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Surveillance and control of anthrax and rabies in wild herbivores and carnivores in Namibia

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Summary: *Anthrax has been studied intensively in Etosha National Park, Namibia since 1966; in addition, since 1975, mortality due to rabies and all other causes has been recorded, totalling 6,190 deaths. Standard diagnostic procedures demonstrated that at least 811 deaths (13%) were due to anthrax and 115 deaths (2%) were caused by rabies. Of the total number of deaths due to anthrax, 97% occurred in zebra* (Equus burchelli), *elephant* (Loxodonta africana), *wildebeest* (Connochaetes taurinus) *and springbok* (Antidorcas marsupialis) *while 96% of rabies deaths occurred in kudu* (Tragelaphus strepsiceros), *jackal* (Canis mesomelas), *bat-eared fox* (Otocyon megalotis) *and lion* (Panthera leo). *Anthrax deaths were highest in the rainy season for zebra, wildebeest and springbok, while elephant mortality peaked during dry seasons. No statistical relationship existed between seasonal rainfall and overall incidence of either anthrax or rabies. Control of anthrax is limited to prophylactic inoculation when rare or endangered species are threatened. Incineration of anthrax carcasses and chemical disinfection of drinking water are not feasible at Etosha. Rabies control consists of the destruction of rabid animals and incineration of their carcasses when possible.*

KEYWORDS: Anthrax – Elephant – Etosha National Park – Jackal – Kudu – Lion – Rabies – Springbok – Wildebeest – Zebra.

INTRODUCTION

Namibia covers an area of 824,000 km², of which 12% is designated as State Wildlife Conservation Reserves. One of the largest is Etosha National Park, which covers 22,270 km², with co-ordinates centering at 16°E 19°S (Fig. 1). Disease epidemics in wild animals, namely anthrax (*Bacillus anthracis*), rabies and rinderpest viruses, are known to have occurred in Namibia during the colonial period under German administration (5, 8). Wildlife in Etosha has played host to these three diseases and, although rinderpest was last recorded at the end of the nineteenth century, epizootic outbreaks of anthrax and rabies have continued. Prior to 1966, when intensive studies of anthrax commenced, no records were kept of deaths among wildlife in Etosha (4). Since 1975, all recorded fatalities have been placed on computer at the Etosha Ecological Institute in Okaukuejo (P.M. Lindeque, personal communication). This report reviews the impact of anthrax and rabies on free-ranging wildlife in Etosha and management attempts to curb the spread of these contagious diseases.

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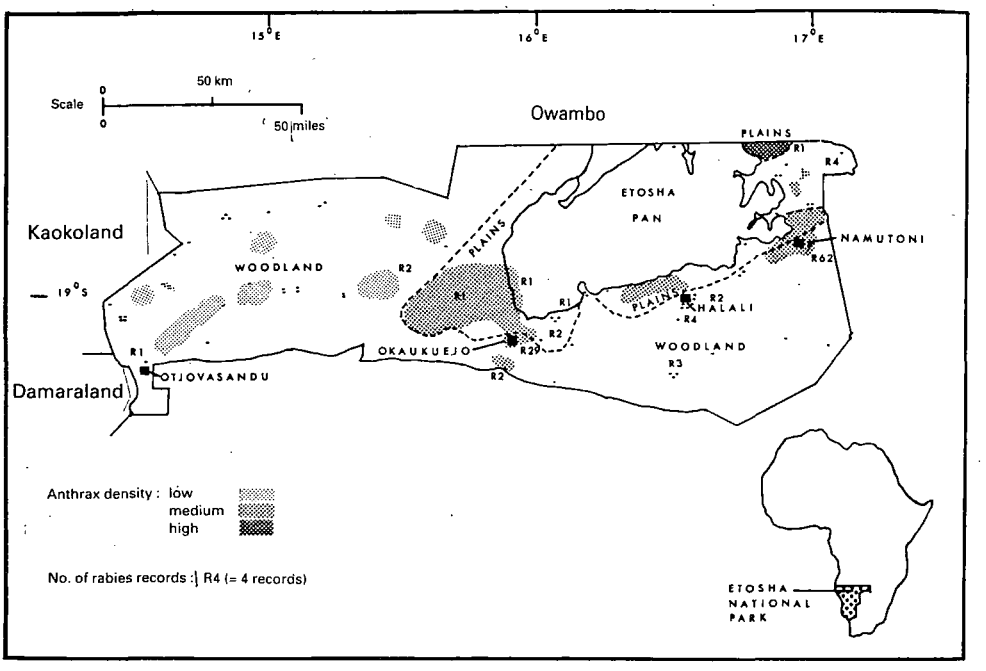

