WILDLIFE PARASITES/DISEASES

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INTRODUCTION

Populations of all living organisms may maintain parasitic populations. Older definitions conveyed the idea that a parasite is a form that inevitably causes harm to its host. This is not always true and it would seem much more satisfactory to define parasitism as a state in which an organism (the parasite) is metabolically dependent to a greater or lesser extent on another (the host). Within this framework parasites can then be categorised as those which are harmful and those which are harmless, or even beneficial, to the host. Damage to the individual host by the parasite and overreaction by the host is known as “disease”. The ill effects of disease are usually visible. This is however, looking at parasitism and disease from an individual’s point of view. Looking broader at population and even ecosystem levels, a parasite which is harmful to the individual host may at the same time be of benefit to the species (survival of the fittest and survival of better gene material) or ecosystem (prevention of overutilization by acting as a culling mechanism). In a nature reserve, which is big enough to accommodate the natural ecological processes, disease is usually looked at from an ecological point of view, rather than the individual.

Other concepts, which should be understood, are “indigenous” on the one hand and “foreign” or “exotic” on the other. An indigenous parasite is a parasite “which belongs naturally to an area” (Oxford Dictionary), which implies that it had a common evolutionary history with its host and other elements of the ecosystem in which it operates. “Foreign” or “exotic”, on the other hand, refers to elements (in this case parasites) which have entered the ecosystem relatively recently and is therefore not a natural element in its new environment.

Severe interaction is most frequently observed where the contact between host and parasite is of recent origin (when two populations first become associated). In time the negative effects of interactions tend to become quantitatively smaller, or absent, or the association can be of benefit to the parties which are involved (symbiosis), or ultimately, it can lead to dependency by both host and parasite on each other. In other words, natural selection tends to lead to reduction in detrimental effects or to the elimination of the interaction altogether, since continued depression of a prey or host population by the predator or parasite population can only lead to the extinction of one or both populations.

Although an indigenous parasite is in balance with its host and the other elements of the ecosystem, it is a dynamic process. These parasitic life forms will sometimes be dormant, but will sometimes flare up in the form of disease. Natural or unnatural stress situations may act as trigger mechanisms. Diseases, such as mange, has been witnessed to break out under natural conditions of stress, such as at time of weaning in wildebeest, cheetah, lion and black-backed jackal in the Kruger National Park. Tick burdens of impala rams were also found to escalate dramatically during the peak of the rut in the Kruger National Park; a known stressful time for the rams. In studies performed in the Kruger National Park it was also found that individual animals which had a previous history of stress like an infection, a wound, bone fracture, etc, invariably accommodate parasite burdens far in excess of the normal acceptable levels. These animals act as reservoirs and disseminators of parasites and in a normal ecosystem would be predator prone with a good possibility of being eliminated.

Normal imbalances can also be created when the habitat is altered by natural phenomena such as drought. Under drought conditions animals concentrate near water holes and form local temporary overpopulations and an acceleration in possible transmissions. Combined with increased stress through social interactions and insufficient food, and the stage is set for disease to emerge out of dormancy and act as a culling factor. At the same time however, such diseases are density-dependent and will abate when the animals scatter after rain or after a certain amount has been "culled" by disease. This culling role of the so-called parasitic life forms is one of nature's ways of relieving excessive pressure on the habitat. This in turn will ensure that habitat quality and quantity is maintained, which is essential for the survival of hosts and their associated parasitic life forms. In a self-sustaining ecosystem it is therefore not the policy to treat these animals, but only to monitor and assess its role in the ecosystem context. By intervening, man is willingly favouring the survival of a particular genetic characteristic above others.

The more complex and diverse the components of this association are, the more stable the relationship is expected to be. A multiple host species situation provides the benefits of predation and scavenging, a better vacuum cleaner effect of each other's parasites and ensures better and wider utilisation of the habitat without the over-domination and resultant over-abundance of a single species. Such a mosaic of species provides natural barriers or buffer systems to the spread of the disease. Parasites may also have an effect on each other or another more benign one might already have occupied the niche of a parasite. This phenomenon of "stability in biodiversity" is therefore a sound reason to re-establish all possible historical life forms as a prophylactic buffer action against the outbreak of disease.

Anything abnormal or unnatural or new, which is introduced (mostly by the actions of man) into a natural self-sustaining ecosystem, can upset the balance and cause outbreaks of disease. Man can alter the natural environment by introducing foreign elements such as fences, placing boreholes and dams in places where nature did not intend having them, indiscriminate veld burning practices, farming practices, etc. This may cause relative over-abundance in an area where the habitat cannot afford it and create conditions for the natural flare-up of diseases. Again, nature's way of relieving the pressure which man has forced upon it. By altering the flow of a river through indiscriminate land use practises, the natural detoxification processes within an area is interfered with, enhancing the possibility of unnatural build up of potential harmful toxins or organisms (such as anthrax spores). By removing the natural predators from a system, not only a major natural culling factor is eliminated, but the system also loses the ability to remove weak or uncompetitive animals, and loses a major beneficiary to the gene pool.

The invasion of a “new” or “foreign” parasite into a host or ecosystem usually gives rise to instability in the system, which may manifest itself in the form of a disease epidemic, often of a violent nature. A classic example is the rinderpest pandemic, which swept through Africa at the turn of the century, killing thousands of cattle and all but wiped out the buffalo population in the Transvaal Lowveld. Eland, kudu, warthogs and bushpigs were also hit hard. Tuberculosis has established itself in the buffalo population of the Kruger National Park, where it has assumed a progressive course in individuals and in the population, and is considered a major threat to especially buffalo and lion populations.

