# README for parasites in Gorongosa and their spatial distribution

Repeated study across taxa lends support to the hypothesis that grazing

ungulates avoid foraging near feces to avoid infection by fecal-oral parasites.

However this observation and others with different infections was recently used

to propose a 'landscape of disgust'. A landscape of disgust proposes that animal

behavior, particularly space use, is at least partially determined by the distribution

of infection risk. Here, we leverage several lines of evidence to examine this idea in

Gorongosa National Park, Mozambique.

Hypotheses:

1(a) Areas of high animal use are high in parasite transmission risk

(b) Areas of high animal use are low in transmission risk due to

parasite avoidance/inhospitability for parasites

Components:

(0) At the broadest scale, is there a positive correlation between

habitat-wise density and EPG?

- floodplain vs. savanna EPG and densities. Aggregated and species-level

(1) At more local scales, what is the observed relationship between

EPG and RAI?

- species-wise tests of correlation between the two

- all assemblage and floodplain grazers only

\*Pattern seems to vary by species but low sample size and

inconsistent trends yield little proof. Distinct lack of

signal at whole assemblage scale but some signal emerges

in some cases at smaller scales

# Perhaps remove: (2) Why is there a lack of pattern at the large scale?

- look at the parasite assemblages of some species to extrapolate

\* There is distinct separation in parasite communities based

on host identity. This analysis lacks the definition that would

be ideal due to the species chosen

(3) Is the landscape of disgust predictable in Gorongosa and how

does predicted LOD relate to RAI?

- plot LOD and RAI side by side. Estimated LOD should show the same pattern with RAI as observed data

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Curtis 2014: Herbivores face another trade-off dilemma. Soils that

have been fertilized with dung produce more nutritious

grass, but also contain more parasite larvae. In feeding

tests, sheep avoided grass laced with gastrointestinal

nematode-containing faeces [54]. Reindeer and caribou

may migrate each year because they are looking for clean,

dung-free pasture on which to feed, calve, and bring up

their young [55].

Hutchings et al 2000: Mammalian herbivores cannot detect

gastrointestinal parasitic larvae themselves, but use faeces

as a cue to avoid ingestion of parasites (Cooper

1997; Hutchings et al. 1998). If, as suggested above, animals

should forage on nutrient-enriched and tall herbage

in areas of high faecal contamination, they then run the

risk of ingesting infective helminth larvae. The foraging

herbivore is, therefore, faced with a trade-off between

nutrient and parasite ingestion, and foraging decisions

should be expected in relation to the consequences of the

benefits of increased nutrient ingestion versus the costs

of increased parasitic infection...However, adding faeces to tall swards

and/or fertilising short swards in choices 1–6 did significantly

affect the degree of selection for tall swards; both

acted to reduce selection. In this experiment a doubling

of sward height had far more impact on herbivore foraging

decisions in relation to faecal contaminated swards,

than a doubling of sward N content. All else being equal,

a doubling of sward height transformed the strong inherent

avoidance of faecal contaminated swards (Hutchings

et al. 1998) into strong selection for tall, faecal contaminated

swards.

Hutchings et al 2001: Herbivores cannot

detect the parasites themselves on swards and thus use

the presence of faeces as an environmental cue to their

presence (Cooper et al. 2000)...There were significant animal treatment effects on

patch selection (Fig. 2). All animals similarly and significantly

selected noncontaminated patches for grazing over

faeces-contaminated patches at the start of the grazing.

