INTRODUCTION

The history of the so-called Zoological Survey has quite a long preamble. The need for such an institution was inter alia mooted by Goddard (1918) and Janse (1920). By 1934 there were already four surveys in existence on the natural resources of the Union of South Africa (Bigalke, 1934). However, none of these covered the indigenous animals of the country. To concerned scientists the deficiency was obvious. Since there was no dedicated government department or other institution available to undertake this task, it was eventually decided to allocate it to the Department of Agriculture, and more specifically, the Division of Veterinary Services and Animal Industry.

Other factors that played an important role in the allocation of the task to the Department of Agriculture were some field problems that were mainly of importance to farmers, namely predators in livestock farming; the transmission of rabies and other diseases to livestock; crop devastation by certain wild birds; the noxious effects of some rodents, including their role in the maintenance of plague (Bigalke, 1934). Most of these problems were particularly evident where farmers were attempting to tame wilderness areas, intensify crop production and improve livestock production.

There was an apparent need to establish a scientific body to study the extent of the problems and advise on or help in the control of problems relating to wildlife (Goddard, 1918; Janse, 1920; Bigalke, 1934; Du Toit, 1938). Eventually, the Zoological Survey was established in 1936 with the aid of a government grant of £1000 p.a., which was increased to £1500 the next year, under the Director of Veterinary Services at Onderstepoort (Kolbe, 1982). According to Thomas (1937), an alarming increase in outbreaks of rabies and African swine fever (ASF) was instrumental in enabling the Director of Veterinary Services to convince the government of the need for research on the bionomics of the various vectors of disease. Two veterinarians, A.D. Thomas and H.O. Mönnig, heads of Pathology and Helminthology at Onderstepoort respectively, undertook to coordinate activities of the Survey, the former playing the leading role from inception to termination. One full-time officer, F.F. Kolbe (Figure 1), was appointed for 4.5 years.

Two advisory committees were formed to assist in the planning and running of the Survey (Kolbe, 1982). Ideally these included zoologists, veterinarians, medical doctors and other experts in related fields. A central committee was formed in Pretoria and another in Cape Town. It was decided that the fields of activity of these committees should not overlap. In the Transvaal it was decided that the Survey should be more orientated towards veterinary matters while the Cape branch would cover subjects such as anatomy, physiology, ecology and zoogeography. At this stage it is not clear what happened to the work identified by the second Advisory Committee seated in Cape Town. As stated by Thomas in the “epilogue” in Kolbe’s report, the Zoological Survey came to an untimely end in 1946.

This paper deals primarily with the research conducted by Kolbe – the only full-time officer appointed for the Survey – and associated veterinary and other scientists who were already employed in other capacities. Attention is also given to some of the controversies associated with the then control of diseases of livestock which emerged at the wildlife/livestock interface.
interface with which Kolbe and his team mates were involved, for example nagana.

SCOPE OF AND METHODS USED IN THE SURVEY

According to Du Toit (1938), then Director of Veterinary Services and therefore in charge of the Zoological Survey, the objectives of the survey were:

• To collect and identify zoologically all forms of wildlife and map their distribution in South Africa – truly a mammoth if not impossible task.

• Note the diseases that wild animals suffer from, or carry and may transmit to domesticated animals and man, for instance viruses, bacteria, worms, ticks, etc.

• Make accurate observations on the feeding habits of wild animals and birds, especially, study their stomach contents and see which are destructive to stock, crops, etc., and distinguish them from the useful ones that prey on vermin and insects and should therefore be protected.

• Determine the rate and season of breeding of wild animals.

• Do detailed studies on peculiar habits, migration, methods of control, biological interrelationships, etc., in cases of groups of special interest.

The Survey was not limited to South Africa. A country such as Tanganyika (now Tanzania) was included if regarded as warranted by the nature of the investigation. Indeed, there seems little doubt that the Survey was used as a convenient tool by the veterinary authorities when a wildlife-associated disease problem, such as rinderpest, arose outside the borders of the Union.