Imbalances in host/parasite relationships can also be caused by the introduction of foreign or exotic hosts into areas to which they are not adapted. Indigenous diseases such as foot-and-mouth disease, African swine fever, malignant catarrhal fever, African horsesickness, bluetongue, heartwater, anthrax, Corridor disease, nagana, etc., have adapted and are inapparent in their their natural hosts. On the other hand, violent negative interactions in the form of disease outbreaks, sometimes of an epidemic nature, may occur in hosts, which are foreign to the area, such as livestock. In earlier years these diseases have actually played guardian to the area which later became the Kruger Park; they actually prevented overexploitation of the area by man and his domestic stock before proclamation. The same principle also applies to a great extent to indigenous species, which have adapted to different circumstances or different areas. It has been the experience that by bringing animals such as eland from the highveld regions of South Africa to the northern and eastern bushveld areas, severe losses may be suffered from diseases such as heartwater, cordophillosis (heart worm) and high tick burdens.

So severe are the threats of these diseases to the farming and export industries, that statutory control measures have been instituted. Many of these diseases are listed as controlled and/or notifiable diseases. Any disease, which does not currently occur in South Africa, is also a controlled, notifiable disease. In a "controlled" disease the state takes over and prescribes control measures, e.g. foot-and-mouth disease, African swine fever, rabies, anthrax, Corridor disease, etc. Statutory control measures include the declaration of control areas, quarantine measures, movements animals or biological products by permit system, etc. "Notifiable" diseases are those diseases of which the occurrence has to be reported to the state veterinary authorities. Further control is the owner's own responsibility.

The indigenous fauna from the northern and eastern bushveld parts of the country harbour many of these diseases and therefore pose a threat to exotic species (mostly livestock) in the vicinity and even further afield. For this reason game movements are subject to statutory control measures such as quarantine measures and movements by permit system.

In a self-sustaining ecosystem the ideal is to control indigenous diseases/parasites by maintaining habitat quality and natural diversity of indigenous life forms, preventing acute overpopulations and to prevent foreign diseases from entering the system. The more intensive a system is managed and the higher unnatural densities of animals are allowed the more intensive disease control methods will have to be applied.

Emergence of new infectious diseases in wildlife is a continuous and ongoing process. The factors that give rise to these diseases, such as ecosystem alterations, movements of pathogens or vectors, movements of hosts, and changes in pathogens may be natural or due to human influences. Managers of wild species need to be cognisan6t of the factors that give rise to emerging diseases and to be alert to the appearance of new diseases. This, of course, requires knowledge of the endemic diseases in wildlife populations and the appropriate veterinary infrastructure to diagnose the spectrum of diseases in wildlife. Though intervention may not always be appropriate and will depend on many factors, in the case of some parasitic and infectious diseases, managers may need to intervene to protect populations or to prevent introduction or spread within the reserve or conservation area, or further afield to domestic animals.

To intervene as a prophylactic measure or, in the presence of a disease outbreak, as a control measure, there are a few tools available to the manager. The most important are: -

- The establishment of an "early warning system" which involves the use of trained field personnel who immediately communicate any suspicious circumstances to management. Necropsy procedures, albeit cursory, should be performed on all carcasses that become available during culling procedures, hunting or from unknown causes. If deemed necessary animals might even be killed in order to do follow-up exploratory survey pathological examinations.
- Most diseases are density dependent and a reduction of the maintenance host population numbers by culling operations can stop the progress of an epidemic.
- Fire can be used to burn large infected areas. This not only has some sterilisation effect but also has the added advantage of keeping the animals temporarily out of an area. In the case of anthrax the incineration of carcasses and burning of vegetation in the immediate vicinity reduces the amount of infective material appreciably.
- For tick control, methods based on the use of the Duncan applicator, laser beam or pressure plate systems, can be used. Helminthics can be incorporated in water, feed or licks. These methods are usually only resorted to in intensively managed areas.
- The remote capture technique, using a dart gun and dart syringe, can be used to treat individual animals. This is mostly used for very valuable animals.
- To prophylactic immunise free-ranging wild animals, a successful mass vaccination procedure has been developed. This consists of ballistic implantation bullets or disposable projectile syringes, which are fired by an operator from a helicopter.

It is beyond the scope of this chapter to discuss in any depth the parasites and diseases which have, or potentially will have, an impact on a wildlife reserve in the

Limpopo basin. The objective is to provide a short description of how to recognise the disease (clinical appearance), the most important epidemiological features (ecology of the parasite/disease), a summary of the control actions that can be taken and how it can impact on decisions by the manager. These diseases fall arbitrarily into one or more of the following categories: -

- Indigenous parasitic life-forms which is carried subclinically and have never yet manifested in a disease outbreak.
- Indigenous parasites/diseases which is mostly carried subclinically, but under certaincircumstances, both natural and unnatural, can break out in disease form of variable impact. Under natural circumstances these disease can act as a culling factor on wildlife populations.
- Indigenous diseases of wildlife which threaten livestock. Many of these diseases can have a potential serious impact on agriculture and the economy of the country and are classified as controlled and/or notifiable diseases by the state.
- Foreign/exotic/alien, or newly introduced diseases into the country. These diseases can have a serious impact on both livestock and wildlife populations. They are also classified as controlled, notifiable diseases.

VIRAL DISEASES

Of all so-called parasitic life forms on mammals, viruses are the most numerous and are the most widely distributed. Viruses are also the most important as far as livestock health is concerned. On the other hand, most viruses, which cause problems in livestock, have adapted to wildlife where the diseases mostly circulate and propagate in an inapparent or sub-clinical form. Exotic viruses can however manifest as disease in wildlife. The most important diseases are described below.

FOOT AND MOUTH DISEASE.

Foot-and-mouth disease (FMD) is a highly contagious acute viral infection, almost exclusively of ruminants and pigs.

Clinical appearance

Although, as the name implies, FMD is characterised by the development of lesions in the mouth and on the feet, the earliest clinical signs are those of a non-specific infectious illness and include fever and general malaise. These signs are usually quickly superseded by lameness, a disinclination to stand, salivation, smacking of the lips and grinding of the teeth. Infected impala tend to stand alone in the shade of trees; they show a disinclination to graze; are inclined to lie down and lag behind the flock. Mouth smacking may be seen and a lameness in one or more limbs. They sometimes show a tendency to shake the leg as if attempting to shake or brush off irritation, or may stamp the leg on the ground. As the disease progresses separation between the horny hoof and the wall of the coronet, known as 'slipper formation' may take place. This is a valuable aid in ageing the infection. In impala this descent is rapid and the "slipper can be at the point of the toe within six months. There are good reasons to believe that most other wild ruminants will show a similar clinical picture. Warthog has been seen to die suddenly as a result of myocarditis. The African buffalo is an exception to the rule and the vast majority of infections in these animals are clinically inapperent.

