BOVINE TUBERCULOSIS IN BUFFALO AND CURRENT PROJECTS IN THE KRUGER NATIONAL PARK

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INTRODUCTION

In 1990 tuberculosis caused by Mycobacterium bovis was first diagnosed in an African buffalo (Syncerus caffer) in the Kruger National Park (KNP). This disease, which is not indigenous to Africa’s free-ranging mammals, probably originated from infected domestic cattle, and is believed to have entered the KNP from across the southern river boundary in the late 1950s or early 1960s. As an alien multi-host disease in a multi-species system, it poses a potential threat to biodiversity within the Kruger National Park ecosystem as well as the associated transfrontier conservation area (TFCA), and has the potential to impact on animal population dynamics. The zonal prevalence and spatial distribution of bovine tuberculosis (BTB) in buffalo and lions are both progressively increasing from south to north in the KNP. The most northerly case (2004) in buffalo was recently diagnosed approximately 40 km from the Park’s northern boundary, which is some 400 km from where the disease first entered the Park approximately 45 years ago. Spillover of the disease from buffalo into a total of 10 other species (lion, leopard, cheetah, hyena, kudu, baboon, warthog, impala, honey badger, and genet) has been documented in the KNP. The disease has also been detected in eland and bush pig on neighboring private conservation properties.

Mycobacterium bovis is considered to be an alien organism within African ecosystems. It is a problematic disease because of the following characteristics:

- It is an alien disease
- It is an intracellular bacteria
- It can infect a wide host range
- It spreads efficiently by aerosol, alimentary, and percutaneous routes
- It has a slow but progressive pathology
- Most infected animals are asymptomatic
- It has a long time course from infection to death
- Infected animals are infectious for the rest of their lives.
- Anergic super-shedders are present in the infected population
- There is no effective vaccine
- It poses a disease risk to livestock at the Park’s boundary interface
- It is a zoonosis

Buffalo are considered to be the primary maintenance host in the Kruger National Park and kudu and warthog appear to have maintenance host potential. Large predators, especially lions, seem to be highly vulnerable to infection with BTB because they are at the top of the “food chain” and are therefore at a high risk of exposure from infected prey animals or carcasses. BTB is a declared controlled disease in South Africa and a successful BTB eradiation scheme has been implemented for cattle, at great expense, over the past five decades. With the emergence of sylvatic reservoirs of infection, there is an increasing risk of transmission of Mycobacterium bovis from infected buffalo to domestic livestock and humans at the Park’s interface with neighboring communities.

IMPLICATIONS OF BOVINE TUBERCULOSIS IN THE KRUGER NATIONAL PARK

Development of Threshold of Potential Concerns

The Kruger National Park adheres to the general objective of managing for biodiversity and a working set of hierarchical management objectives have been developed to guide management and scientific staff in the identification of monitoring and research priorities to assist in the management decision-making process. As part of this process, the concept of “Thresholds of Potential Concerns” (TPCs) has been developed. The formulation of realistic TPCs for bovine tuberculosis as an alien organism was recently developed by veterinary and research staff in Kruger, and will guide all future surveillance, monitoring, research and management actions for this disease.

The potential impacts that bovine tuberculosis may have on the Greater Kruger Park ecosystem are defined in the following two themes of the TPCs for this disease:

1) Spatial and temporal impact of BTB on population dynamics of:
   a) Buffalo as a primary host species
   b) Lions as a spill-over species
   c) Any other species infected by the disease

2) Animal and veterinary public health aspects at the wildlife/domestic stock/ human interface.

Attached to each theme are various monitoring and management activities, linked to timelines and to the outcome of monitoring activities related to the TPC:

Class A: Intrinsic demographics of an invasive alien species (Tracking TPC).
Class B: Biodiversity TPC. Significant measured or predicted (through modeling) negative effects on population growth and structure, and long-term viability of a species that can be attributed to BTB.
Class C: Socio-political TPC. Any detection of infection in neighboring communities and livestock.