All fauna collected were examined externally and internally (comprehensive post mortems were conducted whenever possible), parasites collected and blood and spleen smears taken. Breeding and other habits were recorded as well as regional habitats. Smaller animals were stuffed and flat skins prepared from larger ones.

All records were regrettably later lost as a result of flooding of the basement of the building where these were stored at the Veterinary Research Institute at Onderstepoort. However, Kolbe (1982), from memory, estimates that more than a thousand mammals, hundreds of birds and a few reptiles and amphibia were collected. Identification of specimens was done by:

• Mammals and birds - Dr Austin Roberts

• Reptiles and amphibians - Dr Vivian Fitzsimons

• Ticks - Drs Rene du Toit and Gertrud Theiler

• Fleas, lice and mites - Mr G. Bedford and
  Dr Basil de Meillon

• Blood smears - Dr W.O. Neitz

• Helminths - Prof. H.O. Mönnig and Dr D.J. Ortlepp

• Pathological specimens - Prof. A.D. Thomas, Dr K.C.A. Schultz and Dr H.P.A. de Boom (Thomas & Kolbe, 1970a,b).

• Traps and snares used by different tribes were also collected.

RESULTS AND DISCUSSION

The scope of the research reported by Kolbe does not cover all the objectives originally identified for the Survey. Studies on the biology and control of predators and the relation of wild birds to agriculture, for example, do not feature in his report. It is not unlikely that this work was conducted and published by the researchers concerned, inter alia on specimens collected by Kolbe and co-workers, but the authors of this review have made no attempt to trace it because our purpose is primarily to give credit to the largely unpublished, massive inputs made by Kolbe and the seconded people who worked with him.

The biology and control of rabies vectors

It was well known at the time when the Survey was initiated that small carnivores, such as meerkats (now referred to as mongooses), more specifically the yellow mongoose (Cynictis penicillata) and suricates (Suricata suricatta), were important carriers of rabies in South Africa. We now know that mongoose populations have probably been infected with rabies for many eons and thus may serve as a source of infection wherever they occur (Swanepoel, 1994).

The Field Services component of the Division of Veterinary Services had apparently decided on the eradication of mongoose colonies in an attempt to prevent rabies from spreading “northwards”, wherever that may have been. The aim of this campaign was to eradicate all the mongooses on certain infected farms as reports of cases were received from them. The Survey’s task was to find an effective, fast and economical method of control.

The investigation was done on four adjacent farms in the heavily infected Hoopstad district in the western Orange Free State province. In order to determine the success rate obtained
with various toxic gases, the mongoose burrows had to be
dug up entirely. Thus the enormous extent of the underground
passage system was also revealed (Figure 2), elucidating this
aspect of their fossorial behaviour.

These experiments have been described (Fourie, 1940;
Snyman, 1940), and results obtained with carbon monoxide
created by an internal combustion engine were found to be
as satisfactory and much safer to use than cyanide under
these field conditions. This laborious and obviously impractical
exercise was apparently never put into practice on a wide scale
(Thomas & Snyman, 1943).

Status and biology of indigenous wild pigs
Warthogs (Phacochoerus aethiopicus) and bushpigs
(Potamochoerus porcus) were known carriers of ASF, the former,
particularly, being responsible for outbreaks of this highly fatal
disease in domestic pigs. Bushpigs are also responsible for
extensive damage to crops and young plantations. In order to
obtain more information on the role played by bushpigs, their
habits were studied in the northern Transvaal mountain forests
of the Soutpansberg at and near the well-known landmark,
Hangklip (Thomas & Kolbe, 1942). Attempts to obtain blood
specimens from bushpigs for ASF tests at Onderstepoort,
however, failed, since it was not possible at that time to catch
or shoot them for this purpose. No research was apparently
done on warthogs, the much more important
reservoir of ASF (Plowright et al., 1994). 2002

Studies on tuberculosis in kudus
(Tragelaphus s责psiceros)
These studies were conducted in the eastern
Cape Province where tuberculosis had been
reported by Paine & Martinaglia (1929)
in kudus and common duikers (Sylvicapra
grimmia). This observation was associated
with a high incidence of tuberculosis in
cattle (Bos indicus/taurus) in that area, and
it was therefore thought that these antelope
possibly played an important role in the
occurrence of the bovine disease.