The above descriptions are for the indigenous SAT-1, 2 and 3 strains of virus. With the exotic A,O and C strains unusual and unexpected eventualities are possible. This was well illustrated by very high mortality among mountain gazelles caused by type O virus in a nature reserve in Israel.

Epidemiology

SAT-1, 2 and 3 viruses have caused the overwhelming majority (84%) of identifiable outbreaks in southern Africa and are restricted to the sub-Saharan countries. Types A, O and C are found in central and eastern Africa and the rest of the world. A, O and C are not established in wildlife populations, and is therefore considered exotic to Africa.

The African buffalo is the only free-living species known to be capable of sustaining FMD infections for indefinite periods. Although other clove-hoofed wildlife becomes infected periodically, there is little evidence to believe that that they are important for viral maintenance. Impala are a possible exception, as epidemics, sometimes characterised by the development of severe disease, occur in this species.

Buffalo are the major source of infection for cattle in southern Africa. There are however, two buffalo populations, which are not infected with the FMD virus – those in the northern Natal game parks and the Addo Elephant National Park in South Africa.

Control

Being a controlled, notifiable disease by law, FMD control measures are prescribed by the state veterinary regulatory services. Owners are obliged to report all suspect FMD outbreaks.

Veterinary authorities in South Africa have recognised the high-risk FMD areas in South Africa and established FMD control areas. These control areas are generally confined to regions where buffalo occur and to international boundaries. Control strategies in these localities are aimed at preventing the unrestrained movement of all susceptible animals and their products out of endemic areas, and the immunisation of cattle in the adjoining areas. The control zone which is enforced, is subdivided into four control categories with diminishing stringency of control measures outwards, i.e. the FMD infected area, the endemic zone (also called the redline area), the surveillance zone and the rest of the FMD controlled area.

Separation of endemic and FMD-free areas is effected by the use of both cattle and game fences and by movement control. Thus, the boundaries of the Kruger National Park as well as the the entire northern border of South Africa are game-fenced to prevent the unauthorised movement of game and domestic species from these areas. Being FMD carriers, a complete embargo has been placed on the movement of live buffalo out of the first, or red line control area. There are however some movement of buffalo allowed within the redline area. Other cloven hoofed animals are allowed to leave the control area if quarantined and tested serologically negative for FMD. Although elephants have been experimentally infected with large doses of SAT 2 virus, this species appears to be insusceptible to natural challenge with SAT aphthovirus, and are therefore allowed to be exported from the Kruger Park. Products from cloven-hoofed animals are only released from behind the red line after they have been subjected to prescribed zoosanitary treatment. These regulations and control measures are however continuously being revised, as more reliable tests and better knowledge on the epidemiology of the disease are being gathered. Control measures are adapted accordingly.

Implications

The Maremani Nature Reserve, being near the northwestern border of the Kruger National Park and an international border with Zimbabwe, falls within the FMD redline control area with all its implications. Without the presence of buffalo within the boundaries of the reserve the control measures is expected to be slightly less stringent.

AFRICAN SWINE FEVER

African swine fever (ASF) is an acute and highly lethal disease of domestic pigs, caused by a unique virus which was originally confined to Africa by its natural hosts, namely argasid ticks and wild suids.

Clinical appearance

In domestic pigs classical ASF causes widespread haemorrhage, particularly in lymphoid tissues, and mortality rates are close to 100%. In wild suids the infection is inapparent.

Epidemiology

In southern Africa the distribution of ASF is closely linked to that of warthog and the eyeless tampan (*Ornithodoros moubata*). The tampan, which is an efficient biological vector, is necessary for ASF maintenance in wild porcines. Domestic pigs may be infected via the tampan or by direct contact with raw wild porcine products. Large quantities of virus are present in secretions and excretions of infected domestic pigs, and horizontal transmission occurs readily.

Control

ASF is a controlled, notifiable disease and control measures are prescribed by veterinary authorities.

The northern, northwestern and eastern Transvaal regions, which also, include the Kruger Park, are included in the ASF control zone. Because of the role of warthogs, and possibly bushpigs in the epidemiology of ASF, an embargo has been placed on the movement of these animals or their raw products out of the ASF control areas.

Implications

Maremani falls within the ASF control area and all prescribed regulatory control measures are applicable.

BOVINE MALIGNANT CATARRHAL FEVER`

Malignant catarrhal fever (“snotsiekte”) is a sporadic but almost invariably fatal viral disease of cattle and deer.

Clinical appearance

The disease is characterised by profuse mucopurulent nasal and ocular discharges, keratoconjunctivitis with corneal opacity, and enlargement of periheral lymph nodes. Morbidity is variable, but mortality is virtually 100%. Indigenous wild animals show no symptoms of disease. The local Sanga type cattle breeds are also susceptible to WB MCF.

Epidemiology

The disease has a worldwide distribution. Outside Africa it is usually associated with contact between sheep and susceptible species, principally cattle. Sheep-associated malignant catarrhal fever (SA MCF) is also encountered in South Africa, but is less common than the wildebeest-derived form (WB MCF), which is predominantly associated with blue wildebeest, but also occasionally with black wildebeest.

The increase in game farming has resulted in an increase in the prevalence of WB MCF and has reached alarming proportions in some localities, causing the death of up to 34% of animals in individual herds adjacent to game farms.

With tests Onderstepoort Veterinary Institute can now differentiate between SA MCF and WB MCF.

