RESEARCH COMMUNICATION

FEEDING HABITS AND FLIGHT RANGE OF BLOW-FLIES (*CHRYSOMYIA* SPP.) IN RELATION TO ANTHRAX TRANSMISSION IN THE KRUGER NATIONAL PARK, SOUTH AFRICA

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ABSTRACT

BRAACK, L. E. O. & DE VOS, V. 1990. Feeding habits and flight-range of blow-flies (*Chrysomyia* spp.) in relation to anthrax transmission in the Kruger National Park, South Africa. *Onderstepoort Journal of Veterinary Research*, 57, 141–142 (1990)

Carrion-frequenting blow-flies (*Chrysomyia albiceps and C. marginalis*) were allowed 4 days of feeding on ^{32}P-orthophosphate-labelled blood or an impala carcass (*Aepyceros melampus*) in the northern Kruger National Park, South Africa. The dispersal and density of fly faecal and discard droplets were then established using a Geiger-Counter, indicating that most droplets occurred between a height of 1 and 3 m on nearby leaves and twigs. This coincides with the preferred feeding height of kudu (*Tragelaphus strepsiceros*). During a previous anthrax epizootic kudu comprised 73,15 % of a total medium to large mammal mortality figure of 1054. Further analysis of mortality shows browsers to have been most severely affected, and it is suggested that this is correlated with feeding habits of these animals. Trapping also yielded radioactively labelled *C. albiceps* up to 32,5 km and *C. marginalis* up to 25 km from the isotope source.

Periodic outbreaks of anthrax (*Bacillus anthracis*) in the Kruger National Park (Pienaar, 1961) have resulted in the death of many hundreds of game-animals and pose a major threat to rare species such as roan antelope (*Hippotragus equinus*). As in many parts of Africa the 2 species of carrion blow-flies, *Chrysomyia albiceps* and *C. marginalis*, are abundant in this area and arrive in large numbers soon after the death of an animal (Braack, 1986, 1987). They imbibe bacterially-contaminated blood and other fluids at the carcass, then fly to vegetation in the immediate area when engorged. Reject food is then voided via the anus, and partial regurgitation of so-called "vomit drops" is also engaged in although these seldom touch the resting substrate (unpublished data). In previous unpublished experiments, one of us (De Vos) found that anthrax spores pass unharmed through the digestive tract of these flies and are deposited in large concentrations in a viable form on leaves. Such leaves thus present an ideal source of infection for browsing herbivorous mammals such as kudu (*Tragelaphus strepsiceros*), which could then initiate an anthrax epizootic. Administration *per os* of anthrax spores to experimental animals resulted in rapid mortality (De Vos, unpublished data), lending credence to epidemiological indications that this was a major route of infection. We decided to design an experiment to establish the dispersal and density of such flydroplets in the area around a carcass, and to monitor the flight-range of blow-flies after feeding.

We immobilised a full-grown male impala (*Aepyceros melampus*) with M99 (Etorphine Hydrochloride, Reckitt and Colman Ltd) and placed it in a large, fenced area in a high risk anthrax zone in the northern Kruger Park. The vegetation in this region consisted essentially of stunted mopane (*Colophospermum mopane*), tall mopane, marula (*Sclerocarya birrea*), and leadwood (*Combretum imberbe*) trees up to about 15 m in height, with a fairly dense covering of mixed grasses reaching 0,67 m.

We administered 4625 GBq of radioactive phosphorus (^{32}P-orthophosphate) made up in a 10 mℓ aqueous solution, through the jugular vein and euthenased the animal after allowing the ^{32}P to circulate for 13 min. A deep incision was made into the chest to provide a source of blood for flies, thus simulating to some extent the extensive haemorrhaging from body openings in anthrax mortalities.

After a sharp natural decrease in fly activity 4 days later, we examined the area around the carcass with a Geiger-Counter. Vegetation structure was found to be the main overall determinant of the distribution of fly-droplets as the blow-flies appear to have a preference for small horizontally arranged surfaces as represented by leaves and thin branches, a slightly lesser preference for small vertical surfaces as represented by grass-stalks and vertical twigs, and show an avoidance reaction to wide vertical and horizontal surfaces such as tree trunks and flat card-board discs. They fly to the closest tree or shrub and congregate on that side of the tree or shrub closest to the carcass. Prominent elevated grass-stalks near the carcass also carry a high density of flies. The greatest concentration of flies on the trees occurred between a height of 1 and 3 m, and here from randomly taken leaves we recorded an average of 19 droplets per leaf (n=60). This is very significant as kudu do most of their browzing between 1 and 3 m. Blow-fly droplets were concentrated on prominent objects nearest the carcass, mainly trees and shrubs, with few detectable droplets further away.