Members of the Zoological Survey team launched
an investigation into the species of game involved and
the epidemiology of tuberculosis in that area. They only
encountered the disease in kudus. Their findings were very
different from the customary situation encountered in cattle in
the sense that swelling of the parotid lymph nodes were the
first symptoms to appear. In some cases these glands became
fistulous and discharged to the exterior long before the disease
became generalised. On the basis of these observations it was
postulated that infection probably occurred via skin wounds
caused by thorns of the indigenous trees or by insect (Lyperosia)
or tick bites. In infected animals, the primary lesion developed in the parotid lymph node.

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Paine & Martignalia (1929) found that
Mycobacterium bovis caused the infection
in kudus and a duiker. Thorburn & Thomas
(1940) confirmed this finding in kudus, the
only species they found to be infected.

Studies on gerbils
These investigations were done in collabora-
tion with the Department of Health because
gerbils (Tatera spp.) are the primary source of
infection and therefore very important in the epidemiology of
plague. The grain-producing regions of South Africa with light
sandy soils, such as the wheat-producing districts of the Cape, parts of the eastern Free State and the maize areas of the
Transvaal (now encompassing parts of Mpumalanga, Gauteng
Province, and Northwest Province), are a prime habitat.

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The gerbil population problem and measures to control their
numbers were studied and the latter implemented on an
experimental basis (Davis & Thomas, 1941). Strychnine bait,
traps, prussic acid gas and clubbing gerbils to death whilst
plowing the lands were used as control methods, the latter
followed by one of the former techniques proving to be the
most satisfactory approach. Continuous application of the

![Figure 2. Excavated yellow mongoose burrows being photographed.](image)
The close relationship between tsetse flies and a fatal disease in their cattle has apparently been known by some of the inhabitants of Africa for many centuries. The disease was called “nagana”, derived from the Zulu word “nakane” meaning tsetse fly disease according to Connor (1994), or weakness according to Knuth & Du Toit (1921). It seems that some Africans associated nagana with tsetse flies (Connor, 1994) and others with big game (Knuth & Du Toit, 1921), but they clearly avoided and still avoid tsetse fly belts to protect their animals against nagana. Louis Trichardt, one of the earliest travellers in southern Africa, had no doubt that tsetse flies, which he first encountered in 1837, were responsible for transmitting a fatal disease to his cattle (Preller, 1917).

At the turn of the 19th century Bruce identified *Trypanosoma* spp. as the cause of nagana in domesticated animals and expressed the conviction that wild animals were the source of the infection (Knuth & Du Toit, 1921). We now know that large numbers of naturally infected wild animals showing no sign of disease serve as reservoirs of the infection (Connor, 1994).

The occurrence of several severe outbreaks of nagana in cattle in Zululand during the early part of the 20th century prompted farmers and politicians to clamour for the abolition of the Zululand game reserves and the concomitant extermination of the game as the solution to the problem. The first official shooting campaign started in August 1917 when the district of Umzimkulu was thrown open to hunters by the Natal Provincial Administration. No records were kept but it was estimated that 25 000 wildebeest, not counting other species, were shot (Pringle, 1982).

In 1921 Harris appeared on the scene. He was appointed, by the Chief of the Division of Entomology of the Union government, to investigate the bionomics of the tsetse fly. Harris, although not a qualified entomologist, was a careful observer and soon noticed that the flies landed on the shaded underside or legs of prey and from this he developed the well-known Harris fly trap (Harris, 1927). At this stage the authorities firmly believed that the Harris trap would be the answer to the nagana problem by eliminating the tsetse. But nagana persisted and Harris was transferred to another post (Pringle, 1982).