Control

Until 1993 MCF was a controlled disease and movements of wildebeest was restricted by regulation. These regulations have been lifted. However, due to severe mortalities experienced in cattle there is good reason to believe that the disease will soon be put onto the list of controlled, notifiable diseases again. In such a case wildebeest will only be allowed to be moved to a farm on which they already occur, or to a new farm, if the written permission of all neighbouring farmers is obtained.

Separation of wildebeest and cattle by at least 1000metres is regarded as necessary to prevent infection of cattle.

Implications

With wildebeest on the reserve there is a definite risk to neighbouring stock farmers, and there has been threats of court actions. Umbrella insurance is an option. Best to obtain their permission to keep wildebeest before the time.

RABIES

Rabies is a highly fatal infectious viral disease of humans and all other warm-blooded vertebrates.

Clinical appearance

The disease is usually marked by excitability, furious behaviour, inability to swallow, salivation, convulsions, paralysis, coma and death. Initially it can alter behaviour such as a wild animal that suddenly seems to become tame.

Epidemiology

The virus of rabies is present in the saliva of a rabid animal late in infection and usually enters another animal through a bite wound or via saliva through an existing superficial wound or scratch.

In South Africa, rabies exists in an urban form, associated with dogs, and a rural form, associated with wildlife. There is also considerable evidence that rabies is endemic in Viverridae in South Africa, and possibly also in jackals and several small wild cat species in certain regions. In spite of rabies having occurred along the border of the Kruger Park, with occasional rabid dogs entering the Park, no rabies has ever been diagnosed in wild animals in the Kruger park. This is ascribed to a healthy ecosystem with a high diversity of species providing the necessary buffer action to curb the spread of the disease. In Namibia an overpopulation and a poor species diversity resulted in a major outbreak in kudus (> 20 000 dead). This outbreak was maintained by horizontal transmission through salivary contamination of browse.

Control

Rabies is a controlled, notifiable disease. In order to minimise the spread of the disease, statutory measures have been adopted and control areas delineated in order to control the spread and movement of dogs and other carnivores, and where yearly vaccination of dogs and cats is enforced. The northern area of Limpopo is also included in such a control area.

Implications

Maremani is situated within a rabies control zone and has to abide by the control measures as prescribed.

AFRICAN HORSESICKNESS

African horsesickness (AHS) is an indigenous infectious but non-contagious viral disease of equids.

Clinical appearance

AHS is manifested by pyrexia, inappetence and clinical signs with impaired respiratory and circulatory functions. The mortality in horses, the most susceptible species is in excess of 95%. Zebra can harbour the virus without showing any sign of disease.

Epidemiology

AHS is caused by a virus of multiple serotypes and is transmitted by *Culicoides* midges. The zebra can act as reservoir of the disease.

Control

Yearly immunisation of horses.

Implications

AHS is prevalent in the northern Limpopo region. If horses are kept they should be immunised yearly and put under roof, out of reach of the midges, from dawn to dusk.

With the exception of the Western Province region of South Africa, the only area which is AHS-free, no embargo on grounds of AHS is placed on the local movement of zebra. It is however, a serious consideration for export to other countries.

BLUETONGUE

Although antibodies to bluetongue are found in most wild artiodactyles in South Africa, clinical manifestations of this disease have never been observed in indigenous wildlife. The disease is widespread and endemic in South Africa and although not a factor in local animal movements, it is a major consideration during international exports. It is a notifiable disease.

RINDERPEST

During the turn of the century rinderpest entered North Africa form Asia and then swept south causing devastating losses of livestock, particularly cattle, and large game such as African buffalo. In the Kruger Park only a small herd of 50 buffalo was known to have survived. Unexpected sequels to the disappearance of the host animals, included the disappearance of tsetse fly, and foot and mouth disease for several decades from large areas of southern Africa.

Since game in contradistinction to cattle, were not vaccinated it must be concluded that rinderpest was incapable of sustaining itself in wildlife in southern Africa and carriers of infection were not created in either wildlife or livestock.

In the rest of the African continent, rinderpest eventually became restricted to areas in West and East Africa. From these zones, several epidemics, sending waves of infection in various directions, have recently originated.

This is a potential danger, which can be met by using the biobullet and discardable dart-syringe techniques. The Onderstepoort attenuated live rinderpest vaccine, incorporating the Kabete O strain, was found to be highly effective and safe for use in buffalo and impala.

Being foreign to South Africa, rinderpest is both a controlled and notifiable disease.

CANINE DISTEMPER

Canine distemper virus was reported to have been introduced onto the African continent with domestic dogs.

Clinical appearance

Distemper is an acute or subacute febrile disease of many species of the order *Canivora* It may be manifested by signs of generalized infection, hyperkeratosis, central nervous system disturbance, or any combinatiopn of these. An elevated temperature , swollen eyelids and a purulent lacrimal exudate with a possible loss of vision, diarrhoea, thirst, cough, listlessness, anorexia and emaciation. Morbidity and mortality rates vary among species but may be high in susceptible species. Distemper caused significant mortalities in lions from Serengeti when 30% of the population died. The major population decline of the wild dogs in Serengeti is attributed to distemper.

Epidemiology

Aerosol or direct contact is the presumed methods of natural transmission.

Control

In a collection of distemper-susceptible animals, control can be achieved by: -

- Preventing contact with the virus by quarantining all animals brought into the area and vaccinating the new residents before or during that time.
- Protection by immunization (vaccination).

Implications

This can be a serious disease amongst carnivores in a wildlife reserve. Best to adhere to the prophylactic control methods as explained above. All domestic carnivores should be immunized before entering the area, and thereafter yearly.

BACTERIAL DISEASES

TURBERCULOSIS

Bovine tuberculosis caused by *Mycobacterium bovis* is a chronic contagious infectious disease of mostly animals, but humans are also susceptible.