Twenty-one blow-fly traps (Braack & Retief, 1986) were then placed up to 25 km west and 37,5 km north of the carcass. The traps were emptied 6 days later and radioactive flies were found in all except 3 traps (Table 1). *Chrysomyia albiceps* was recorded at a maximum distance of 32,5 km and *C. marginalis* at 25 km. In previous experiments (Braack & Retief, 1986) using radioactively-marked flies in the same area, *C. albiceps* was recovered 40 km and *C. marginalis* 63,5 km from a release point. These flies therefore cover considerable areas in their searches for carrion. Despite this capability of distant flight, the post-feeding habits of *Chrysomyia* mitigate against their causing infection at foci well removed from the source of the meal. Most important is their habit to rest on nearby vegetation for periods of up to several hours after engorgement,

Received 2 January 1990—Editor

TABLE 1 Radioactive flies caught in traps placed at various distances from carcass

Distance from carcass	*Chrysomyia albiceps*		*Chrysomyia marginalis*		Other flies
	♂	♀	♂	♀	
Roan camp (0 km)	3	—	12	51	3 *Lucilia* & 3 *Musca*
2.5 km N	—	4	—	6	3 *Lucilia*
2,5 km W	—	—	—	—	2 *Lucilia* & 1 *Sarcophaga*
5,0 km N	—	6	—	11	2 *Lucilia*
5,0 km W	1	—	1	11	—
7,5 km N	—	5	1	19	2 *Lucilia*
7.5 km W	1	3	1	5	—
10,0 km N	Trap damaged by scavenging mammal				
10,0 km W	1	—	—	4	—
12,5 km N	—	2	—	6	—
12,5 km W	—	1	1	4	1 *Musca*
15,0 km N	—	5	—	7	—
15,0 km W	—	—	—	6	—
17,5 km N	—	—	—	9	—
17,5 km W	—	1	—	5	—
20,0 km N	—	1	—	9	—
20,0 km W	—	1	—	—	—
25,0 km N	—	1	—	1	—
25,0 km W	—	1	—	6	—
32,5 km N	—	1	—	—	—
37,5 km N	—	—	—	—	—
Total	6	32	19	163	12 *Lucilia*, 4 *Musca* 1 *Sarcophaga*

thus depositing the bulk of their potentially infective droplets in the immediate vicinity of the carcass. Like many other haematophagous insects these blow-flies engage in haemoconcentration (Briegel & Rezzonico, 1985; Langley, 1976), a process whereby many but not all erythrocytes and perhaps also other blood constituents are selectively retained in the body while a considerably clearer fluid is ejected from the anus. This process of haemoconcentration in *Chrysomyia* is very rapid, occurring either during ingestion or within seconds thereof, and then again within minutes thereafter. We refer to these as "discard droplets" to distinguish between these droplets and the darker, more pasty excreta which is passed several hours later and called faecal droplets. The major portion of the meal and infective droplets is therefore discarded in the immediate vicinity of the carcass soon after ingestion.

Although not as abundant as certain other herbivores such as buffalo *(Syncerus caffer)*, kudu appear to be the most vulnerable to anthrax and of 1054 medium to large-mammal mortalities in the 1960 epizootic, 771 (73, 15 %) were kudu (Pienaar, 1961). Waterbuck *(Kobus ellipsiprymnus)* and buffalo followed next but with a much reduced incidence of only 7,12 % and 5,50 %, respectively. Both these species are grazers and the evidence suggests that the exceptionally heavy kudu mortalities are correlated with their feeding habits. Blow-flies are also significantly more abundant in wooded areas (Braack & Retief, 1986) as are kudu, probably another epidemiological factor which facilitates the carcass-blowfly-kudu cycle of infection. Of the total mortalities amongst all herbivorous species during the 1960 anthrax epizootic, browsers constituted 79,19 % and grazing species 20,81 %, showing the disproportionate loss of life amongst browsers.

Witnesses of the 1960 epidemic ascribed the dissemination of anthrax as being effected "chiefly by vultures from dead animals on which they fed to watering places which they visited in order to bathe or drink", and the differential mortality amongst animals as being due to "inherent resistance" (Pienaar, 1961). Blow-flies are alotted a secondary role. It is our opinion that despite the role of differential immunity, differential mortality is probably in considerable measure also determined by the feeding habits of these animals. The potential of blow-flies in increasing the availability and accessibility of bacterial spores should not be underestimated. We suggest that vultures are the main agents for long-distance dispersal of anthrax, but that blow-flies cause local dissemination with a potential for explosive spread within a region.

The fact that blow-flies deposit the majority of discard droplets in the immediate vicinity of a carcass, however, greatly facilitates disease-management efforts as the area can then be burnt. This practice has been applied for some time during anthrax epizootics in the Kruger National Park.

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Printed by the Government Printer, Private Bag X85, Pretoria, 0001