ALTERED HELMINTH FAUNA IN AFRICAN ELEPHANTS IN RESPONSE TO RESOURCE AVAILABILITY

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Hany Elsheikha, Jaanvi Patel and Vincent Obanda look back over research into gastrointestinal issues facing Kenyan elephants, examining how habitats can affect parasite fauna formation.

PARASITISM is one of the key factors that can influence health, population structure, behaviour, sexual selection and reproductive status of the affected host (Moore, 1984; Watve and Sukumar, 1997; Cleveland et al, 2002).

Elephants, the keystone conservation species (Paine, 1969), are listed as near threatened (Blanc, 2008). They host diverse gastrointestinal parasites (Condy 1974; Vitovec et al, 1984; Kinsella et al, 2004; Fowler and Mikota, 2006; Carreno and Kinsella, 2008), which may cause deleterious pathological lesions even in apparently healthy free-ranging elephants (Basson et al, 1971). In addition, parasites can cause fatal infections in captivity – probably exacerbated by distress (Vitovec et al, 1984).

Elephant populations in Kenya are highly fragmented, and isolated into relatively small ecosystems within and around reserves and parks (Figure 1). The isolation is a consequence of continued habitat fragmentation and sprawling human settlements, which lead to a loss of dispersal corridors and connectivity.

It is likely that isolated populations in different habitats may vary in parasite infection patterns and rates due to variations in factors that influence parasite growth, transmission and establishment within hosts.
The emergence and proliferation of parasitic diseases has been linked to ecological, climatic and environmental changes (Patz et al, 2000; Foley et al, 2008). Drought, which causes both hydric and nutritional stress to animals, may alter the host-parasite equilibrium and trigger clinical disease in free-ranging hosts (Fowler and Mikota, 2006).

Knowledge about the parasite infection patterns in free-ranging wildlife can be of major importance for both the understanding of ecological problems and management of population health, especially when the frequency of adverse weather conditions (such as droughts) is predicted to increase in the already arid and semi-arid wildlife-rich regions of Africa (Easterling et al, 2000).

Therefore, the objectives of this study were to provide a description of the gastrointestinal helmintic parasitofauna in separate elephant populations in Tsavo East and Amboseli national parks in Kenya, and to evaluate the role of habitat on the parasite infection patterns.

**Study sites**

Amboseli National Park lies on the southern border of Kenya and Tanzania, north-west of Mount Kilimanjaro.

It is 392km$^2$, but the Amboseli ecosystem extends to about 3,500km$^2$. The park is located at longitude 37° to 37°30’ east and latitude 2°30’ to 2°45’ south. The area is generally flat, at an altitude between 1,000m to 1,155m. The climate is hot and dry, with a steady increase in temperatures since 1976. The present vegetation structure consists of pockets of *Acacia xanthophloea* and *Acacia tortilis* woodlands, scrub or bush land and highly grazed grassland.

Enkongu Narok and Longinye are the major swamps, and the main source of forage and water for wildlife during the dry seasons.

Elephants and buffalos forage deep in the swamps, while other herbivore species congregate around the swamps foraging on barely emerged pasture. Vegetation in the swamp includes *Cyperus immensus*, *C papyrus*, *C merkii* and *C laevigatus*, whereas edge plants are dominated by *Cyndon dactylon* grassland. The rest of the park is a mosaic of dry pasture land containing grass and scrubs, which are often overgrazed.

The ecosystem has a population of 1,417 elephants, according to the 2005 census.

However, due to severe drought during this study, only 219 remained in the park while the rest had dispersed. Amboseli elephants are the only free-ranging populations whose individual families are known, based on monitoring for more than 27 years by the Amboseli Elephant Research Programme.

Tsavo East National Park is in south-east Kenya at 2°46’43” south latitude and 38°46’18” east
longitude, adjacent to Tsavo West National Park. This semi-arid savannah region covers 11,747km² and has a general altitude ranging from 229m to 2,438m above sea level as a result of the craggy hills and mountains. However, a larger section of the park is generally flat.

Tsavo typically receives two unpredictable wet seasons, with an average annual rainfall of 250mm to 500mm and harsh dry seasons. Habitat consists of grassland that covers nearly 70 per cent of the area, as well as predominantly Commiphora bushland and woodland.

The Tsavo ecosystem, which comprises both Tsavo East and West national parks, holds Kenya’s largest elephant population – 10,397 individuals, based on the 2005 census (IUCN, 2007). Tsavo East is also home to various mega-herbivores such as buffalos, rhinos and hippos. Several streams water the area, including the Mbololo River and the Athi-Galana River.

**Faecal sampling and analyses**

Freshly voided elephant dung was collected over a two-week period from Tsavo East (n = 30) and Amboseli (n = 50) elephant populations. Faecal collection was performed randomly by picking small portions from at least three dropped boli, both on the surface and inside the boli.

Approximately 10g of each sample was collected and placed in sterile, airtight, plastic faecal pots, and a 70 per cent ethanol-saline solution was added as a preservative. The samples were stored in cool boxes and transported to the Kenya Wildlife Service Laboratory in Nairobi, where all analysis was performed within three weeks post-collection. Faecal samples were analysed using the quantitative McMaster technique.

Comparison of means of eggs per gram (epg) between elephant populations and between sexes were based on the Student’s t-test (independent t-test) at a confidence value of 95 per cent (P = 0.05). P > 0.05 was considered not significant. Mean faecal egg count was expressed as mean ± standard deviation (SD) epg. All statistics were generated by SPSS version 11.0.