FIG. 1

Anthrax and rabies occurrence in Etosha National Park in Namibia, from 1975 to 1990

Local densities of anthrax are shown, together with localities where rabies occurred and the number of rabies records for each locality

MATERIALS AND METHODS

Earlier diagnosis of anthrax (1966-1974) was made by examining microscopically Giemsa-stained blood smears from carcasses. McFadyean-stained blood smears were used during the period 1975-1984. Subsequently, selective polymyxin-lysozyme-EDTA (ethylenediamine tetra-acetic acid)-thallous acetate agar (6) and trimethoprim-colistin blood agar (7) were also employed to isolate anthrax organisms.

Field kits, including microscopes, were issued to patrolling rangers to enable them to perform initial identifications of anthrax spores at the site where a carcass was located. A second set of blood smears from each carcass was fixed and brought to the laboratory at Okaukuejo for staining and detailed microscopic examination under oil immersion (100× magnification). When carcass decomposition precluded the preparation of blood smears, experienced field staff evaluated other evident disease signs which indicated suspected anthrax.

Initially, attempts were made to incinerate anthrax-positive carcasses in the field by burning with wood soaked in engine oil and to chemically disinfect contaminated waterholes. Animals suspected of being rabid were shot and the brain removed for laboratory verification. Incineration of the remainder of these carcasses was also attempted.

RESULTS

Anthrax

A total of 6,190 mortality records exist for the period 1975-1990; of these, anthrax was confirmed in 811 cases (13%) and suspected in 704 (11%), as shown in Tables I and II. The percentage mortality in zebra (*Equus burchelli*), elephant (*Loxodonta africana*), wildebeest (*Connochaetes taurinus*) and springbok (*Antidorcas marsupialis*) (97%) is the same as that reported by Ebedes (4) for the period 1967-1974 (Table III). Although Ebedes (4) found that anthrax had been responsible for death in 54% of all carcasses located (compared to 13% in this study), this figure is probably biased because the study concentrated on the open plains of Etosha where the greatest incidence of anthrax occurred. Zebra, wildebeest, elephant and springbok carcasses are relatively easy to locate due to their size and the preference of these species for inhabiting open areas. The present study also considers carcasses found throughout Etosha, including those of secretive species which are difficult to locate after death.

TABLE I

Wildlife deaths recorded in Etosha National Park (6,190 cases) during a sixteen-year period (1975-1990)

Year	Anthrax		Rabies		Other causes	Unknown causes	Total
	Confirmed	Suspected	Confirmed	Suspected			
1975	10	0	2	0	27	8	47
1976	28	9	1	1	280	65	384
1977	36	5	1	3	338	125	508
1978	43	18	0	0	252	157	470
1979	103	23	0	0	179	120	425
1980	22	18	0	3	141	120	304
1981	66	22	0	0	173	96	357
1982	26	85	3	0	174	86	374
1983	9	9	61	7	267	99	452
1984	142	348	15	2	194	68	769
1985	23	44	7	4	221	73	372
1986	42	19	2	0	250	92	405
1987	32	6	10	0	135	44	227
1988	57	32	10	0	238	58	395
1989	114	37	0	0	187	78	416
1990	58	29	3	0	123	72	285
Total	811	704	115	20	3,179	1,361	6,190
Mean	51	44	7	1	199	85	387
%	13	11	2	<1	51	22	100

TABLE II

Mortality caused by anthrax and rabies in nineteen species of wildlife at Etosha National Park (1,650 cases) expressed as a percentage of the total occurrence of each disease (1975-1990)