A shooting campaign was initiated in 1929, this time by the Division of Veterinary Services: “The farmer must come before game. There is only one alternative to the present policy – complete extermination,” Dr P.R. Viljoen, acting Director of Veterinary Services, stated at a meeting of the Game Advisory Committee, thus echoing the views of the Minister of Agriculture, General J.C.G. Kemp. A total of 15 130 zebras, estimates based on tails which were hacked off as evidence, were shot by seven teams comprising 11 hunters in each team. In the 18 months up to November 1930, 26 162 ungulates were shot in the buffer zones around Umfolozi Game Reserve and 377 inside.

Rhinoceros were excluded from the campaign. The purpose of the campaign was to clear the area around the Reserve and confine the remaining game (and tsetse flies) within it. At least 1400 ungulates were also shot at this time in the Mkuzi Game Reserve (Pringle, 1982).

The public outcry was enormous and Harris was recalled in 1929 to do further experiments with his fly traps. Dr P.J. du Toit, Director of Veterinary Services, when he visited the tsetse control camp at Umfolozi in 1930 to inspect the Harris fly traps, believed that these would be the answer (Pringle, 1982).

Following a successful field demonstration of the Harris trap in 1930, the Natal Administration ordered 1000 and, during the first year of operation with 487 traps, Harris caught 7 299 992 flies (Harris, 1932). However by 1937, when he was operating 8900 traps, he caught only 57 000 flies. Eventually he had 26 000 traps in the Zululand game reserves and the more traps he set the fewer flies he caught. The Zululand farmers and Harris, *inter alia*, were by now convinced that the traps were successful (Harris, 1938). The problem was, however, that by 1939 nagana was flaring up again (Pringle, 1982).

There was clearly official doubt about the efficacy of the Harris traps in controlling the fly, hence the authorisation of the investigation carried out by Kolbe. From 1940 Kolbe, who was seconded from the Zoological Survey at Onderstepoort to Umfolozi in Zululand, conducted research on methods to improve the trapping operations. This included methods to improve the visibility of traps by better placement, changing the colour of the covering hessian and increased exposure of the traps to air currents by changing the way they were suspended from branches. Unfortunately Kolbe was recalled to Onderstepoort for another assignment before he had completed a further experiment on the spraying of the hessian of the Harris traps with an insecticide, namely pyrethrum which had also been tried by Harris much earlier (Pringle, 1982).

Although the Veterinary Division initially still placed their faith in the effectiveness of Harris traps, Kolbe’s studies and the discovery by J.S. Henkel (Conservator of Forests in
Natal) that tsetse flies used restricted and permanent breeding sites – a “hidden population” (apparently discovered independently by Kolbe) – confirmed that the trap was no more than a surveying tool and could never successfully reduce the fly population. Henkel believed that these breeding sites could be eliminated or made unfavourable, thereby exterminating the flies. Despite Kolbe’s conviction that his proposed alternative (Kolbe, 1940/41) of concentrating on the “hidden population” by spraying the hiding places with, for example, a long-acting residual insecticide, at the required intervals, would succeed, this advice was ignored at the time. However, it proved prophetic, as indicated below.

Official disillusionment with trapping, coupled with increasing losses of cattle from nagana in especially the 1942/43 epidemic, persuaded the Division of Veterinary Services to try once again to control the disease by eliminating the reservoir, namely the game. This led to the Division’s second game eradication campaign, which lasted from December 1942 to 1950 and accounted for 138 529 ungulates.

By 1949 Kluge, who had replaced Harris in 1941, was identifying the breeding sites of the “hidden population” of tsetse flies by searching for their pupal casings in the sand of river beds and valleys in Zululand (Pringle, 1982). This was followed by a successful aerial spraying campaign using the insecticides DDT or BHC and aimed specifically at the mapped breeding areas. The campaign lasted until 1952 and eventually led to the extermination of Glossina pallidipes, the most important vector of nagana.

