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SALMONELLA INFECTION IN THE AFRICAN ELEPHANT AND THE BLACK RHINOCEROS

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SUMMARY

Salmonellosis in two captive African elephants and a black rhinoceros is described. Necropsy findings and characters of the salmonellae isolated are outlined. Possible sources of infection are discussed and on the basis of their findings, the authors make recommendations for the care of newly captured wild animals.

INTRODUCTION

There are very few reports on the isolation of *Salmonella species* from East African game animals. Guilbride, Coyle, McAnulty, Barker and Lomax (1962) isolated five *Salmonella* serotypes from 149 samples of hippopotamus (*Hippopotamus amphibius*, L.) intestinal contents. Taylor (1968) lists the countries from which she has examined strains of salmonella isolated from wild animals; Kenya, Tanzania and Uganda are all mentioned but only six species of game animal are included in her list (baboon, elephant, giraffe, hippopotamus, monkey and rhinoceros) and no generic or specific names are given. Gitter and Brand (1969) examined faeces samples from 22 species of animals and birds in the Nairobi National Park and 42 species from the Nairobi Animal Orphanage. A total of 743 samples were examined and no salmonellae were isolated from the animals in the Orphanage. Five samples from the Park yielded salmonellae, 2 from hyaena (species unidentified) and one each from Kongoni hartebeeste (*Alcelaphus buselaphus cokei*), giraffe (*Giraffa reticulata*) and ostrich (*Struthio camelus*) (as identified by Gitter and Brand).

Salmonella infections in the Indian elephant (*Elephas maximus*, L.) have been recorded from many parts of the world—Ceylon (McCaughey, Schmid, Velaudapillai & Weinman, 1953; McGaughey, Schmid, St. George & Velaudapillai, 1954; McGaughey, 1961), Ghana (Zwart, 1962) and Australia (Atkinson, Woodroofe & Culver, 1952). With the exception of McGaughey *et al.* (1954), these reports describe salmonellosis in working animals or in zoo exhibits. McGaughey *et al.* (1954) examined faeces from the jungle and found that those of wild elephants were negative for salmonellae; however, when a wild elephant was captured the first specimen of faeces dropped in captivity gave a positive isolate.

The only references in the literature to salmonella infection in the black rhinoceros are those of Taylor (1968) and King (1969), both of whom mention the same incident as in this report. Because of the dearth of reports on salmonellosis in the African elephant (*a*) *Loxodonta africana* blumenbach and black rhinoceros (*b*) *Diceros bicornis*, L.), the authors considered that their observations were worth recording.

HISTORY AND NECROPSY FINDINGS

Several young elephants had been captured by professional game trappers in Uganda and moved to their Nairobi holding ground. The animals, approximately a year old, were penned individually but direct contact between the animals was

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possible through the bars of the pens. According to the owner the animals were feeding well and were healthy until one morning an elephant was found dead. When a *post-mortem* examination was carried out the animal was seen to be in poor condition. There was a very marked ascites but apart from this the only abnormality seen was a chronic gastro-enteritis with thickening of the mucosa of the stomach and the intestine, and a diphtheritic deposit on the mucosa of the intestine. The bladder was markedly distended and the urine contained numerous clots of what appeared to be fibrin. Cultures were made on to sheep blood agar,* MacConkey agar† and into selenite broth‡ from heart blood, spleen, liver, kidney, various portions of the intestines, and urine. In all cases a pure culture of a non-haemolytic non-lactose fermenting organism was obtained. This was identified as *Salmonella enteriditis*. (For details of bacteriology findings, see below.)

As a result of this diagnosis the holding ground was visited and recommendations were made concerning hygiene, feeding and treatment. The owner was informed that this was a salmonella serotype which commonly infected man and the possibility of a human carrier was outlined. Rectal swabs were taken from as many of the animals as were handleable (there were elephant, rhinoceros and several antelope species on the holding ground), and were inoculated into selenite broth. No salmonellae were isolated from any of the swabs. Although treatment with nitro-furazones had been recommended, none was given. Eight days after the holding ground was visited, a second elephant died and was presented for *post mortem* examination. The lesions were identical to those seen at the previous examination including the fibrin-like clots in the urine. Samples of heart blood, spleen, liver, kidney, intestines and urine were inoculated on to sheep blood agar, MacConkey agar and into selenite broth, and again pure cultures of *S. enteriditis* were isolated.

Following the report of the second *post mortem* examination, treatment with nitro-furazones by mouth was started. No further deaths occurred.

