EXOTIC DISEASES OF DEER : A REVIEW

C.G. Mackintosh

INTRODUCTION

Exotic diseases of deer have been of considerable interest in the last eight years when deer have been imported into New Zealand from the northern hemisphere to either infuse new genetic material for existing species (wapiti, European red deer) or to introduce species (eg, Pere David's, Mesopotamian fallow).

It is crucial that exotic diseases are not introduced with imported animals and therefore import protocols have been drawn up by the MAF in Wellington, based on a range of information including an earlier review of exotic diseases (McAllum, 1981) and a submission from the Deer Branch. As information comes to hand it is necessary to modify protocols to either tighten or loosen controls relating to listed diseases, incorporate new tests which give better sensitivity and specificity, to institute or change treatments, to incorporate new diseases and to alter the protocols to allow for the importation of embryos or semen rather than the live animals.

The following is a review of the exotic diseases known to affect deer, diseases which may be present in New Zealand for which exotic strains may occur overseas, import protocols, breakdowns in the system to date and the implications of importation of embryos and semen.

SPECIFIC EXOTIC DISEASES KNOWN TO AFFECT DEER

Tables I, II and III give comprehensive lists of viral, bacterial, rickettsial, protozoal, endoparasite and ectoparasite diseases, along with the species of deer shown to be infected naturally or experimentally, and the geographical regions where the agent has been isolated, and whether they are classed as a zoonosis.

V I R A L D I S E A S E S

Aujeszky's Disease is caused by a herpes virus which produces nervous signs and mortality in young pigs and abortion in sows. Persistently infected pigs are the major disseminators of infectious virus. The clinical syndrome in cattle, sheep and other species is called "pseudorabies" or "mad itch" because pruritis is the most prominent feature. Pseudorabies is apparently not transmitted between ruminants (Gibbs, 1981) and therefore deer are not likely to be important carriers of this virus. Nevertheless, imported deer should be seronegative for this disease.

Bluetongue (BT) and Epizootic Haemorrhagic Disease (EHD) are closely related arthropod-borne diseases. BT primarily affects sheep causing fever, hyperaemia, frothing at the mouth and nasal discharge. There is a marked loss of condition and animals may die. Cattle and deer are usually subclinically infected and may act as important reservoirs of BT virus (Jones et al., 1981). EHD affects white-tailed and pronghorn antelope severely while infection in mule deer, elk and moose is usually subclinical. The geographical distribution of BT is worldwide whereas EHD is confined to parts of USA, western Canada and Nigeria (Hoff & Trainer, 1981).

Epizootics generally occur in late summer and early fall. Both diseases are transmitted by Culicoides midges which are not present in New Zealand and are unlikely to become established here. Nevertheless, imported deer should be seronegative for BT and EHD.

Bovine herpes virus-1 (BHV-1)/IBR and Cervine herpes virus-1 (CHV-1) - Serological titres to BHV-1 (IBR) have been found in reindeer in North America (Dietrich, 1980) and Scandinavia (Ek-Kommonen et al., 1982) and red deer in the UK (Lawman et al., 1978). Subsequently, a herpes virus has been isolated in the UK from deer with ocular and upper respiratory disease which differed serologically from BHV-1 (Reid et al., 1986). Ronsholt et al. (1987) isolated a herpes virus from UK red deer which had characteristics in common with BHV-1 but was distinguished by its host specificity, serological reaction and genomic restriction fragment pattern. It was tentatively designated CHV-1 with the authors concluding that CHV-1 was a potential threat to red deer farming but was a minor inconvenience for cattle.

Ross (1987) indicates that CHV-1 infections in young deer are relatively mild and resolve spontaneously with little consequence. If the disease is not present in New Zealand already then it would be preferable to avoid its introduction. Imported animals should be seronegative for BHV-1 and CHV-1. There is, however, still a small risk of importing latently infected seronegative deer. A period of quarantine will help to reduce this risk because the stresses of importation may cause the expression of a latent infection.

Foot and Mouth Disease (FMD) has a worldwide distribution and although all species of deer appear to be susceptible to infection few develop serious clinical disease (Hedger, 1981). Experimental infection studies (Forman et al., 1974) suggested that pharyngeal virus was rarely recovered from red and roe deer beyond 14 days after exposure, whereas all fallow deer carried virus in the pharynx for a minimum of 5 weeks. These results suggested that FMD could be transmitted by close contact between deer and domestic animals. Wild deer were considered unlikely to be important in the maintenance and transmission in an epidemic of FMD in domestic livestock. To safeguard our livestock stringent controls must be used to prevent FMD infected deer entering New Zealand. Currently, all live deer from European countries where FMD exists must first go through 6 months quarantine and testing in the UK prior to 1 month's quarantine before shipment to New Zealand. This should be adequate safeguard. FMD is not currently present in USA or Canada.