**Load and diversity of the parasite community**

Out of the 80 samples analysed, 70 (87.5 per cent) were infected. Both elephant populations were infected with nematodes, and one trematode species. Morphologically, the trematode egg appeared oval, yellow and operculated (Figure 2) – indistinguishable from the eggs of the fasciolid Protofasciola robusta.

The prevalence of nematodes and trematodes varied in both populations (Figure 3). Samples in Tsavo had an equal sex ratio (male:female) 15:15, while those from Amboseli had more females (19:31). In Tsavo East, the elephant population’s ages ranged from one to 30 years, while in Amboseli, known ages were from three to 47 years. The prevalence of parasites varied between the sexes in both populations (Figure 4).
The elephant population in Amboseli had a higher mean epg (94.3 ± 133.8) compared to those in Tsavo East (43.1 ± 78.8). However, the difference in mean epg between the two parks' populations was not significant (P = 0.06).

Although male elephants in Tsavo East had higher mean epg (54.6 ± 102.8) compared to the females (31.6 ± 44.5), the difference was not significant (P = 0.43). Likewise, males in Amboseli had a non-significant (P = 0.37) increase in the mean epg (117.3 ± 184.9), compared to females (80.6 ± 96.5). Samples collected in the afternoon had a non-significant (P = 0.34) increase in the mean epg (100.3 ± 151.3) compared to samples collected before noon (44.3 ± 41.3). Diurnal fluctuation of mean worm load was measured for different hours (Figure 5), with the least worm load occurring between noon and 2pm. The distribution of helminths in the population in Tsavo East (Figure 6a) and Amboseli (Figure 6b) were skewed to the left.

**Discussion**

The results of this study demonstrated that elephants in Amboseli and Tsavo East were widely infected with gastrointestinal helmintic parasites.

Helminths seem to be extensively spread in elephant populations across Africa, as they occur in forest elephants as well (Kinsella et al, 2004; Nakande et al, 2007). Nematode species that infect elephants were diverse, and a single host may harbour as many as nine different nematode species (Kinsella et al, 2004). On the other hand, it appears that *P robusta* (Figure 2) is the most common trematode in both savannah and forest African elephant species.

A discrepancy in life history between nematodes and trematodes may explain the higher prevalence of nematodes in elephant populations in the two parks (Figure 5).

Nematodes usually have a direct life cycle, while the fasciolid trematodes need an intermediate aquatic host snail to develop their infective stages, which takes relatively longer (Fowler and Mikota, 2006).

It is interesting that female elephants had higher parasite prevalence in both populations compared to males (Figure 4), while males were more heavily burdened with worms. It is likely that the higher prevalence is linked to the group-ranging pattern of the elephant family, which consists mostly of females.

However, the sex-linked difference in worm burden is consistent with the male-biased theory in which male mammalian hosts are expected to have high parasite burdens (Schalk and Forbes, 1997; Moore and Wilson, 2002).

Factors such as behaviour or physiology have been suggested to underpin such differences (Grossman, 1985; Schuurs and Verheul, 1990). However, in the present study, the sex-related
difference in worm burden was not statistically different, which may suggest that at population level, infection intensity averages out, with an equal probability of either sex suffering from the parasite-detrimental effects.

Worm load in this study had its highest peaks in the afternoon (Figure 5), which is comparable with the rhythmic shedding of coccidian oocysts in antelope (Ezenwa, 2003) or avian species (López et al, 2007). It is likely that the difference in the periodicity of egg release gravid worms tend to coincide with the warm conditions of late afternoon, which are favourable for parasite development.

In parasite ecology, it is well known that a link between host population density, transmission rates and abundance of directly transmitted macroparasites, such as nematodes, exists. Thus, ecological factors that later hosts contact should influence parasite populations’ structure, diversity and dynamics. Host density and contact rates can be influenced by an array of variables, such as habitat quality and host behaviour. For example, when a key resource such as lush pasture or water is clustered in the habitat, aggregation and host crowding (in effect, high host density) occurs, which then can affect the patterns of infections by increasing parasite transmission between infected and susceptible animals.

During periods of drought in Amboseli, elephants and other herbivores congregate in and around the swamp for fresh for-age and water. Pasture in these sites is most likely to be heavily contaminated with infective parasite stages, which increase the risks of parasite transmission (Morand and Poulin, 1998; Rogerson et al, 2008). It is, there-fore, possible that the relatively higher prevalence in Amboseli elephants (Figure 3) is a consequence of resource-driven host aggregation (Arneberg, 2002; Taylor et al, 2005).

Such resource areas, like swamps where hosts cluster, are core transmission foci, and are generally avoided by hosts with large home ranges (such as the elephants; Bordes et al, 2009). However, in this study, Amboseli elephants did not avoid such areas, which suggests that during resource scarcity, hosts may compromise their parasite avoidance strategies. A lack of statistical difference in worm load (P > 0.05) between the two populations may imply lack of a significant relationship between habitat types or vegetation structure per se and parasite burden (Hulbert and Boag, 2001; Vidya and Sukumar, 2002).

**Conclusion**

Amboseli elephants had higher parasite prevalence compared to the Tsavo East population. This was attributed to increased host aggregation around sites that contained water and lush pasture in Amboseli, suggesting that key resources’ distribution within the habitat can influence the parasites’ infection pattern.

This finding suggests that the parasite fauna in elephants is influenced by how resources are spatially distributed within the habitat, and that the spatial distribution of the host population
influences the prevalence and diversity of the parasites. Further studies are required to substantiate this finding. However, if it is true, such elephant-parasite-environment dynamic interactions should be considered in the conservation and management of Kenya’s elephant populations.

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