The TPCs and management objectives are linked at all levels and the related research and monitoring activities are aimed at achieving a holistic understanding of the disease and its potential biodiversity impacts, and
to identify realistic management actions. The following research and monitoring projects have been already been undertaken, or are currently active with regards to this very complex disease problem.

**CURRENT AND PAST BTB-RELATED PROJECTS IN THE KRUGER NATIONAL PARK**

**Monitoring Activities**

As an alien organism, and a potential risk to biodiversity and animal population dynamics within the Greater KNP, the monitoring of BTB is strongly linked to the alien impact/ecosystem objectives of the KNP. Broadly it is stated “To anticipate, prevent entry and where feasible and/or necessary control invasive alien species in an effort to minimize the impact on, and maintain the integrity of indigenous biodiversity.”

After the detection of the first confirmed BTB case in a buffalo, various detection exercises have taken place in the Kruger National Park. A total of 2071 buffalo carcasses were examined by detailed inspection during 1991 and 1992. BTB was found in 10% of the buffalo sampled, and the within herd prevalence ranged as high as 67% (Rodwell 2000). The overall prevalence of BTB was highest in the southern region of the Park, with a progressively decreasing prevalence gradient as the sampling proceeded northwards, confirming the disease was probably first introduced across the Park’s southern border. In 1998, during a Park-wide monitoring exercise, 618 buffalo were lethally sampled and examined for BTB. A marked increase in prevalence and spatial distribution of BTB was detected between 1991 and 1998.

In 2000, a non-lethal monitoring exercise on buffalo, making use of the blood-based gamma interferon test, was successfully carried out to sample 608 buffalo in the northern section of the Kruger National Park. The presence of tuberculosis was confirmed in 5 of the 30 herds sampled. Most of the positive herds detected were close to the southern region of the northern section of the Park, confirming the slow northerly progression of the disease.

In 2003 a follow-up non lethal BTB monitoring survey was conducted in the same area. A total of 651 buffalo from 30 herds were sampled with an alarming result of 11 of the 30 herds testing positive for TB. This was a marked increase of TB positive herds compared with the 2000 survey results. The prevalence was still relatively low, but the northward spread of the disease appeared to have accelerated significantly.

In 2005 a detailed buffalo BTB monitoring exercise was planned, linked to the recently revised and fully developed TPC for bovine tuberculosis in the KNP. This monitoring program will be conducted in buffalo herds in the south of the Park where the highest zonal incidence was detected in the last survey in 1998. Its primary objective will be to validate and determine whether the thresholds for the following TPCs have been reached or exceeded: Class A — Intrinsic demographics of an invasive alien species (Tracking TPC) and the level of increased or sustained zonal prevalence of BTB in buffalo to above 40% in any zone. Monitoring is required to determine the time scale over which this will occur. It will also be used to validate the TPC and determine if recalibration is required. At the time of this abstract being written the survey was ongoing and results will only be available in the latter part of 2005.

**SUPPORTING AND PROPOSED RESEARCH ON THE MONITORING AND MANAGEMENT OBJECTIVES**

Current and proposed future research projects based on the premise that the Tracking TPC will be exceeded are as follows (principal researchers/institutions in brackets):