Clearly the money used for the last unimaginative game eradication campaign could have been much better spent in following up Henkel’s and Kolbe’s ideas on the “hidden population” experimentally.

Rinderpest

Rinderpest had disappeared from South Africa by 1903 but persisted further north in equatorial Africa where it was reported in both cattle and in game (Thomas & Reid, 1944; Rossiter, 1994). Alarming southerly extension of the disease in cattle occurred in the years from 1937 to 1941 (Rossiter, 1994). This was followed by a successful aerial spraying campaign using the insecticides DDT or BHC and aimed specifically at the mapped breeding areas. The campaign lasted until 1952 and eventually led to the extermination of Glossina pallidipes, the most important vector of nagana.

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According to Kolbe (1982), the Union of South Africa supplied a team that vaccinated all livestock – more than 1 500 000 inoculations were done using triple vaccination, presumably with a serum-virus vaccine or attenuated goat (Capra hircus) vaccine in combination with serum-virus vaccine - in a 6-40 km wide corridor lying between the two lakes and bordered on its southern and northern sides by wooden, game-proof fences (Figure 3) that were erected on the boundary of Northern Rhodesia (now Zambia) and Tanganyika (now Tanzania) (Thomas & Reid, 1944; Kolbe, 1982; Rossiter, 1994).

In 1941, Kolbe and Thomas, using Zoological Survey equipment, and Reid (a local veterinary officer) were tasked to study the occurrence of rinderpest in the game in that area of Tanganyika and to determine the efficacy of the above-mentioned fence in limiting the spread of the disease (Thomas & Reid, 1944). They found that the main focus of the disease was in the Mlepa-Sakalilo area in the Rukwa valley on the eastern foothills of the Fipa range of mountains (Kolbe, 1982). Their findings were published (Thomas & Reid, 1944), but for unknown reasons Kolbe is not one of the co-authors. Rinderpest was diagnosed symptomatically and on typical post mortem lesions in buffaloes (Syncerus caffer), eland (Tragelaphus oryx), kudus and a puku (Kobus vardoni). Virus was also transferred to calves and goats from sick buffaloes and eland. The fences were fairly effective. Where they had been well constructed, such as the northern fence, they stopped the movement of all wildlife except elephants (Loxodonta africana). Even wild pigs were stopped and well-trodden game paths were noticeable along the fences.
Miscellaneous zoological specimens, ecto- and endoparasites and pathological material

From Kolbe’s report (1982) it is clear that a wide variety of zoological specimens were collected by him and his closest associates and then supplied to other scientists who were not necessarily directly involved with the Zoological Survey (see above). One example is the ticks that were collected by Survey staff, which developed into a National Tick Survey in 1939, in a sense perhaps eventually replacing the defunct Zoological Survey, the former continuing for several decades under Gertrud Theiler which produced many publications (e.g. Theiler, 1961).

Blood and spleen smears taken in Zululand during the first game eradication campaign were examined by Neitz (1931, 1933). Although this work was started long before the launching of the Zoological Survey, it was listed in his report by Kolbe (1982), together with Neitz’s other research on wildlife, such as his description of a blood parasite in the yellow mongoose (Neitz, 1938), his discovery of a fatal theilerial infection in a duiker (Neitz & Thomas, 1948) and proof of the susceptibility of two species of Highveld antelope, namely blesbok (Damaliscus pygargus phillipsi) and black wildebeest (Connochaetes gnou), to heartwater (Neitz, 1935). There was also the work done on fleas, lice, mites and helminths by a variety of other scientists who published their studies independently, for which the Zoological Survey received, with few exceptions such as Ortlepp (1938), little direct credit. The same applies to specimens of mammals, birds, reptiles and amphibians that were identified by scientists working mainly at the Transvaal museum.