Rabies has a worldwide distribution and is endemic in wildlife in parts of Europe, Asia, Africa and North and South America. Sporadic cases occur in deer but they are regarded as dead-end hosts (McDiarmid, 1980). Nevertheless, New Zealand should avoid importing rabies infected deer. Thus imported deer should only come from areas certified free of rabies or they should be quarantined for six months.

Rinderpest is a highly infectious disease characterised in cattle by fever, necrotic stomatitis, gastroenteritis, lymphoid necrosis and high mortality. It also causes severe disease in most species of deer. Transmission is by direct contract. Rinderpest is present in parts of Africa and Asia but

Europe, except for Turkey, has been free since 1930 while North and South America are also free. Deer should only be imported from countries free of rinderpest or be quarantined and critically tested prior to importation.

Skin papillomas and Fibromas have been reported in most species of deer in North America, UK and Europe. Deer fibromas are usually firm, round nodular skin tumours up to 1 cm in diameter although some are up to 25 cm diameter. They are usually brown or black with a smooth or wrinkled surface. Most fibromas are found around the eyes, mouth, neck and medial aspect of the forelegs. They have a viral aetiology but the mode of transmission is unknown (Sundberg and Nielsen, 1981). Clinically these fibromas appear to be unimportant but they may lead to a reduction in hide value. Only deer free of fibromas should be imported.

Vesicular stomatitis virus (New Jersey strain, VSVNJ) is endemic in parts of North America and the antibody prevalence is high amongst wildlife including deer, feral swine and racoon. Sudden outbreaks, seasonal occurrence, and movements of VSNJ outbreaks in North American livestock suggest an anthropod spread of the virus. The disease in cattle, swine, horses and deer is characterised by fever, large vesicles in the mouth and on the nose, lips, muzzle, coronary band and teats, salivation, anorexia and depression. The vesicles break, leaving raw erosions which heal in a few days. The disease is a zoonosis and causes influenza-like symptoms (Seymour and Yuill, 1981). It is not known if we have a suitable anthropod vector.

To prevent its introduction into New Zealand deer should not be imported from areas where vesicular stomatitis occurs. Serological testing and quarantining of deer from affected areas could be contemplated.

Louping ill is an arbovirus causing an often fatal encephalitis in sheep and causing occasional natural disease in horses, humans, pigs and cattle. It is transmitted by the tick Ixodes ricinus. It is found only in the UK and has been isolated from a roe deer and there is serological evidence of infection in red, roe and sika deer (Seymour and Yuill, 1981). Experimental infections in red and roe deer suggest that these species are unlikely to have a significant role in the ecology of louping-ill virus because the plasma titres were too low to infect the tick vector (Reid et al., 1982). It is probably unlikely that we have a suitable anthropod vector. However, imported deer should be seronegative and have no clinical evidence of disease.

Spongiform encephalopathy (Chronic wasting disease) is listed under "virus diseases" although the aetiology is not known. It has occurred in parts of North America in mule, black-tailed, mule X white-tailed hybrid deer and wapiti. The lesions in the CNS are "qualitatively comparable to other spongiform encephalopathies of animals (scrapie, transmissible mink encephalopathy) and man (Kuru, Creutzfeld-Jakob disease)" (Williams and Young, 1982). The clinical course of the disease lasted 1 to 6 months and was characterised by nervousness, hyperexcitability, changes in behaviour toward handlers, and progressive weight loss leading to emaciation.

Deer should not be imported from areas or herds where this disease has occurred. There is no test available.

RICKETTSIAL DISEASES

Rocky Mountain Spotted Fever is due to a tick-borne infection of wildlife in North America which causes acute severe disease in humans characterised by fever and a macular rash on wrists and ankles and influenza-like symptoms. Serological evidence of infection has been found in white-tailed deer. Dermacentor, Amblyomma, Rhipicephalus, Haemaphysalis, Otobius and Ixodes spp are either known or presumed to be vectors.

It is possible that the New Zealand tick Haemaphysalis longicornis may act as a vector if infection was introduced.

Deer should not be imported from areas where this disease occurs.

Q-fever is caused by Coxiella burneti and infections are present in a wide range of wildlife and domesticated animals in most parts of the world. It is transmitted by close direct contact and a wide range of insect vectors. Infections in deer have been demonstrated in Europe and North America (Bell, 1981) but infections in animals are usually mild and often inapparent. The disease in humans is characterised by fever, influenza-like symptoms and pneumonia. Cases are usually mild and fatalities rare although intractable endocarditis can result. Tetracyclines and chloramphenicol are used to treat human cases.

Currently deer are tested by CFT for Q-fever on entry to quarantine in Canada and the UK. However, the test is not particularly sensitive and therefore treatment with tetracyclines should be considered.