Clinical appearance

Bovine tuberculosis is generally a chronic, and often sub-clinical disease. In most infected cattle and African buffalo the disease is only clinically detectable in the latter, or terminal, stages. The lungs and lymph nodes of the upper respiratory tract are mostly affected. Emaciation and coughing is usually apparent towards the terminal stages of infection. In kudu the disease manifests itself mostly as multiple, rounded, soft swellings in the region of the throat. These abscesses later open up with pus being discharged from fistulas. The only detectable sign of infection in lions is emaciation towards the terminal stages of the disease. The infection in wildlife seems to be progressive and eventually leads to the death of the affected individual. It also seems to be progressive within the buffalo population and eventually prevalence figures of >90% are attained, such as happened in the Kruger National Park.

Epidemiology

Bovine tuberculosis is an exotic disease, which entered South Africa via infected cattle. Cattle are also responsible for the disease being established in free-living wildlife populations, which seem to be highly susceptible to infection.

Normally cattle are the maintenance hosts, but in the wild situation African buffalo can take over this role, such as happened in the Kruger National Park. For the disease to become endemic in an area the maintenance host must be present. Buffalo is at this stage the only known maintenance host for tuberculosis in wildlife. Other animals such as lion and kudu seem to be incidental hosts.

Buffalo acquire infection almost exclusively aerogenously by the inhalation of infected droplets from a coughing or sneezing animal with open tuberculosis. Predators, such as lion, are exposed to infection by eating infected animals.

Control

Tuberculosis is a controlled, notifiable disease.

Once tuberculosis has established itself in an area in the presence of buffalo only very drastic measures can be taken. Presently the only possible way to eradicate TB from an endemically infected area is to eradicate the known maintenance host, buffalo, from the area. Without a maintenance host in the area the chances are good that the disease will not persist.

Best is to take the necessary prophylactic measures to ensure that the area stay "clean". If buffalo are to be introduced into the area it should be certified TB-free animals. Any other animal introduced into the area should only come from a known TB-free area.

In cattle use is made of the tuberculin test to eradicate TB from a herd. This test has also been developed for buffalo and lion, and can on extrapolation be applied to other wildlife. At its best it is however only a herd test and infected individuals can slip through. It is however a good aid in ensuring that only “clean” individuals are introduced, especially if a retest is done a couple of weeks later.

Significance

This disease is “bad news” on a game farm and every effort should be made to keep it out of the area. If buffalo is introduced they must be “clean” and kept that way. It might mean that a sample will have to be tuberculin tested at intervals.

To make sure that infected kudu do not enter the area the fence will have to be upgraded to be kudu-proof.

An “early warning” system will have to be instituted, which means that: - 1. All animals, which are hunted and/or culled, will have to be screened for TB. 2. All suspect cases that are encountered during normal operations will have to be shot and necropsied.

BRUCELLOSIS

Brucellosis appears to be primarily a disease of cattle, causing first calf abortions, which has opportunistically entered some wildlife populations in southern Africa. In the Kruger National Park, brucellosis caused by Brucella abortus bovis (biotype I) is maintained in the buffalo populations at an infection rate of up to 22,6%, as shown by serological evidence. This buffalo population however appears to have adapted well and shows an annual increase of 12 - 15 % in spite of the infection. Buffalo seems to be the only wild animal capable of maintaining the infection. They can be serologically tested for carrier status.

Brucellosis is widespread in agricultural areas and for these reasons movements of game are not restricted on account of this disease. No other control measures in wildlife have been adopted.

Brucellosis is a notifiable disease.

ANTHRAX

Anthrax is a peracute, acute and subacute highly contagious disease of domestic and wild animals and humans caused by the bacterium *Bacillus anthracis.*

Clinical appearance

In most species of animals anthrax is characterised terminally by the development of a rapidly fatal septicaemia that results in sudden death, and by the presence of the organism in blood and body fluids at death. The principal lesions are those of widespread oedema, haemorrhage and necrosis. Most ruminants manifest peracute (apoplectic) and acute clinical manifestations which is characterised by sudden death without prior signs of illness. Equids usually suffer from the acute form, which sometimes show oedematous swellings before death. Omnivores (e.g. pigs), carnivores and immunised animals usually contract the subacute to chronic form. The most frequent sign is an oedematous swelling of the face, throat and neck following primary infection of the pharynx, pharyngeal tissues and regional lymph nodes. It may progress to a more acute form or may recover. In all cases haemorrhages may be present.

Epidemiology

Within an infected host *B. anthracis* spores germinate to produce vegetative forms which multiply, eventually killing the host. When conditions are not conducive to growth and multiplication, they tend to form spores, but need oxygen. Most spores develop after an infected carcass has been opened by scavengers or man. The vegetative cells of *B. anthracis* are not particularly resistant to adverse environmental conditions, whilst spores are very resistant and are capable of surviving for very long periods until the opportunity to infect another host arises. In the Kruger an example has been recorded where live and virulent anthrax spores were isolated from bone remnants, dated 250±years ago. Spores from an infected carcass are liberated to the environment via water runoff, scavengers (mammals, insects and birds) and the actions of man. Transmission occurs directly from an infected carcass or products thereof (hides, wool, bone meal, etc.), or indirectly via the contaminated environment.

Due to effective vaccines and farm management practises, anthrax is now only a disease of importance in free-living wildlife populations. Due to obvious difficulties encountered in vaccinating free-living wild animals, anthrax poses a major threat to these populations. Major epidemics have and are still being recorded in wildlife conservation areas.

In an indigenous and endemic anthrax area such as the Kruger National Park anthrax behaves as a natural culling mechanism and only acts up in epidemic form when the ecosystem is under stress, such as overpopulation of its host species. In the

Kruger it was found that a high kudu density, probably in combination with other stressful events such as excessive drought, might set an epidemic in motion.