Species	Mortality (%)			
	Anthrax		Rabies	
	Confirmed	Suspected	Confirmed	Suspected
Burchell's zebra (*Equus burchelli*)	38.7	41.8	–	–
Elephant (*Loxodonta africana*)	27.4	24.4	–	–
Blue wildebeest (*Connochaetes taurinus*)	21.7	18.4	–	–
Springbok (*Antidorcas marsupialis*)	9.6	6.6	–	–
Kudu (*Tragelaphus strepsiceros*)	0.7	1.4	54.7	35
Gemsbok (*Oryx gazella*)	0.6	5.0	–	–
Hartmann's zebra (*Equus zebra hartmannae*)	0.5	0.2	–	–
Black rhinoceros (*Diceros bicornis*)	0.3	1.6	–	–
Giraffe (*Giraffa camelopardalis*)	0.3	0.4	–	–
Eland (*Taurotragus oryx*)	0.1	–	1.7	10
Steenbok (*Raphicerus campestris*)	–	0.1	–	–
Ostrich (*Struthio camelus*)	–	0.1	–	–
Black-backed jackal (*Canis mesomelas*)	0.1	–	26.1	35
Bat-eared fox (*Otocyon megalotis*)	–	–	11.3	15
Lion (*Panthera leo*)	–	–	3.5	–
Brown hyaena (*Hyaena brunnea*)	–	–	0.9	–
Wild dog (*Lycaon pictus*)	–	–	0.9	–
Aardwolf (*Proteles cristatus*)	–	–	0.9	–
Spotted hyaena (*Crocuta crocuta*)	–	–	–	5
Total	100	100	100	100

There was no statistical relationship between rainfall and incidence of anthrax (Fig. 2). Although higher mortality occurred among zebra, wildebeest and springbok on the plains during the rainy season (January to April), this was counteracted by the sharp rise in elephant mortality during the dry season (May to December). This contrast may be explained by the preference which elephants show for browsing *Acacia* species during dry periods, leading to possible mouth lesions caused by thorns, which would facilitate the passage of anthrax when drinking from suspected infected water-points (3). In addition, susceptibility to infection may well be enhanced by the nutritional stress which accompanies the dry periods (3).

TABLE III

Mortality caused by anthrax in ten species of wildlife at Etosha National Park (1,524 cases), during the period 1967 to 1974, recorded yearly from July to June

Species	1967-1968	1968-1969	1969-1970	1970-1971	1971-1972	1972-1973	1973-1974	Total	% by species
Burchell's zebra (*Equus burchelli*)	149	126	105	117	189	82	59	827	54.3
Wildebeest (*Connochaetes taurinus*)	105	58	77	41	122	88	41	532	34.9
Springbok (*Antidorcas marsupialis*)	19	18	17	17	13	9	9	102	6.7
Elephant (*Loxodonta africana*)	–	8	10	1	1	2	3	25	1.7
Gemsbok (*Oryx gazella*)	2	3	9	1	2	–	–	17	1.1
Kudu (*Tragelaphus strepsiceros*)	1	–	2	1	1	1	1	7	0.5
Ostrich (*Struthio camelus*)	–	1	1	2	–	–	1	5	0.3
Giraffe (*Giraffa camelopardalis*)	–	–	1	–	2	1	1	5	0.3
Eland (*Taurotragus oryx*)	–	–	–	–	2	–	–	2	0.1
Cheetah (*Acynonyx jubatus*)	–	–	–	2	–	–	–	2	0.1
Total	276	214	222	182	332	183	115	1,524	100
% by year	18.1	14.0	14.6	11.9	21.8	12.0	7.6	100	

Rabies

Rabies was confirmed in approximately 2% of all wildlife deaths in Etosha during 1975-1990, while an additional 0.3% of animals dying were suspected of having rabies (Table I). These levels are considerably lower than the incidence of anthrax reported for the same period; however, only two of the eight species in which rabies was confirmed, i.e. kudu (*Tragelaphus strepsiceros*) and eland (*Taurotragus oryx*), could be located relatively easily. The remaining six species are carnivores and insectivores, the secretive or nocturnal habits of which undoubtedly resulted in an underestimation of mortality from rabies. A single case of suspected rabies was reported in another species, the spotted hyaena (*Crocuta crocuta*). A rabies epidemic occurred in kudu on farmland in Namibia from 1977-1982 (1), later affecting Etosha similarly. The first cases in Etosha were reported in January 1983, at the eastern boundary of the Park which adjoins farmland. The sporadic nature of rabies outbreaks among wildlife in Etosha is illustrated by the fact that in only two years (during the epidemic in kudu) did rabies become obvious. As is the case with anthrax, no statistical relationship between rabies outbreaks and rainfall could be demonstrated (Fig. 3).