The black rhinoceros, too, had been recently captured. Dr. J. King of the Game Department was translocating rhinoceros from an area which was rapidly being invaded by human habitation. The animals were being captured for release in the Nairobi Game Park (King, 1969). After capture the animals were held in temporary pens belonging to a professional game trapper to enable them to settle down before movement to Nairobi, where they were to be held for a further month before being released in the Park.

The rhinoceros was observed to be behaving strangely on the fourth day after capture; it was using its horn in an attempt to lever open the bars of the cage. This resulted in the animal breaking its horn. Two days later the animal was down and froth was seen coming from its mouth; respirations were slow and deep. Later that day the animal died. Dr. King carried out a *post mortem* examination. There was excess fluid in the abdominal cavity; although the stomach was full, the small intestine was empty and there was a marked enteritis. The large intestine appeared normal as did the other organs in the abdominal cavity. The urine appeared to be normal. There was some congestion in the lungs and the pericardial sac contained approximately 500 ml of bloody fluid. The left ventricle had a 'cooked meat appearance' (King, personal communication). Tissue smears were sent for microscopic examination and liver samples for bacterial culture. *Salmonella typhimurium* was isolated in pure culture from the liver.

* 8 per cent sheep blood agar prepared with Oxoid blood agar base (CM55).
† MacConkey agar prepared with Oxoid MacConkey agar No. 2 base (CM109).
‡ Selenite broth prepared with Oxoid selenite broth (CM39).

A number of the rhinoceroses were in poor condition (King) and he effected improvements in pen hygiene and increased the provision of green forage. He also commenced moving the animals to the Nairobi National Park. By the time a drug sensitivity test had been carried out and the results transmitted to Dr. King, the animals were responding to an abundant diet and clean pens. Consequently there was no need to treat any of the animals.

BACTERIOLOGY

All media and reagents employed for various tests were prepared by the methods described by Cowan and Steel (1965). After 24 hours' incubation on sheep blood agar at 37°C the colonies of both isolates were approximately 3 to 4 mm in diameter, non-haemolytic, translucent and regular. On MacConkey agar the colonies were the same size and white. Both organisms were small slender rods, gram-negative, non-acid fast and motile. The sero-diagnosis was performed using Burroughs Wellcome Diagnostic Sera. Cultural, biochemical and serological reactions are recorded in Table I. The cultural and biochemical characteristics of both isolates were the same and corresponded closely with the description of the genus *Salmonella* given by Cowan and Steel (1965). Antigenic structure indicated that the elephant isolates were *S. enteritidis*, while the isolate from the black rhinoceros was *S. typhimurium* (Kauffmann, 1954). Both isolates were sent to Dr. J. Taylor at the Salmonella Reference Laboratory, Colindale, London, England, who confirmed the identity of the isolates. She also subtyped the *S. enteriditis* as *S. enteritidis* var. Jena.

TABLE I

Growth, biochemical and serological characteristics of isolates, from two African elephants and one black rhinoceros

Test	Elephant isolates result	Rhinoceros isolate result
Relationship to free oxygen	Facultative anaerobe	Similar
Motility	Motile	Similar
Colonial characters	On sheep blood agar at 24 hours colonies circular 3 mm in dia., smooth surface and entire edge	Similar
Biochemical characters:		
Catalase	+	+
Oxidase	−	−
Urease	−	−
Gelatinase	−	−
Indole	−	−
Nitrite	+	+
H_2S	+	+
Citrate	−	−
Malonate	−	−
Methyl red	+	+
Vosges Proskauer	−	−
Carbohydrate utilization:		
Glucose	Acid + Gas	Acid + Gas
Lactose	−	−
Sucrose	−	−
Mannitol	Acid + Gas	Acid + Gas
Dulcitol	Acid + Gas	Acid + Gas
Arabinose	Acid + Gas	Acid + Gas
Adonitol	−	−
Salacin	−	−
Antigenic structure:		
O antigen	1, 9, 12	1, 4, 5, 12
H antigen—Phase 1	g, m	i
H antigen—Phase 2	−	1, 2