Tick-borne fever (TBF) (Erlichiosis pasture fever): The agents of TBF are Erlichia sp (and related organisms) which commonly affect dogs, horses, cattle, sheep, deer and other wildlife in UK, Europe, Africa and Asia. Infection is transmitted by ticks (Ixodes sp, Hyalomma sp, and Rhipicephalus sp). Infections in animals are usually subclinical or mild, with tetracyclines speeding recovery (Bell, 1981).

Imported deer should have blood smears examined using Giemsa stains and/or fluorescent antibody. Treatment with tetracycline should be considered at the end of quarantine.

BACTERIAL DISEASES

Anthrax (Bacillus anthracis) is an infectious, febrile disease characterised in animals by sudden onset and rapidly fatal course, exudation of tarry blood from body orifices, enlargement of the spleen and gelatinous infiltrations of the subcutaneous and subserous tissues. It has a universal geographical distribution. In Europe it still causes deaths in wild animals including red, fallow and roe deer, moose, wild boar, badgers and hares (Choquette and Broughton, 1981).

The incubation period is from hours to several days. Therefore a four week period of quarantine for imported stock should prevent the shipment of infected animals.

Brucellosis (Brucella suis) type 4 infections have been described in caribou, reindeer and moose in Alaska, Canada, northern Europe and USSR. They cause reproductive failure and affected animals often develop swollen lower limb joints. Experimental infections in cattle and sheep suggest that this agent may not represent a threat to domestic livestock (Tessaro, 1986). If the importation of these deer species was contemplated then stringent testing would be required.

Brucella abortus infections are endemic in some North American elk herds and bison herds (Thorne et al., 1978; Tessaro, 1986). Infections in European and UK deer have been described but are probably rare (Witter, 1981). All imported deer should be from herds free of clinical brucellosis and be negative to individual tests.

Lyme Disease is caused by a spirochaete, Borrelia burgdorferi and is transmitted by ticks (Ixodes sp). Infection is carried by a variety of wildlife including deer. In America, Europe and the UK small mammals and passerine birds are the principle reservoirs of infection, and deer may serve as amplification hosts, allowing tick numbers to increase and become more widespread (Muhlemann and Wright, 1987). Human cases are associated with a history of tick bite and recreational activities in wooded or forested areas, or contact with dogs carrying ticks. The human disease is characterised by initial rash, fever, chills, headache and backache. The disease progresses to a second phase of worse headaches, inability to concentrate and sometimes facial nerve paralysis and/or severe meningitis. A third stage may develop with the onset of arthritis anything up to two years after the bite (Long, 1987). There has been a recent dramatic rise in cases in the USA. It is now the most frequently diagnosed tick transmitted illness in the USA. The disease is now found in the UK, throughout Europe and it has been recorded in USSR, Australia, Japan, China and Africa. Because its symptoms are severe the disease has elicited much interest over the 12 years since it was first described (Long, 1987).

Although we do not have Ixodes sp in New Zealand we should try to avoid importing deer infected with this bacteria. All deer for importation should have blood smears examined by direct immunoflourescence (Lane & Burgdorfer, 1986). It appears that broad spectrum antibiotics including tetracyclines control the infection and therefore consideration should be given to treating all imported deer.

Tularaemia is caused by Francisella tularensis, it is primarily a plague-like disease of wild lagomorphs and rodents. It is transmitted by a wide variety of ectoparasites, by direct contact with infected animals and contact with environmental contamination. The disease occurs in Europe and Asia while serological evidence of infection in deer has been demonstrated in mule and white-tailed deer in North America. It has not been demonstrated in UK or Australia. A human case of tularaemia was associated with dressing a mule deer carcass in USA (Emmons et al., 1976).

Tularaemia in man is characterised by sudden onset of chills and fever, swollen lymph nodes and lung involvement. Infection responds to streptomycin and tetracyclines.

All imported deer from infected countries should be tested (agglutination test) and treated with tetracyclines.

Campylobacter hyointestinalis: There is one report in the literature of infection with this organism in Moluccan rusa deer on two farms in south-east Queensland causing ileitis and persistent diarrhoea with chronic wasting. The significance of this disease is not known. Only clinically healthy deer should be imported.

PROTOZOAL DISEASES

Various blood-borne protozoal infections have been demonstrated in deer in most parts of the world.

Anaplasmosis: Anaplasma marginale is a widely distributed parasite of ruminants found in most parts of Africa, southern Europe, USSR, Asia, Middle East, Australia, North and South America. Infections in black-tailed, mule and white-tailed deer have been described in North America (Howe, 1981). Experimental infection has been reported in rusa (Owen, 1985) and the organism in deer remains infective for cattle although the parasitaemia in rusa is very low (1%) compared with 4 to 80% in black-tailed and mule deer which are probably natural hosts.