DISCUSSION

Anthrax

Veterinary regulations applicable to anthrax prophylaxis or control of anthrax-infected carcasses on commercial farmland in Namibia are not feasible in a wildlife

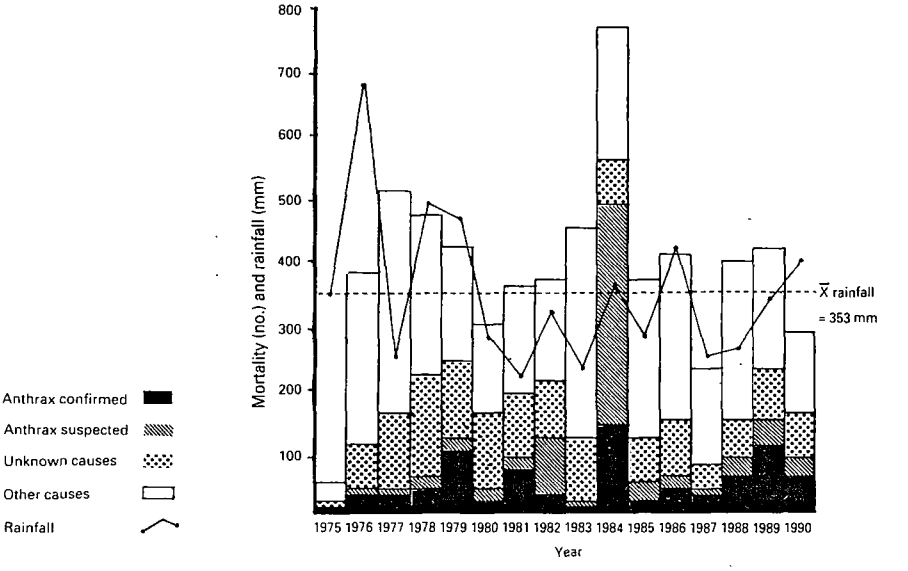

FIG. 2

Number of deaths due to anthrax in relation to the total number of deaths among wildlife, and rainfall recorded at Etosha National Park (1975-1990)

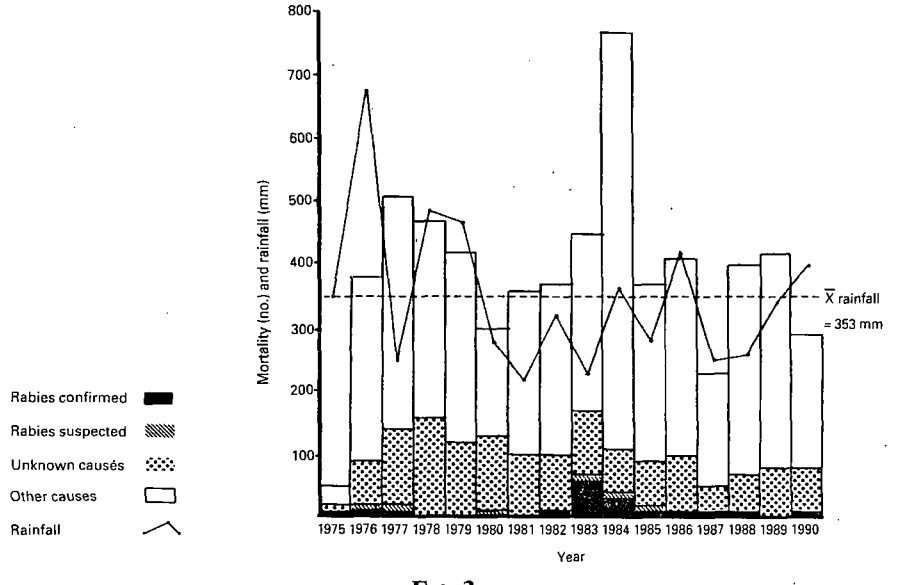

FIG. 3

Number of deaths due to rabies in relation to the total number of deaths among wildlife, and rainfall recorded at Etosha National Park (1975-1990)