DISCUSSION

All the animals, although wild, were in captivity when they died. The elephants had been in captivity several months, the rhinoceros only six days. It is interesting to note that on both holding grounds the management and hygiene left much to be desired. King (1969) records, in the case of the rhinoceros, that 'water for the animals to drink was supplied from a nearby Masai well and poured into a depression in the ground, which quickly became contaminated with faeces because the pens were not cleaned regularly'. Dirty conditions, particularly where workers are not provided with adequate latrines, could assist in the transmission of infection from human to captive wild animal. It was not possible in these outbreaks to ascertain whether any staff member was a *Salmonella* carrier because the employers were not prepared to subject their staff to medical examination. Since both the species of *Salmonella* isolated are common pathogens of man, it is not unreasonable to assume that man might have been the source of infection. Gitter and Brand (1969) obtained no isolate from wild animals in captivity in the Nairobi Orphanage but five salmonellae were isolated from animals in the Park (*S. bovis-morbificans* 3 times and *S. ujamaro* and *S. chingola* once each). However, at the time of their investigation, July to October 1968 (Gitter & Brand, 1969), *loc. cit.* although the Somali villagers together with 900 head of cattle and 480 head of sheep had been removed from the Park, a Masai manyatta had been constructed within the Park boundary (Hamilton & King, 1969) and the possibility of cross-infection of wild animals either from humans or from their cattle or sheep cannot be excluded in the work of Gitter and Brand (1969). The serotypes they isolated are however uncommon as pathogens of man.

Guilbride *et al.* (1962) carried out their *post mortem* examinations on hippopotami in the Queen Elizabeth National Park in Western Uganda and isolated *S. uganda* on five occasions, *S. bareilly* twice, and *S. typhimurium*, *S. aberdeen* and *S. miami* once each. They do not mention the possibility of contact with humans but comment that *Salmonella* infections of cattle and other animals are common in Uganda. *S. typhimurium* is the most widely distributed salmonella throughout the animal kingdom as well as being the most frequently isolated type (Taylor, 1968). Of the other serotypes isolated by Guilbride *et al.* (1962), none is recognized as a pathogen with a specific host.

McGaughey *et al.* (1954) considered that elephants in Ceylon contracted infection from polluted water contaminated by human or animal excreta. They also suggested that the wild population harbour these organisms and that the stress of capture is sufficient to cause the animal to excrete these pathogens if not to precipitate disease.

The effects of infection by salmonellae are dependant upon age, and McGaughey *et al.* (1954) note that young elephants succumb to infection whereas adults may become symptomless carriers. In the incidents described in this report, two young elephants died, as did an adult rhinoceros. However, the rhinoceros, which was described by King (1969) as being 'a magnificent bull' did break his 79 cm horn four days after he was captured; two days later he was dead. Although *S. typhimurium* was isolated from the liver, being the only organ submitted for bacterial examination, the fact that the organism was isolated in pure culture suggests that death resulted from a salmonella septicaemia. No such doubt occurs with the two elephants whose deaths undoubtedly resulted from salmonella septicaemia. Zwart (1962) suggested that salmonella infection in an Indian elephant in Ghana resulted from the stress of the journey and change in diet. Atkinson *et al.* (1954) give no details of their Indian elephant isolate other than to state that the elephant had diarrhoea from which *S.*

newington was isolated. Taylor (1968) indicated that infection with salmonellae in the wild is uncommon but suggested that animals can become infected when living in an infected environment. She commented that on arrival in Britain, wild animals are not uncommonly infected with salmonellae; this she attributed to close contact with man in the collecting areas and during travel.

CONCLUSIONS

All the evidence suggests that game animals rarely if ever suffer from clinical salmonellosis in the wild and that the disease is one of capture, captivity and contact with man. It is therefore imperative that people associated with the capture of wild animals should know the risks involved. It is also essential that holding ground hygiene should be of the highest quality to prevent animals from coming into contact with the disease when they are in a state of stress or shock.

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Infection a *Salmonella* chez l'elephant africain et le rhinoceros noir.

Résumé—On décrit l'infection salmonellique chez deux éléphants africains en captivité et chez un rhinocéros noir. Les signes nécropsiques et les caractères des *Salmonella* isolées sont rapportés.

Les auteurs, après avoir discuté des sources possibles d'infection et en se basant sur leurs observations, font des recommandations au sujet des précautions à prendre pour les animaux sauvages récemment capturés.

Infeccion con Salmonela en el elefante Africano y en el rinoceronte negro.

Sumario—Se describe Salmonelosis en dos elefantes Africanos en cautiverio y en un rinoceronte negro. Se delinean los hallazgos de necropsia y los caracteres de las Salmonelas aisladas. Se discuten las posibles fuentes de infeccion y sobre la base de sus hallazgos, los autores hacen recomendaciones para el cuidado de animales salvajes recientemente capturados.