During the early years of this century suspicion was already cast upon the role of kudus as disseminators of anthrax along the Zoutpansberg Mountains. During 1937 the problem reached such high dimensions that, convinced with the validity of their argument, the farming community of the Zoutpansberg area made representations to the Provincial Administration to the effect that all kudus in the Zoutpansberg area should be exterminated as a control measure against anthrax. The following passage is quoted from a letter by the Provincial Secretary to the Secretary of Agriculture and Forestry: "Vertoë is aan hierdie Administrasie gemaak om koedoes in die Zoutpansberg area to laat uitroei, daar dit beweer word dat hulle draers van miltsiekte is en beeste aansteek". For investigation purposes the matter was referred to Dr. W.J. Wheeler, who was the Government Veterinary Officer, Louis Trichardt, at the time. He made the following report to the Senior Veterinary Officer, Pretoria, on the 25th May 1937: -

> *"Anthrax : Zoutpansberg District.*
>
> *With reference to your Minute V39/9/23 of 20-5-37 about above, may I inform you that I personally have investigated the reports about koedoe dying in the Zoutpan area.*
>
> *Several cases of Anthrax have been diagnosed in cattle in the vicinity. As far as I could gather, this state of affairs has been going on for several years viz. that koedoe start dying, and immediately after the cattle contract anthrax. So accustomed are the farmers to this that immediately the koedoe start dying, all cattle are inoculated, when mortality promptly ceases."*

It therefore seems that anthrax had been a problem in the Soupansberg area, even before anthrax was diagnosed in the Kruger National Park.

Control

Anthrax is a controlled, notifiable disease by law, and control measures are prescribed and enforced by veterinary authorities.

Control measures usually include the following:- Effective surveillance and reporting procedures, providing an early warning system and delineating high-risk areas. Quarantine procedures, isolating an infected and contaminated area and animals until safe. In order to prevent sporulation of the vegetative growth form of *B. anthracis,* carcasses are not be opened. For disposal of carcasses, where possible, burial should be discouraged in favour of incineration or rendering. For the disinfection or decontamination of anthrax infected/contaminated material, formaldehyde (2-10%) is generally preferred. In particularly valuable animals, which have been exposed to anthrax, treatment with bactericidal antibiotics can be used as a prophylactic measure. Simultaneous vaccination is contraindicated. Vaccination. As a prophylactic measure: yearly vaccination of all cattle with Sterne spore vaccine in high-risk areas. During an outbreak: vaccination of immediate surrounding and in-contact herbivores. This also applies to captive wild animals. Most of the control measures, as used for livestock and captive wildlife, are difficult, if not impossible, to apply or enforce on large populations of free-ranging wildlife. Nevertheless, herd animals such as American bison, which can be corralled or captured, can be vaccinated. Long-stemmed, hand-held automatic vaccinating syringes are used from the sides of a crush. The strength and the wild and unruly nature of most animals however, make this method very hazardous and difficult. An aerial method of immunising free-ranging wildlife was subsequently developed. This method involves the use of a disposable dart-like projectile syringe, which is fired from a dart gun and helicopter. This method was later improved by the use of a ballistic implantation method. It consists of a gun-like device capable of accurately delivering, over short distances, biodegradable implant projectiles (bio-bullets) containing the vaccine. Apart from immunisation, anthrax control procedures which have been used in wildlife situations are, *inter alia*: the fencing-off or burning of known anthrax-contaminated vegetation; the location of carcasses from a helicopter or slow flying fixed-wing aircraft; covering carcasses with branches or spraying with 2% formalin, or incineration of carcasses as soon as possible so as to prevent their dismemberment by scavengers; and the replacement of natural waterholes by drinking troughs in which the water can be disinfected.

In areas where anthrax is considered indigenous it is debatable whether active control measures should actually be instituted. In the Kruger National Park the policy is to institute active control measures against anthrax only if it affects biodiversity negatively and/or where the actions of humans are providing unnatural impetus to an outbreak.

Implications

Based on the above evidence the assumption can be made that in earlier years, before the appearance of humans on the scene, anthrax in the Zoutpansberg area must have behaved much the same as in the Kruger today. Anthrax spores therefore is most probably present in remnants of bone, waiting to strike out when conditions are right.

As explained earlier, anthrax is most probably a necessary interacting element of an extensive natural ecosystem, with a tendency towards a symbiotic relationship. In smaller conservatories the effect of the action of humans is usually so great that the disease tends to exceed its density dependent limits and control measures should be instituted. As a prophylactic measure the habitat should be kept healthy and stressful situations such as overpopulations, of especially kudu, prevented. An early warning system should be instituted. This consists mainly of the collection and examination of blood smears collected from carcasses in the field. During an outbreak carcasses should be seeked out and covered or incinerated. Aerial vaccination of at least animals of value, should be considered.

RICKETTSIAL DISEASES

HEARTWATER

Heartwater is a tick borne rickettsial disease, which causes heavy mortality among cattle, sheep and goats in southern Africa. A wide variety of antelope and the African buffalo, which are native to the endemic regions and are refractory to artificial infection, are the maintenance hosts. The leopard tortoise and helmeted guinea fowl have been found to harbour *Cowdria ruminantium* for several weeks and may serve as a source of infection for the *Amblyomma* ticks.

The Northern Limpopo region is an endemic heartwater region and care should be taken not to introduce animals from heartwater free areas. Eland and blesbok have been found to die when moved from the Highveld to the Lowveld .

Heartwater is a notifiable disease by law.

PROTOZOAL DISEASES

CORRIDOR DISEASE

Corridor disease (CD) is an acute, usually fatal disease of cattle resembling East Coast Fever and is caused by infection with *Theileria parva lawrencei* which is transmitted by ticks from African buffaloes.

Clinical appearance

CD occurs only in cattle and is characterised by enlargement of the superficial lymph nodes, severe pulmonary oedema and death. The mortality rate is about 80%. In the African buffalo infection is subclinical.

Epidemiology

CD occurs sporadically throughout southern and eastern Africa wherever there is contact between cattle and infected African buffaloes in the presence of the vector ticks, *Rhipicephalus appendiculatus, R. zambeziensis and R. duttoni.* These ticks do not occur in the Addo Elephant National Park and African buffaloes from that area is therefore not infected.

CD occurs only in cattle that graze pastures on which African buffaloes are, or have been recently present.