Natural transmission is by various biting insects, including flies, mosquitoes and a wide range of ticks, especially Dermacentor spp, Boophilus spp and Haemaphysalis spp. Hypodermic needles contaminated recently with blood may also transmit infection.

Infected deer do not usually show signs of disease, unlike cattle which usually develop anaemia and up to 50% mortality. Diagnosis depends on the demonstration of anaplasma bodies in the red blood cells in a smear, and various agglutination tests of varying sensitivity and specificity have been developed (Lowe, 1981). Intravenous tetracycline in combination with dithiosemicarbazone given twice at 24 or 48 hour intervals has been shown to eliminate A. marginale from splenectomised calves.

Babesiosis: Babesia spp have been recorded in red deer in Austria (Hinaidy, 1987) and there is serological evidence of infection in Scottish red deer (Blaxter et al., 1974). B. bovis which occurs in southern Europe, Middle East and Asia has been reported in roe and red deer. Enigh and Friedhoff (1962) transmitted B. divergens to splenectomised red, fallow and roe deer. The authors considered that wild deer may serve as natural reservoirs for B. divergens which occurs in northern Europe. Enigh and Friedhoff (1962) also discovered a new species, B. capreoli of roe deer which was apparently not transmissible to sheep or cattle. B. bigeminia, which may be infective for white-tailed deer, is found in Central and South America, Africa, Australia and southern Europe.

The vectors for Babesia sp include Ixodes, Boophilus, Rhipicephalus and Haemaphysalis spp.

Babesiosis infection in deer is usually subclinical although acute fatal cases have been observed in roe deer and Pere David's deer (Hinaidy, 1987). However deer may act as reservoirs of infection for cattle which may show severe haemoglobinuria, anaemia and emaciation and may die. B. divergens and B. bovis are less severe than B. bigemina in cattle (Soulsby, 1968).

It is possible that the only tick in New Zealand, Haemaphysalis longicornus, is not suitable as a host for Babesia. Nevertheless, infected animals should not be imported.

All imported deer should have a number of blood smears examined for the presence of Babesia sp. A complement fixation test could also be used. Routine treatment of all deer may also be considered.

Theileriosis: (Theileria cervi) is found endemically in white-tailed deer in North America. It cannot be transmitted experimentally to sheep, cattle (Soulsby, 1968) or fallow deer (Kocan et al., 1987). Theileria spp have also been identified in fallow, red and roe deer in Austria (Hinaidy, 1987) and probably occur in most European deer although the host specificity of these species is unknown. Theileria organisms have been reported in rusa deer in New Guinea (Owen, 1985). Infections appear to be subclinical, and are transmitted by ticks commonly affecting deer in Europe, but which are not present in New Zealand. It is probably unimportant.

Trypanosomiasis: Infectionswith Trypanosoma spp have been reported in Polish red deer and moose (Kingston et al., 1985), fallow, roe and red deer in Germany (Friedhoff et al., 1984; Hoffmann et al., 1984), and all species of cervids in North America (Kingston et al., 1982). The identities, host specificities and cycles of infection are not known for all these species.

T. evansi occurs in the Middle East, Asia, South East Asia and Central and South America, and infects a wide range of hosts including deer causing the disease, Surra (Soulsby, 1968). Transmission is by biting flies with severe disease occuring in horses, camels, elephants and domestic livestock.

The Trypanosoma spp occurring in Europe appear to be relatively benign but efforts should be made to exclude infected animals from shipments to New Zealand until more is known about them. Effective treatment should be investigated. Deer should not be imported from areas where T. evansi occurs.

Eperythrozoonosis: Naturally occurring latent infections have been described in black-tailed, white-tailed, mule deer and elk in North America (Howe, 1981). It is thought to be transmitted mechanically by anthropod vectors. Contaminated needles may transmit disease. Infections, generally subclinical, are probably unimportant. Suitable vectors are probably present in New Zealand (as transmission occurs with E. ovis in sheep).

Besnoitia: These protozoa closely resemble Sarcocystis spp and utilise two hosts: a carnivorous host in which sexual reproduction occurs and an intermediate host prey in which asexual reproduction occurs. B. tarandi occurs in reindeer and caribou in Alaska and Canada and causes bones and tendons to become roughened (Dau, 1981). This disease is probably of no importance to New Zealand unless reindeer or caribou are imported.

Eimeria: A new species of coccidia (Eimeriidae) occurring in epididymal semen in elk in Canada was described recently (Hrudka et al., 1983). Its significance is not known. Semen imported into this country should be certified free of protozoa.