Ezenwa 2004: Selective defecation and selective

foraging are two behaviors that have been discussed as potential defense strategies

used by grazing ungulates to reduce infestation by fecal–oral transmitted parasites

(Hart 1990, 1992). While both behaviors are known to occur in domestic animals,

evidence that they actually reduce levels of parasitism is scant. For example,

domestic horses create permanent defecation sites and it has been suggested that

this selective clustering of fecal eliminations in space serves to sequester parasites

allowing subsequent avoidance during foraging (Taylor 1954; O¨dberg & FrancisSmith

1976). Similar observations have also been made in wild primates (Gilbert

1997), but direct links between selective defecation and reduced parasitism are

lacking in both groups. Selective foraging in the form of fecal avoidance has been

documented in cattle (Taylor 1954), sheep (Crofton 1957; Cooper et al. 1977,

2000; Hutchings et al. 1998), horses (O¨dberg & Francis-Smith 1977), and captive

reindeer (Moe et al. 1999). By selectively avoiding grazing near feces, animals are

thought to reduce consumption of parasites, thereby lowering their infection

rates. Unlike selective defecation, selective foraging has been associated with

reduced parasite intake (Michel 1955; Cooper et al. 2000), which suggests that this

behavior may serve as an effective antiparasite strategy for grazing ungulates...Dik-dik

feeding trials showed that individuals preferentially avoided feces

when feeding. Individuals presented with a choice of calf feed in the vicinity of either

'dung' or 'no dung' took significantly more bites from the 'no dung'

treatment (Paired t-test: t ¼ )3.57, df ¼ 30, p ¼ 0.001; Fig. 3)...In the current study, larval

abundance counts around different feces formations showed that dung middens

do have higher infective larvae concentrations in their immediate vicinity when

compared to single fecal pellet groups and control areas. However, it is unclear

whether these high concentrations of larvae actually remain confined to midden

sites...Furthermore,territorial male Grant’s gazelles were found to have significantly higher strongyle

egg counts than did either non-territorial males or females, possibly because these

males spend more time on territories and in closer proximity to dung middens

(Ezenwa 2004b)...Even if fecal avoidance is an effective antiparasite strategy used by some wild

ungulates, there are significant costs associated with this behavior that could lead

to individual- and species-level variation in responses to feces.

Garine-Wichatitsky et al. 1999: For instance, grazing herbivores have evolved

a tendency to avoid foraging near recently dropped

faeces as a mean of reducing infestation from faecalborne

parasites (Michel, 1955; Hart, 1994 for

review)

Brambilla et al. 2013: In reindeer, Rangifer tarandus, the

presence of abomasal macroparasites reduces the fertility rate of

females (Albon et al. 2002; Hughes et al. 2009), and, as parasite

burden increases, body weight and back fat depth decrease in both pregnant

and nonpregnant individuals (Stien et al. 2002; Hughes

et al. 2009). Parasite load can also affect growth (Ezenwa & Jolles

2008) and symmetry (Lagesen & Folstad 1998) of secondary sexual

characters in ungulates...Normally, grazing distribution patterns in large herbivores is

affected by abiotic and biotic factors (e.g. distance to water, ground

morphology and slope, quality and quantity of food; Bailey et al.

1996), but they can also be influenced by the quantity of faeces

(Cooper et al. 2000; van der Wal et al. 2000; Hutchings et al. 2001a,

2002b). Previous studies have shown that herbivores use behavioural

antiparasitic tactics to reduce infection such as the use

of defecation sites to prevent parasite dispersal (Ezenwa 2004; Apio

et al. 2006) or the avoidance of areas highly contaminated by faeces

during foraging (Hutchings et al. 2003)...

van der Wal et al. (2000) observed avoidance of faecal-contaminated

areas in reindeer but did not find a correlation between the potential

infectivity of the vegetation eaten and the parasitic levels of

individuals.

Fankhauser et al 2008: Grazing intensity on the entire site also did not decrease

after dung was brought in. Although the proportions of

behaviour types (“grazing”, “lying”, “walking” and “standing”;

Table 1) significantly differed between control and

trial periods (chi-square test, p<0.001), changes were in

fact to the opposite than expected. “Grazing” was more

frequent in the trial (39%) than in the control period (26%;

chi-square test for “grazing” and “lying/walking/standing”,