Control

CD is a controlled, notifiable disease. Farming with cattle in the presence of buffalo is a hazardous undertaking and statutory control over the movement of infected buffalo in South Africa has been adopted. This is to ensure that CD can not become a more widespread problem and to lessen the possibility of a transformation of *T.p. lawrencei* to *T.p. parva* with the disastrous re-emergence of East Coast Fever.

Control is based on the prevention of contact between buffaloes and cattle. Game reserves in cattle raising areas should be securely fenced. In some cases a double fence is a prerequisite. The introduction of buffaloes into farming areas for the purpose of game ranching or safari hunting is prohibited, unless the buffaloes can be certified free from infection.

Implications

The vector ticks of CD are present in the northern Limpopo area. Even if CD-free animals are introduced, the chances are that they will eventually pick up the disease. With buffaloes on the reserve there is therefore a risk to neighbouring cattle farmers.

CYTAUXZOONOSIS

A protozoal parasite, which was found in an eland in 1960, was named *Cytauxzoon taurotragi.* Similar parasites have since then been found in many other wild ruminants and was invariably associated with disease and death. The disease collectively became known as cytauxzoonosis. Subsequently it has been taxonomically renamed and the genus *Cytauxzoon* discarded in favour *Theileria.* There is however still some controversy around the taxonomy at genus level.

Clinical appearance

The disease usually progresses over about two weeks with the only signs being progressive loss of condition, weakness and ataxia, and frequent recumbency. Opacity of the cornea and lung oedema has been seen. Severe anaemia seems to be a consistent feature. The disease is always associated with excessively high tick burdens.

Animals, which are prone to high tick burdens, such as eland and roan antelope, have been found to especially susceptible. All ruminants however seem to be susceptible.

Epidemiology

As with other *Theileria spp* infection is dependent on tick vectors, most probably *Rhipicephalus appendiculatus, R. evertsi evertsi, R. zambeziensis* and *R. pulchellis.* The disease therefore has a very wide distribution.

The infection is most probably transmitted to an animal via a vector when still young and the becomes a carrier. In most healthy animals within these vector regions the intra-erythrocytic piroplasms, a form in the life cycle of *Theileria,* can be demonstrated.

The disease only manifests itself in animals with excessively high tick burdens, and possibly a form of tick toxicosis. Such tick burdens are always the result of a stressful situation in the life of the animal. Cytauxzoonosis is therefore an end result of another stressful situation and is not a disease *per se.* It is frequently found in an individual animal that has sustained an injury, newly introduced animals (not yet fully adapted), animals under social or feeding stress (such as overpopulations within a restricted area) or animals introduced into an area for which they are not fully adapted. The disease is therefore indicative of something which is wrong; mostly a habitat problem.

Control

The only control measure that can be taken is to eliminate the stress under which the animals find themselves.

Implications

This is a natural disease and nature's way of getting rid of the weak burdens, and under a natural management regime the occurrence of such diseases should be noted and imbalances rectified if necessary. With newly introduced animals care should be taken to relieve stress as far as possible. Excessive tick burdens can be relieved.

COCCIDIOSIS

Coccidiosis is a protozoal disease, which occurs in many mammalian and all domestic livestock species. It is caused by infection with members of the genera *Eimeria and Isospora.*

Clinical appearance

Most infections in wildlife are subclinical. Disease manifestations under stress are characterised by enteritis and diarrhoea. Anorexia, dehydration, depression, recumbency and death may follow, especially in young animals. Severe outbreaks with deaths have been experienced in impala lambs and buffalo calves in intensively held captive situations in the Kruger National Park.

Epidemilology

Coccidia are generally host specific.

Coccidiosis is essentially a disease of young animals under intensive management systems. Disease usually occurs when resistance is lowered after stress such as that resulting from overcrowding, weaning and transportation or when animals are maintained under unsanitary conditions. The disease has never been seen in adult animals, although they may harbour the parasites. The clinical manifestation of the disease has also never been seen in free-ranging animals.

Control

Well-managed and hygienic conditions under which animals are held will prevent disease outbreaks. For prevention and treatment chemotherapy is very effective.

Implications

The disease is only a problem of intensively held young animals, such as breeding units. In such a case the necessary management practises will have to be instituted. If such a venture is not contemplated the disease is of no consequence.

ARTHROPODS AND HELMINTHS

In general lay terms arthropods and helminths are commonly called external parasites and internal parasites respectively, referring to the locality where they are most commonly found on/in vertebrates. Although this holds true for helminths, some arthropods are also found internally, such as lung worms, stomach bots, etc. A common feature is that all of these parasites are macroscopic in size , the smallest needing maybe a magnifying glass to view.

The phylum *Arthropoda* refers to the fact that the members have jointed legs. Virtually all of the parasitic members are found in the classes *Insecta* (lice, fleas and flies) and *Arachnida* (pentastomids, mites, hard and soft ticks).

The name helminth is applied to parasitic and non-parasitic species belonging to the phyla Platyhelminthes (flukes and tapeworms) and Nemathelminthes (roundworms and their relatives), also commonly referred to as trematodes and nematodes respectively.

Clinical appearance

Artropod parasites may be involved in the transmission of other organisms (act as vector), or they may have a direct effect upon the host. A high burden of external and/or internal parasites is debilitating to the host animal and may lead to progressive emaciation, weakness and death. Sometimes high tick burdens can be witnessed by eye or binoculars. Otherwise a necropsy is necessary. Even then it may be necessary to do actual counts of the parasites in order to assess whether the level of parasitism exceeds the level that the host can tolerate. In cases of mange, caused by mites, the skin is bare, thickened and usually covered with crusts. High tick burdens can go over into tick toxicosis, which causes further debilitation.

Epidemiology

A certain level of parasitism of wild animals by indigenous arthropods and nematodes is normal for all animals. There are however situations which may give rise to excessive burdens of parasites, resulting in disease manifestations.

