susceptible to infection by the same parasite species (Awachie, 1972; Baer, 1961; Blackmore and Owen, 1968; Cameron, 1964; Jenkin, 1963; Segun, 1971; Vinson and Iwantsch, 1980). Evolution of host specificity along host taxonomic lines may result from selection favouring parasites whose antigens more closely resemble those of the host (Dineen, 1963; Jenkin, 1963) parasites capable of coating themselves with host antigen (Smithers *et al.*, 1969); parasites that respond to the host by producing host-like substances (Capron *et al.*, 1968); parasites that depress host immune responsiveness (Cypess *et al.*, 1973; Faubert, 1976) or in other ways control the development of a host defensive response (Vinson and Iwantsch, 1980).

In the present study we show a case of parasite-host specificity by describing a new parasite species which is different from that infecting the taxonomically similar host (*Gazella gazella* sp.) inhabiting the near Arabian mainland.

## MATERIALS AND METHODS

Sampling was carried out during a four-week field study (during October 2009 and February 2010) on Farasan Kebir, the largest island of the Farasan Archipelago harbouring the endemic subspecies of *Gazella gazella farasani*. A total of 24 fresh faecal samples from gazelles in Farasan Island were collected from the ground into wide-mouth, screw-capped plastic containers immediately after the animal had defecated. A few samples were collected during a systematic search for localised defecation sites in the study area. The numbers of gazelles in the Farasan Island was so small and it was extremely difficult to see a herd of few gazelles and they dispersed singly in wide areas. Samples from such latrines were fresh but could not be assigned to a sex or age class. Faecal samples were preserved in 2.5% (w/v) potassium dichromate ($K_2Cr_2O_2$) and transferred to the laboratory at King Khalid Wildlife Research Centre (KKWRC). In order to obtain measurements and microphotographs, faecal cultures were examined daily using the floatation method over saturated sodium chloride solution as described by Mohammed and Hussein (1992). Cover slides were searched for unsporulated and sporulated oocysts using a magnification x40 objective lens.

To obtain measurements and microphotographs of sporulated oocysts (sporocysts), three grams of fresh faecal pellets were ground to fine particles using pestle and mortar and mixed with 2.5% (w/v) aqueous solution of potassium dichromate, strained with a fine-mesh wire strainer and suspended in shallow layers of the solution in Petri dishes at room temperature (25±2°C) for sporulation. Measurements of sporulated oocyst were taken using a calibrated ocular micrometer and photomicrographs were made using a Nikon camera (Nikon Company, Japan) attached to a Nikon microscope (Nikon Company, Japan). All measurements were depicted in micrometers (µm, Mean±SD). The description of the new *Eimeria* sp., was based on measurements of sporulated oocysts, presence or absence of micropyle, micropylar caps, oocyst shape and wall color.

## RESULTS AND DISCUSSION

Eleven out of 24 sampled Farasan gazelles (45.8%) were infected with a single species of *Eimeria*. The number of oocysts per individual sample was only few and it was not easy to quantify the infection using modified McMaster technique unlike coccidian parasites detected in goats. This species of *Eimeria* was different to those found in domestic goats inhabiting and browsing in the same area as the wild gazelles. The observed *Eimeria* species is also different from that found in mainland mountain gazelles of Saudi Arabia (*Gazella gazella* sp.) and from *Eimeria* species found in other members of the genus *Gazell1a* (Table 1). Hence, we postulate the detected parasite represents a new species of *Eimeria*.

### *Eimeria farasanii* n. sp.

**Description:** Unsporulated oocysts spherical to subspherical, slightly flattened at micropylar end. Oocyst wall 2.9±0.8 (2-4) thick, smooth, double-layered, each of about the same thickness, outer layer bluish green, inner, slightly thicker, layer yellow, with narrow micropyle measuring 3.6±1.1 (3-5) but without micropylar cap. Sporulated oocysts (N = 100) measured, 20.8±1.8×19.5±1.6 (19-25×18-23), length/width ratio 1.07±0.05 (1.04-1.15). Oocyst residuum and oocyst polar granule are both absent. Each sporulated oocyst with four sporocysts which are elongate, (N = 150) measured 8.2±1.1×3.2±0.7 (7-10×2-5); length/width ratio 2.6±0.5 (2-4). Stieda body present, substieda body absent. Sporocyst residuum present, consists of diffuse, coarse, refractile granules. Sporozoites elongate (N = 50), 6.5±1.2 (6-8), each with a small refractile body at wide end.

**Type host:** The Farasan gazelle, *Gazella gazella farasani* (Thouless and Al Bassri, 1991).

**Type locality:** Miharraq, Farasan Kebir, Farasan Islands, Saudi Arabia.

**Prevalence:** Found in 11 of 24 Farasan gazelles (45.8%).

**Site of infection:** Unknown, oocysts recovered from feces. Low level infection was noticed in gazelles and this coccidian parasite was probably of low pathogenicity.