conservation area the size of Etosha. For example, yearly inoculation of susceptible wildlife populations of zebra, wildebeest, springbok and elephant against anthrax is prohibitively expensive, time-consuming and impractical. For the same reasons, burial of carcasses in Etosha cannot be contemplated. A measure of control may have been obtained when Ebedes (4) attempted to incinerate anthrax-infected carcasses. However, scavengers usually open carcasses before they are located, thereby spreading anthrax spores to the surrounding areas, including water-holes, when the scavengers subsequently drink (2, 4). Moreover, large-scale incineration, especially when elephant carcasses are involved, depletes wood resources and is ecologically unsound. Chemical disinfection of drinking water with quaternary ammonium, iodine derivative and chloride of lime was tested (4), but later discontinued because of the possible side-effects on ruminal and intestinal flora of wildlife, and the destruction of invertebrate fauna in natural springs.

At present, the only viable method of anthrax control in Etosha is prophylactic inoculation by dart-gun of rare and endangered species where numbers are limited, such as black rhinoceros (*Diceros bicornis*) and roan antelope (*Hippotragus equinus*). The drawbacks of this inoculation are that it must be repeated yearly and usually requires a helicopter.

Turnbull and colleagues (10) failed to isolate *B. anthracis* from water-hole and soil samples, contrasting with the earlier findings of Ebedes (4) but agreeing with the results obtained by Winter (13); these authors also considered the possibility that Ebedes (4) may have incorrectly identified the closely-related *B. cereus* and its relatives as *B. anthracis*. Recently, Turnbull and colleagues (11) confirmed that anthrax is the major uncontrolled cause of mortality among zebra, wildebeest, springbok and elephant at Etosha. Furthermore, these authors also confirmed earlier field observations by demonstrating that all lion and spotted hyaena sera tested carried antibodies specific to anthrax toxins, while most herbivore species had no antibodies for anthrax (11).

Moreover, Turnbull and colleagues (11) state that although the numerous gravel "borrow pits" created for road-building in Etosha may have initially upset the ecological balance in favour of an increased incidence of anthrax, they no longer play a particular role in its perpetuation. If this is so, then anthrax spores have apparently spread throughout Etosha (Fig. 1). A number of factors combine to make the management of anthrax at Etosha a problem which has yet to be solved, namely:

- the viability of *B. anthracis* spores (12)
- the rapidity with which relatively large carcasses are reduced by scavengers (9)
- the difficulty of locating carcasses fresh enough to obtain a blood smear before putrefying bacteria obscure a positive identification.

Rabies

Sixty-two of the 115 cases of rabies (54%) were reported at places of human habitation, namely tourist rest camps, staff quarters and entrance gates to Etosha. The remaining animals displaying symptoms of rabies were mostly located in the immediate vicinity of water-holes.

When an epidemic of rabies occurred in kudu during 1983-1984, the first cases of lions contracting rabies in Etosha were also recorded. All four reports of rabid lions were from the eastern sector of Etosha where the highest density of kudu occurred, and

it seems likely that these and other lions became infected when they hunted rabid kudu, which would have been relatively easy prey. The typical method employed by lions, of strangling or suffocating prey, would bring the mouth and eyes of the lion into direct contact with infected saliva. Rabid carcasses are usually incinerated after removal of the brain, and all staff who have potential contact with rabid animals are routinely vaccinated with human diploid cell vaccine. The procedures for management of rabies at Etosha are therefore currently limited to prophylactic and post-exposure vaccination of humans, destruction of animals suspected of being rabid and incineration of the fresh carcasses where possible.

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SURVEILLANCE ET CONTRÔLE DE LA FIÈVRE CHARBONNEUSE ET DE LA RAGE CHEZ LES HERBIVORES ET LES CARNIVORES SAUVAGES EN NAMIBIE. – H.H. Berry.