Tick burdens of impala rams were found to escalate dramatically during the peak of the rut; a known stressful time for the rams. It was also found that individual animals which had a previous history of stress like an infection, a wound, bone fracture, etc, would invariably accommodate a parasite burden far in excess of the normal acceptable levels. In a survey on the parasitic burdens of warthog in a natural environment an individual which suffered from foot-and-mouth disease harboured 653 adult *Amblyomma hebraeum* ticks, which is virtually as much (654) as the combined total for 56 other animals in the survey. The same phenomenon was repeated in other surveys. These animals act as reservoirs and disseminators of parasites and in a normal ecosystem are predator prone with a good possibility of being eliminated. Without the full quota of natural predators these animals may survive longer and serve as a reservoir of parasites and an unnatural impetus to infestation by these parasites.

Normal imbalances can also be created when the habitat is altered by drought. Animals concentrate near water holes and form local temporary overpopulations and an acceleration in possible transmissions. Combined with increased stress through social interactions and insufficient food, and the stage is set for disease to emerge out of dormancy and act as a culling factor. In a survey on impala it was found that tick and worm burdens escalate drastically during drought periods. At the same time however, such a disease is density-dependent and will abate when the animals scatter after rain or after a certain amount has been "culled" by disease. This culling role of the so-called parasitic life forms is one of nature's ways of relieving excessive pressure on the habitat. This in turn will ensure that habitat quality and quantity is maintained, which is essential for the survival of both hosts and parasitic life forms.

Ticks are particularly good indicators of stress. A high tick burden in an individual or population is an indication that either the individual or population is under stress. Tick burdens are so sensitive that it has been used as an indicator of carrying capacity in smaller nature reserves. The advantage is that tick burdens are visible to the naked eye or binoculars. Better still is to do actual counts on animals that are hunted or culled.

Control

The only control measure for infestations which rise above the normal acceptable limits, is to eliminate the underlying reason.

Excessively high stocking rates usually go hand in hand with a deterioration of pasture quantity and quality, and thus an increased incidence of parasitism and disease. To prevent this, ensure that forage utilisation pressure is optimal. If need be culling should be instituted. In an intensive farming/ranching system where ecologically acceptable densities are exceeded high parasitic burdens are inevitable and more intensive management procedures will have to be adopted. To control ticks there are a few options available, such as the Duncan applicator, pressure plate and laser beam applicators, etc.

During and immediately after periods of drought be aware of sudden outbreaks of disease and be proactive in managing the problem. If need be culling can be stepped up and animals taken out and utilised before parasites eliminate them. Again it would be best to take out the obviously weak and debilitated individuals.

High build-up of parasites occurs in animals under stress. For example an animal which has sustained an injury. In a natural environment predators most probably would have eliminated such an animal. In an essentially predator-free environment, field personnel should assume the role of the absent predators, and eliminate all obviously debilitated animals or animals with excessively high tick burdens. By getting rid of these animals a formidable source of parasites will be eliminated.

A healthy and natural biodiversity should be aimed for. Species mop up each other's parasites, preventing unnaturally high build-ups of parasites.

A close watch should be kept for foreign parasites. Adopt rigid control measures to minimise the risk of passive transport of other organisms

Implications

Indigenous external and internal parasites are natural and integral parts or elements of a natural ecosystem and are good indicators of the health of the ecosystem and, therefore, carrying capacity. This principle can be used as an aid in determining the carrying capacity of the area. Use can be made of culled and hunted carcasses.

MANGE

Mange is the term used to describe a skin condition caused by mange mites. Sarcoptic mange, caused by *Sarcoptes scabiei,* and has to date been reported from 104 species of domestic, and wild animals. Humans are also susceptible. *Notoedres cati*, also from the Family: *Sarcoptidae*, is a similar parasite ,but attacks mainly the cat family.

Clinical appearance

The parasites pierce the skin to suck lymph and feed on epidermal cells. Their activities produce a marked irritation which causes intense itching and scratching, which aggravates the condition. The resulting inflammation of the skin is accompanied by an exudate which coagulates and forms crusts on the surface, and is further characterised by excessive keratinisation and proliferation of connective tissue, with the result that the skin becomes much thickened and wrinklede. There is a concomitant loss of hair which may be very widespread. All parts of the body may evetually become affected.

Epidemiology

Since transmission is by direct or indirect contact it tends to be density-dependent. When population densities are high disease manifestations tend to break out. This was well demonstrated in the black backed jackal populations of Addo and the Kruger National Park (Phalaborwa region) and lion populations of the Kruger. Most animals harbour the disease subclinically and disease only breaks out when the animals are under stress, such as when cheetahs from Namibia were introduced cheetahs to the Kruger. They were under competitive stress from the resident population and all succumbed from mange. Wildebeest calves, at the stressful time of weaning, is also very prone to the disease. In spite of its appearance and outcries of concerned public, sarcoptic mange epidemics in ecologically stable host species will have little or no long term ramifications at population level. However, in endangered or relic populations the disease can have a serious impact and control measures might be considered.

Control

In free-ranging control measures are aimed at creating a healthy ecosystem and maybe rectifying excessive densities of the affected species. For very valuable animals chemotherapy can be considered. The animal will have to be immobilised and treated.

Implications

Sarcoptic mange occurs normally in a healthy ecosystem. Sporadic outbreaks should be of no concern, but would be indicative of some stress situation.

NEW WORLD SCREW WORM

A foreign parasite such as the New World screw worm (NSW) has the potential to cause devastating problems to wildlife. Significant mortality (up to 80%) of white tailed deer fawns was recorded in southern USA! A genuine fear was expressed that that a newly introduced NSW, such as happened in Libya, could result in the extinction of many otherwise severely endangered species. The Libyan NSW was introduced introductions to the zoo.

TSETSE FLIES

There is good reason to believe that the tsetse fly belt is moving south at an alarming rate. It has already crossed the Lundi River on its downward trek! For the past few years nothing has been done to combat it. The possibility is good that tsetse, with nagana and possibly also sleeping sickness, will in due course re-enter South Africa. The most likely place of entrance is from Zimbabwe through the Limpopo valley. From an ecological point of view it holds no threat, but from an agricultural and tourism point of view it can be very costly.