CONCLUSIONS

Thus the Zoological Survey not only generated vast quantities of invaluable material that was utilised for scientific purposes, but also gave rise to offshoots which became scientific forces in their own right. The reason for this brief record of the existence of the Zoological Survey is that, if it were not recorded, there would never be a record of what was, at the time, an extremely important research effort into wildlife research by the Division of Veterinary Services. Reasons for its demise, in 1946, seem to have been many, not least of which were the influence of World War II, lack of interest by the authorities concerned, loss of interest by most of the scientists who were involved on a part-time basis and resignation of the research officers, especially F.F. Kolbe who was a main player.

EPILOGUE

It is clear that most of Kolbe’s work was concentrated on diseases of animals which occurred at the livestock/wildlife interface, such as nagana, ASF, tuberculosis and rinderpest. Control of these diseases in livestock was the primary function of the Division of Veterinary Services of the Department of Agriculture. This would explain their almost complete preoccupation with them and their use of Zoological Survey staff and funds for research on them.

Thus it seems strange that despite realisation by the Division of the importance of research on the above-mentioned diseases, the rather simplistic and crude method of elimination of game was used when the latter was perceived to be a great danger to livestock. It is apparent that in the case of nagana, for example, Kolbe did not espouse this view and, with the power of hindsight, it is clear that an error of judgement was made.

Much later, in 1953, when a new fatal form of theileriosis - Corridor or buffalo disease – broke out in cattle in the corridor between the Umfolozi and Hluhluwe Game Reserves in Natal (now KwaZulu-Natal), and buffaloes identified as healthy carriers, elimination of the buffaloes was mooted by some of the affected parties, but fortunately research prevailed (Neitz, pers. comm., 1960).

There have been enormous advances since those early days in research and, concomitantly, in the attitude of officials. For example:

- Buffalo calves of cows in the Kruger National Park (KNP) are being raised free from buffalo disease, foot and mouth disease (FMD), tuberculosis and brucellosis to supply the great commercial demand for buffaloes;
- FMD, also carried by buffaloes, is being contained in the KNP by improved surveillance methods and official immunisation of threatened livestock adjacent to the KNP with much improved vaccines;
- It is now known where in this country warthogs are likely to be carriers of ASF and where not. Control can therefore be relaxed in certain areas; The different virus types of bovine malignant catarrhal fever that infect wildebeest and sheep (Ovis aries) can now be distinguished, and it is already clear that the former is much more common and hence poses a greater threat;
- Anthrax is indigenous to game parks such as KNP and Etosha where control in wildlife is difficult, but immunisation of livestock is a very effective method of control;
- Rabies in mongooses (viverrids) is an ancient endemic disease caused by a specific type of Lyssavirus and can be expected wherever, especially, the yellow mongoose occurs.

There are many more infectious diseases which operate at the livestock/wildlife interface, but they are of lesser importance and will not be discussed here. Full particulars can, however, be obtained from the review article by Worthington & Bigalke (2001).

Game, once the sole “property” of the State, now belongs to the land owners which has also changed the attitude of organised agriculture, particularly as ecotourism has become an important source of revenue. However, nagana still kills millions of cattle each year in Africa, and the need for research continues, as recently evidenced by the remarkable finding of Akman et al. (2002) that the key to extermination of the tsetse fly may lie in the inquiline bacterium Wigglesworthia glossinidia, which lives in the fly. This bacterium has 62 genes for making 10 different B vitamins, including folate,
biotin and thiamine, on which the fly depends for successful reproduction. When deprived of *Wigglesworthia* flies became infertile but, when provided with a vitamin supplement, they thrived. Blood, on which the flies feed, happens to be deficient in these vitamins. On the other hand, tsetse flies have inadvertently contributed to conservation in Africa by restricting nomadic herdsmen and their movements.

Problems with disease transmission between game and livestock persist. To honour the legacy of F.F. Kolbe, scientists and veterinarians need to continue to collaborate to optimise the balance between livestock farming and game management.

ACKNOWLEDGEMENTS


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