**Sporulation:** Exogenous, within 7-8 days at 25±2°C in 2.5% $K_2Cr_2O_7$.

Table 1: Morphometric comparison between *Eimeria farasanii* n. sp. and *Eimeria* species described from other gazelle species

| | Oocyst | | | Sporocyst | | | |
|---|---|---|---|---|---|---|---|
| *Eimeria* species | Mean size (range) | Micro-pyle | Micro-pylar cap | Polar granule | Stieda body | Resi-duum | Type host |
| *E. farasanii* n. sp. | 20.8×19.5 (19-25×18-25) | + | - | - | + | + | Farasan gazella, *Gazella gazelle farasani* |
| *E. idmii,* Mohammed and Hussein (1992) | 42×30 (36-48×27-37) | + | + | - | + | + | Arabian mountain gazella *Gazella gazella* ssp. |
| *E. abenovi* Svanbaev (1979) | 32×23 (24-27×19-26) | + | - | - | - | - | Goitred gazelle, *Gazella subgutturosa subgutturosa* |
| *E. chinkari* Pande *et al.* (1970) | 25×22 (24-27×19-26) | - | - | - | + | + | Beunett's gazelle or Chinkara, *Gazella bennetti* |
| *E. dorcadis* Montvani (1966) | 29×18 (26-31×15-26) | - | - | - | - | + | Dorcas gazelle, *Gazella dorcas* |
| *E. elegans* Yakimoff *et al.* (1932) | (23-45×16-25) | + | - | ± | - | + | Goitred gazelle, *Gazella subgutturosa subgutturosa* |
| *E. gazella* Musaev (1970) | 24×20 (20-28×17-25) | - | - | - | - | + | Goitred gazelle, *Gazella subgutturosa* |
| *E. rheemi* Hussein and Mohammed (1992) | 25×21 (20-34×18-30) | + | - | - | + | - | Arabian sand gazelle, *Gazella subgutturosa marica* |

**Types:** Phototypes and preserved materials in authors' collection at KKWRC.

**Etymology:** The specific name is derived from the subspecific name of the type host Farasan Gazelle (*Gazella gazella farasani*) which inhabits Farasan Islands (Fig. 1, 2).

Levine and Ivens (1986) added another 5 species of *Eimeria* from other members of the genus *Gazella* Blainville, 1816. Later, Mohammed and Hussein (1992) and Hussein and Mohammed (1992) added two new eimerain species found in the Arabian sand gazelle and in the Arabian mountain gazelles. *Eimeria farasanii* n. sp., showed pronounced differences to its closely related relative *Eimeria idmii*. It has a very small oocyst with no micropylar cap and appears to be the smallest *Eimeria* species among antelope eimerians (Mohammed and Hussein, 1992). From *E. chinkari*, *E. dorcadis* and *E. gazella* by the presence of the micropyle and from *E. abenovi* and *E. elegans* it can be separated by the presence of the sporocyst residuum. The shape of *E. farasanii* n. sp., as well as the oocyst measurements were closer to *E. rheemi* reported from the Arabian sand gazelle, however, *E. rheemi* lacks the sporocyst residuum. Kasim *et al.* (1991) redesrcibed *E. gazella* and found out that the oocysts of *E. gazella* investigated contained numerous small polar granules and a sporocyst residuum. The original description of *E. gazella* was from the Goitred gazelle (*Gazella subgutturosa*) and detecting it in *Gazella gazella arabica* would raise a question of whether *E. gazella* can infect both *Gazella gazella* sp. as well as *Gazella subgutturosa*,


Fig. 1: A photomicrograph of unsporulated oocyst of *Eimeria farasanii* n. sp. from Farasan gazelle (*Gazella gazella farasani*), scale bar = 5 µm

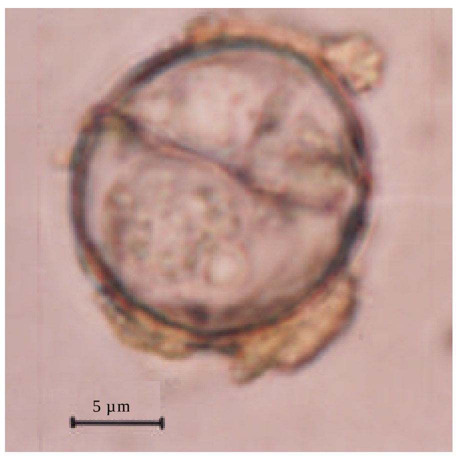


Fig. 2: A photomicrograph of sporulated oocyst of *Eimeria farasanii* n. sp. from Farasan gazelle (*Gazella gazella farasani*). The mirocpyle with no micropylar cap, sporocyst with steida body and residuum. Scale bar = 5 µm

Wronski *et al.* (2010) reviewed the taxonomy of the mountain gazelle in the Arabian Peninsula including gazelles from Farasan Islands. Farasan Mountain gazelles are distinguishable from both mainland populations and the type specimen of *G. arabica*, putatively collected at Farasan in the 19th century (Groves, 1983; Thouless and Al Bassri, 1991). It remains unknown if Kasim *et al.* (1991) have really examined specimens from *Gazella gazella arabica* or not.

The fact that *Eimeria farasanii* n. sp. can be thoroughly separated from all other gazelle and antelope eimerians inhabiting the Arabian Peninsula indicates intra-specific parasite-host specificity.

Parasites depend to a large extent on the evolutionary processes of their hosts, meaning that parasites tend to evolve in parallel with their host species. When two host species have evolved from a common ancestor, the parasites that were originally present in that common ancestor evolve with the two new hosts. So, the modern descendants of the original host ancestor will have parasites descended from those originally present in the ancestral host and the phylogenetic tree of a group of parasites frequently corresponds to the phylogenetic tree of their hosts (Baverstock and Johnson, 1990; Tenter, 1995). Based on phenotypic differences in skull morphometry and fur coloration the subspecies *Gazella gazella farasani* was described (Thouless and Al-Basri, 1991). Although analysis of mitochondrial DNA indicate that several immigration (or introduction) events form the basis for today's Farasan gazelle population it was hypothesized that during the last ice age (i.e., app. 16,000 years before today) a land bridge between Farasan Islands and the Arabian Peninsula enabled mainland Mountain gazelles to immigrate to the archipelago (Thouless and Al-Basri, 1991; Bailey *et al.*, 2007).

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