- Infection model of BTB in buffalo (Lin-Mari De Klerk-Lorist; University of Pretoria)
- Current study in progress to study the BTB infection rate, changes in disease prevalence, and mortality index in selected buffalo herds in the central and southern districts (Paul Cross, University of Berkeley; Justin Bowers & Craig Hay, University of Pretoria; Veterinary Wildlife Services, SANParks).
- Current study in progress to monitor fission/fusion events in buffalo herds that promotes herd-to-herd transmission of BTB (Justin Bowers & Craig Hay, University of Pretoria).
- Current study in progress to test the efficacy of BCG vaccine in semi-free range buffaloes (Lin-Mari De Klerk-Lorist, University of Pretoria).
- Comparative study of select lion populations in the BTB high prevalence and BTB-free areas of the Park. This study includes lion population biology, TB prevalence and incidence, as well as morphometric and hematological comparisons. (Dr Dewald Keet, Chief State Veterinarian, Kruger National Park).
- Macro- and histopathology of bovine tuberculosis infection in free-ranging lions in the KNP. (Dr Dewald Keet, Chief State Veterinarian, Kruger National Park).
- Interaction between lion and buffalo and the impact of TB with regards to the lion population in the central district of the park (Craig Tambling, University of Pretoria).
- Genetic typing of the BTB bacteria in the Kruger National Park (Anita Michel, Institute for Veterinary Research, Onderstepoort).
- An in-depth epidemiological study of BTB in the buffalo with special focus on medium and longer term effects on populations must be initiated.
- A disease risk assessment at the wildlife/domestic stock/human interface on KNP boundaries needs to be initiated in cooperation with the Department of Agriculture and the Department of Health.
- New vaccine candidates for use in buffalo need to be identified and evaluated.
- Vaccine delivery techniques for buffalo need to be researched.
- Genetic markers for BTB resistance in buffalo need to be identified to allow for the future accelerated selection by breeding of genetically resistant animals.

These projects refer mainly to BTB in buffalo and lions, and not to any other species for which projects exist or are proposed.
MANAGEMENT ACTIVITIES RELATING TO BTB IN BUFFALO

SANParks has not developed a management strategy policy for BTB in buffalo. Since the disease was first diagnosed in 1990 in KNP, resources have been focused on surveillance and monitoring projects to determine the distribution and rate of spread of the disease, opportunistic BTB surveillance in other species, validating the comparative skin test and a blood-based test for diagnosing BTB in live buffalo, describing the macro- and histopathology of BTB, molecular typing of the M. bovis strain, determining the survival of the mycobacteria outside the host under varying conditions, developing an infection model for BTB in buffalo to evaluate the efficacy of potential vaccine candidates, development of a protocol for breeding “disease-free” buffalo, and the completion of a pilot study to test BCG vaccine in captive buffalo. Once BTB reaches the northern most boundaries, SANParks will need to determine which, if any, management strategies they will adopt to prevent the spread of the disease into domestic stock or humans in the TFCAs. It is also acknowledged that BTB is a potential risk to South African communities bordering the KNP.

The breeding of “disease free” buffaloes (350 buffalo have been bred to date) for stocking other National Parks outside the high BTB risk zone with Kruger genotype buffalo, has been successfully developed and is currently ongoing. This is the only active management intervention activity currently related to the BTB problem in Kruger.

Should high zonal prevalence (≥40%) be reached and sustained in buffalo herds it will be important to determine if these levels will have a negative impact on population dynamics, particularly with reference to buffalo and other species, including lion. It is possible that biodiversity may be affected at lower prevalence levels or that the impact at high levels will be tolerated and sustained by the ecological systems within KNP. The influences of BTB on biodiversity will determine if management interventions are required and what form they should take. It is believed that in the future the emphasis for BTB monitoring should shift to biodiversity and socio-political TPCs.

CONCLUSION

BTB will be in the Kruger system for some time to come and no definitive solution is currently available to slow, never mind stop the infection. The available tools and knowledge are inadequate to make drastic decisions to control this disease, and it is accepted philosophy that the overall impact of any management action must not be worse than the effects of the disease, and must be beneficial to the greater ecosystem.

Many millions of Rands have been spent studying the disease, indicating the commitment of SANParks management and research staff, as well as the financial support received from various funding agencies, in our attempts to understand this disease, so that rational and realistic management interventions can be made, where this is found to be necessary.

Much work still needs to be done, and similar to the experiences in the human medical field, no immediate or medium-term solutions have yet been identified to effectively control this complex disease.

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Selected References