ENDOPARASITES

Nematodes: There are a variety of exotic nematodes which infect deer in other countries (see Table II). They include:

a) Nematodes in the family PROTOSTRONGYLIDAE which involve either the lung or CNS and are found in Europe, Australia and North America (Soulsby, 1968). Treatment of this family may be difficult because Muellerius and Elaphostrongylus, which are in this family and are present in New Zealand , are not very susceptible to anthelmintics such as benzimidazoles and ivermectin. Thus eliminating these nematodes from imported deer may be impossible and therefore, all imported deer should be tested specifically for these species.

   Elaphostrongylus cervi also occurs in red, fallow and roe deer in Europe and wapiti in North America. Although it occurs in New Zealand it would be sensible to ensure all imported deer are free of it.

b) Nematodes in the family FILARIIDAE, whose larval forms are microfilariae, are transmitted by biting mosquitoes, fleas, flies. This group includes Elaephora, Wehrdikmansia and Onchocerca spp whose adult forms occupy blood vessels or subcutaneous sites (Soulsby, 1968). They may result in damage to hides or blemishes to subcutaneous tissue on carcasses. There is often pruritis associated with the lesions. They are commonly found in deer throughout the world. Intermediate hosts are not always known. Treatment with ivermectin is probably effective, especially against the microfilaria, as it is used successfully for human onchocerciasis.

c) Nematodes in the TRICHOSTRONGYLIDAE family including Marshallegia, Nematodirus and Haemonchus spp have been reported in wapiti, red and fallow deer in Europe and North America (Soulsby, 1968).

d) Setaria spp occur in the peritoneal cavity of deer in Europe, USSR and North America. No clinical signs have been ascribed to infection with this parasite but fibrous lesions in the abdominal cavity are often seen post mortem. Erratic migrations involving occlusion of the oviduct in a cow have been reported (Soulsby, 1968). The significance of infection and effective treatment should be investigated.

e) Gongylonema spp are present in deer and other animals in Asia and North America. The adults inhabit the wall of the oesophagus or rumen but the significance and effective treatment are not known.

Trematodes - There are a number of exotic trematodes found in deer overseas. Fascioloides magna is present at high endemic levels in North America and Europe and has a life-cycle similar to Fasciola hepatica. It has been reported in wapiti, red, white-tailed, black-tailed, fallow and sambar deer and moose (Soulsby, 1968). It causes fibrous cysts in the liver. Bovidae may be unsuitable hosts for this parasite which fails to reach maturity. However, sheep, which are also unnatural hosts, may suffer severe liver lesions.

Fasciolicidal drugs are probably effective. In USA deer movements are controlled where they share grazing with domestic livestock.

It is important that this parasite is not introduced into New Zealand.

Dicrocoelium dendriticum: Occurs in the bile ducts of a variety of livestock and wildlife including deer in North America and Europe. The intermediate hosts are both snails and Formica ants.

Benzimidazoles and/or other fasciolicidal drugs may be effective against this parasite.

Parafasciolopsis fasciolaemorpha: This parasite is found in the bile duct and small intestine of deer in eastern Europe and USSR. The intermediate host is Planorbis corneus found in swamps and the parasite is unlikely to be important in New Zealand. Fasciolicidal drugs are probably effective.

Cestodes: There are number of exotic cestodes of deer (see Table II) but most of them are probably of little significance with respect to deer imported into New Zealand.

E C T O P A R A S I T E S

New Zealand is fortunate that we do not have many of the serious deer ectoparasites including warbles, nasal bots, keds, ticks (Ixodes, Dermacentor, Otobius, Boophilus spp), head flies, etc. (see Table III).

It is important that deer are thoroughly treated on a number of occasions with ectoparasiticides which are effective against all these ectoparasites.

A combination of ivermectin orally and topical application of Coumaphos administered during quarantine overseas and on at least two occasions, three weeks apart in New Zealand quarantine is probably sufficient.

O T H E R D I S E A S E A G E N T S

In addition to the exotic disease agents above, there are a number of diseases present in New Zealand of which there are exotic strains which affect deer overseas. It is important that these strains are not introduced into New Zealand. They include some Mycobacteria and Pasturella.

Mycobacterium paratuberculosis (Johnes disease): In the last three years there has been a serious outbreak of Johnes disease involving yearling red deer in Scotland. This appears to be a particularly virulent strain adapted to deer (H. Reid, pers. comm).

Mycobacterium avium (Avian TB): A number of cases of generalised TB have occurred in red deer in the UK (H. Reid, pers. comm). Such cases are rare in red deer in New Zealand and it is likely that these are different strains.

Pasteurella multocida: Epidemics of haemorrhagic septicaemia, swollen head and neck and sudden death have occurred in fallow deer herds in the UK, associated with P. multocida serogroup B, somatic serotypes 3 and 4 organisms (Jones & Hussaini, 1982; Rimler et al., 1987). Kummeneje (1980) reported epidemics of P. multocida causing acute pneumonia in reindeer calves in late winter/spring.