***Résumé** : La fièvre charbonneuse a été étudiée de manière approfondie dans le parc national d'Etosha, en Namibie, depuis 1966. Les cas mortels dus à la rage et à toute autre cause ont été recensés depuis 1975 ; ils s'élèvent au nombre de 6 190. Les méthodes de diagnostic classiques ont montré qu'au moins 811 de ces cas (soit 13 %) étaient dus à la fièvre charbonneuse et 115 (2 %) à la rage. Parmi les cas de fièvre charbonneuse, 97 % sont survenus chez le zèbre* (Equus burchelli), *l'éléphant* (Loxodonta africana), *le gnou à queue noire* (Connochaetes taurinus) *et le springbok* (Antidorcas marsupialis) *; 96 % des morts dues à la rage ont été enregistrées chez le grand koudou* (Tragelaphus strepsiceros), *le chacal à chabraque* (Canis mesomelas), *l'otocyon* (Otocyon megalotis) *et le lion* (Panthera leo). *Les taux de mortalité par fièvre charbonneuse ont été les plus élevés pendant la saison des pluies pour le zèbre, le gnou et le springbok et pendant la saison sèche pour l'éléphant. Aucune relation statistique n'a été trouvée entre la pluviométrie et l'incidence globale de la fièvre charbonneuse ou de la rage. La prophylaxie de la fièvre charbonneuse se limite à la vaccination préventive spécifique lorsque des espèces rares ou en voie de disparition sont menacées. A Etosha, il n'est pas possible d'incinérer les carcasses des animaux morts de fièvre charbonneuse ni de désinfecter l'eau de boisson par des produits chimiques. La prophylaxie de la rage consiste à abattre les animaux atteints et à incinérer les carcasses dans la mesure du possible.*

MOTS-CLÉS : Chacal à chabraque – Éléphant – Fièvre charbonneuse – Gnou à queue noire – Grand koudou – Lion – Parc national d'Etosha – Rage – Springbok – Zèbre.

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VIGILANCIA Y CONTROL DEL CARBUNCO BACTERIDIANO Y DE LA RABIA EN LOS HERBÍVOROS Y LOS CARNÍVOROS SALVAJES EN NAMIBIA. – H.H. Berry.

***Resumen**: Desde 1966, el carbunco bacteridiano es estudiado detalladamente en el Parque Nacional de Etosha, en Namibia; además, desde 1975, se computaron los casos de muerte debidos a la rabia o a cualquier otra causa, con un total de 6.190 muertes. Los métodos clásicos de diagnóstico mostraron que al menos 811 de éstas (13%) se debían al carbunco bacteridiano y 115 (2%) a la rabia. Entre las primeras, 97% se dieron en cebras* (Equus burchelli), *elefantes* (Loxodonta africana), *ñus de cola negra* (Connochaetes taurinus) *y springboks* (Antidorcas marsupialis), *mientras que 96% de las muertes por rabia se registraron en las especies siguientes: gran kudu* (Tragelaphus strepsiceros), *chacal de gualdrapa* (Canis mesomelas), *otoción* (Otocyon megalotis) *y león* (Panthera leo). *Cebras, ñus y springboks tuvieron porcentajes de mortalidad por carbunco bacteridiano más elevados en la estación lluviosa, y los elefantes en la estación seca. No se constató ninguna relación estadística entre pluviometría e incidencia global del carbunco bacteridiano o la rabia. La profilaxis del carbunco bacteridiano se limita a la vacunación preventiva específica cuando especies raras o con peligro de desaparición se ven amenazadas. En Etosha no se pueden incinerar los animales muertos por carbunco bacteridiano ni desinfectar con productos químicos el agua para beber. La profilaxis de la rabia consiste en sacrificar los animales afectados e incinerarlos, en la medida de lo posible.*

PALABRAS CLAVE: Carbunco bacteridiano – Cebra – Chacal de gualdrapa – Elefante – Gran kudu – León – Ñu de cola negra – Parque Nacional de Etosha – Rabia – Springbok.

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