Deer should not be imported from herds which have suffered clinical disease associated with M. paratuberculosis, Mavium or P. multocida.

IMPORT PROTOCOLS

On an international level most countries report serious disease outbreaks immediately and animal health statistics annually according to the International Zoo-Sanitary Code (1986) which has 3 disease lists:

List A - highly communicable diseases of major international importance, eg, F&M, Rinderpest, etc.
List B - communicable diseases of importance within countries and which are significant in the international trade of livestock, eg, Anthrax, leptospirosis, brucellosis, tuberculosis, etc.
List C - communicable diseases of importance at individual production level, eg, Clostridial diseases, Malignant catarrh, BVD, Warble infestation, caseous lymphadinitis, etc.

(see Appendix I)

Most import/export protocols incorporate safeguards against these listed conditions which largely relate to domestic livestock. One of the major problems faced by regulatory authorities drawing up protocols for the movement of deer is that there have been no agreed lists of diseases or standards laid down. Obviously it is only possible to draw up regulations for known diseases. However, the complete disease status of most wild and park deer populations is unknown, and because deer have been farmed for such a short time knowledge of their diseases is still accumulating. Consequently it is necessary to periodically update the protocols in the light of new information.

It is important to understand the aetiology and epidemiology of diseases before we can reasonably assess risk and apply testing or treatment strategies. Because of the seriousness of List A and B diseases a conservative approach has usually been applied where there is insufficient knowledge to exclude the risk of imported deer carrying these disease agents. For example the protocol for importation of deer from UK to New Zealand requires that there be no clinical evidence of scrapie in the herd of origin although there is no evidence that deer carry this disease.

Most countries that we deal with have a well established veterinary infrastructure and some degree of animal disease surveillance (although this is mostly for diseases of domestic livestock) and this allows them to certify the disease status of their country or districts as free from List A, B and C diseases. Thus most protocols have three levels of disease clearance:

a) Country free of particular diseases (usually List A)
b) District/premises and/or herd is free of particular diseases (usually List B)
c) The animal is tested for a various specific disease agents (List A, B and C). In addition the animal usually requires treatment with specified anthelmintics, ectoparasiticides and antibiotics.

The International Zoo-Sanitary Code sets out rules recommended for trade in animals and animal products. These detail the standards of certification of freedom of disease (above A, B, C), standards for testing of individuals for various diseases, and standards for transport, disinfection and sanitary measures. Unfortunately there are no recommendations relating to deer diseases but the general procedures are applicable to deer importation.

Unfortunately, the whole system has the potential for abuse or error because there is a lot taken on trust. The certification of properties or districts for freedom of disease is particularly crucial and yet dishonesty, lack of care or ignorance could easily lead to false certification. This situation could occur in New Zealand also where, for example, Johnes disease probably occurs in many sheep flocks where it has not been officially diagnosed or reported. An official who is unaware of this could certify the farm as free of Johnes.

There is some evidence that some tests have been poorly or incorrectly carried out overseas (eg, TB testing in deer) and some anecdotal stories of questionable certificates. One area of concern is the origin of animals being imported into New Zealand from Canada. A certificate is required, stating that "the animals must have been born and lived continuously in Canada". It is common knowledge that a number of elk have been imported from USA to Canada and some of these are likely to have been exported to New Zealand. Therefore there is the serious question as to who has the responsibility to check up on these certificates. If we suspect false certification will anything be done about it?

BREAKDOWNS IN THE SYSTEM TO DATE

So far there have not been any List A diseases introduced into New Zealand associated with deer importation. However, there have been a number of potentially serious agents that have come to New Zealand. On two occasions winter ticks (Dermacentor albipictus) have been found on wapiti in quarantine in New Zealand following importation from Canada (Heath, 1986). The wapiti were treated in Canada with Famphur which appears to be ineffective against this tick. Subsequent treatment in New Zealand with Coumaphos appears to have been effective.

TB testing of deer in New Zealand quarantine has resulted in a large number of reactors and two strains of M. bovis and a number of M. avium strains have been isolated from these animals. It is disturbing that these cases have got as far as New Zealand quarantine despite two TB tests prior to shipment. It is hoped that there have been no animals which were false negative to all the TB skin tests. In future it would be desirable to have all imported animals subjected to a Blood test for TB (BTB) in addition to the routine skin test, in order to improve the chances of detecting false negatives to the skin test.

One of the problems with skin testing for TB is that other countries have different standards for reading the test. Even now, despite recommendations from New Zealand MAF personnel, the UK MAFF protocol for deer imported from Hungary to the UK states that a positive to the TB skin test is "a greater than 2 mm difference or any oedematous reaction". Experience in New Zealand has shown that any visible or palpable reaction should be classed as positive.

An outbreak of acute exudative pneumonia occurred in a group of red and fallow deer in New Zealand quarantine within a few days of arrival from the UK. Streptococcus zooepidemicus was isolated in pure culture from one of these animals and the pneumonic lesions were associated with large numbers

of bacterial cocci. Deer from Denmark accompanied the UK deer but none for the former were affected. One can speculate that the organism was introduced by the imported deer. It may even have been carried by the Danish deer which were unaffected.

These examples all demonstrate the importance of quarantine in New Zealand after arrival.

A post mortem examination of an imported Canadian wapiti that died soon after release from quarantine in 1982 incidentally disclosed nasal bots in the naso-pharynx. They were identified as Cephenimya trompe and had survived treatment with "pour-on" organophosphate compounds intended to eliminate ectoparasites, warbles and nasal bots. Other wapiti in that shipment were traced to their farm destinations and treated with ivermectin. Subsequently all imported deer have been treated with Ivomec in their country of origin and in New Zealand quarantine.

A worrying feature of all these cases is the thought that cases of these and other diseases have escaped detection to date, or have not been reported.

There are a number of parasites, eg, Setaria, Onchocerca, Trypanosoma spp etc, which have not been tested for and which may have already been introduced.

UPDATING OF CURRENT IMPORT PROTOCOLS

In the light of the information gathered for this review I believe the current import protocols of live deer from the UK and Canada should be reviewed to take account of the following points:

1. Aujeszky's Disease, Rabies, Anthrax, Avian Tuberculosis, Haemorrhagic Septicaemia (due to Pasteurella multocida), Q-fever, Tick-borne fever or Rocky Mountain spotted fever, Lyme Disease, Tularaemia, IBR and CHV.1 should be included in the clause requiring "no clinical or pathological evidence" on the property of origin for the last 12 months.

   None of these are currently listed.

2. Brucella suis type 4 should be tested for as well as Brucella abortus in all deer from Canada, Alaska and Scandinavia.

3. The Agar Gel Immuno-Diffusion (AGID) test appears to be more sensitive for Johnes Disease in deer (A. Gregg, pers. comm) and should therefore be used instead of, or in addition to, the CFT.

4. The Canadian protocol should include a fluorescent antibody test for Babesia spp (the UK protocol already requires this).

5. Protocols should either test and exclude deer positive for all blood borne protozoa (Anaplasma, Babesia, Eperythrozoa, Theileria and Trypansoma spp) or should institute routine treatment effective against the relevant organism(s). Information about the appropriateness of tests and drug efficacy would have to be supplied by the authorities in the exporting countries.

6. Protocols for deer importation from Canada should require two treatments, 14 days apart, with a recognised flukicide to eliminate Fasciola hepatica and Fascioloides magna.

7. All deer should be treated with tetracyclines for 4 days (4 daily injections with a short-acting or 2 injections 48 hours apart with a long-acting oxytetracycline 20 mg/kg) just prior to embarkation, in order to eliminate rickettsial (Q-fever) and bacterial (Lyme disease, Tularaemia, Campylobacter, Yersinia, Pasteurella) infections. It may also have some efficacy against some blood borne protozoa.

8. Exporting countries should supply information on the efficacy of currently used anthelmintics and ectoparasiticides against the parasites listed in Tables 2 and 3, especially nematodes in the PROTOSTRONGYLIDAE and FILARIIDAE families. If there is no effective treatment for any of these parasites then they should be specifically tested for and affected animals excluded.

Embryos and Semen

Recent advances in superovulation of deer, embryo recovery, semen collection, embryo and semen freezing, will make the importation of frozen deer embryos and semen a very practical alternative to live deer. Not only should it be cheaper and simpler but it will also reduce or eliminate many of the disease risks. An intact zona pellucida surrounding the embryo is an effective barrier against a number of important disease organisms. Appropriate washing procedures have been devised using enzymes and antisera to remove certain viruses from bovine, ovine and porcine embryos. However, some viruses enter pores and sperm tracks in the zona and resist removal (Shelton, 1987). Also, none of these procedures have been verified for deer embryos and it is dangerous to assume that they will work for all species. Therefore, each virus of interest should be tested to determine whether it can be transmitted by washed deer embryos. Nevertheless, as long as normal quarantine procedures relating to List A and B disease agents are fulfilled for donor deer in their country of origin there is no greater risk with importing frozen embryos, and in fact the risk is almost certainly reduced by standard washing procedures. In addition, a period of monitoring of the donor animals after embryo recovery or semen collection should ensure that they were not incubating any diseases at the time of collection. This is especially relevant for virus infections with long incubation periods such as rabies. If deer embryos are recovered in the northern hemisphere during their natural breeding seasons the frozen embryos or semen could simply be held for six months before implantation or insemination during our breeding season, easily allowing post collection monitoring of donor animals.

Frozen semen cannot be washed in the same way as embryos and it carries greater risk of transmitting diseases, eg, IBR has been shown to survive well in frozen bovine semen (Drew et al., 1987). However, it carries no greater risk with respect to List A and B diseases as long as similar testing and quarantine standards apply.

The biggest advantages of embryo and semen importation are the elimination of parasite transmission, the reduction in risk associated with many bacteria, and the dramatically reduced transport costs. The Import

Protocols for embryos and semen should therefore be similar to those for live deer with regard to viral, bacterial and rickettsial diseases but less stringent for parasite diseases.

CONCLUSIONS

If deer and deer embryos and semen are to continue to be imported into New Zealand it is necessary that high standards of disease surveillance, certification, testing and treatment are carried out. In the absence of information on specific diseases a conservative approach must be taken. Consequently there should be some record kept of their movement within New Zealand after release from quarantine for a period of about 12 months to ensure that retrospective testing, treatment or slaughter can be carried out if necessary.

Import protocols should be routinely reviewed in order to cope with changing circumstances, new information of disease occurrence overseas, recent research findings, new emerging diseaes, new tests and new treatments.

Protocols for deer importation should go beyond the standard International Zoo-Sanitary Code, which deals with common diseases of domestic livestock and zoonoses, and ensure the continued safety of our farmed deer population which is around $\frac{1}{2}$ million and should be 1 million by 1991. We have a responsibility to ensure that our deer are free from serious diseases so that deer farming can be maintained as a viable enterprise. There is also a big potential in the future for the export of live deer, embryos and semen from New Zealand and the absence of serious diseases will facilitate this.

REFERENCES

Bell, J.F. (1981): Q. fever; Tick-borne fever and rickettsial pox.
In Infectious diseases of wild mammals. Second edition.
Eds J.W. Davis, L.H. Karstad, D.O. Trainer. Iowa State Uni. Press. USA pp 388-402.

Blaxter, K.L.; Kay, R.N.B.; Sharman, G.A.M.; Cunningham, J.M.M.; Hamilton, W.J. (1974): Chapter 10: Health.
In Farming the red deer.
Dept. Ag & Fish Scotland, HMSO. pp 70-76.

Choquette, L.P.E.; Boughton, E. (1981): Anthrax.
In Infectious diseases of wild mammals. Second edition.
Eds J.W. Davis, L.H. Karstad, D.O. Trainer. Iowa State Uni. Press. USA pp 288-296

Dan, J. (1981): Besnoitia
In Alaskan Wildlife Diseases
Ed R.A. Dieterich. Inst. Arctic Bio., Uni. of Alaska, Fairbanks, Alaska. p 178.

Dieterich, R.A. (1980): Current status of reindeer/caribou diseases in Alaska.
In Proc. Second Int. Reindeer/Caribou Symp., Roros, Norway, 1979.
Ed E. Reimers, E. Gaare and S. Skjenneberg. pp 438-441.

Drew, T.W.; Hewitt-Taylor, C.; Watson, L.; Edwards, S. (1987): Effect of storage conditions and culture technique on the isolation of infectious bovine rhinotracheitis virus from bovine semen.
Vet. Rec. 121: 547-548.

Ek-Kommonen, C.; Veijalainen, P.; Rantala, M.; Neuvonen, E. (1982): Neutralising antibodies to BVH-1 in reindeer.
Acta vet. Scand 23: 565-569.

Emmons, R.W.; Ruskon, J.; Bisset, M.L.; Uyeda, D.A.; Wood, R.M.; Lear, C.L. (1976): Tularaemia in a mule deer. J. Wildl.Dis. 12: 459-463.

Enigk, K.; Friedhoff, K. (1962): The host specificity of Babesia divergens.
Z. f. Parasitenkunde 21: 238-256.

Forman, A.J.; Gibbs, E.P.J.; Baber, D.J.; Herniman, K.A.J.; Barnett, I.T. (1974): Studies with FMD virus in British Deer (red, fallow and roe) II Recovery of virus and serological response.
J. Comp. Path 84: 221-229.

Friedhoff et al. (1984): Zbl. Bakt. Hyg A 256: 286-287. (cited by Kingston et al., 1985).

Gibbs, E.P.J. (1981): Persistent viral infections of food animals : their relevances to the international movement of livestock and germ plasma.
Advances in Veterinary Science and Comparative Medicine 25: 71-100.

Heath, A.C.G. (1986): Failure of famphur treatment of wapiti (Cervus canadensis) to affect egg laying and embryogenesis in the winter tick, Dermacentor albipictus.
N.Z. Vet. J. 34: 176.

Hedger, R.S. (1981): Foot and mouth disease.
In Infectious Diseases of Wild Mammals. Second edition.
Ed J.W. Davis, L.H. Karstad, D.O. Trainer. Iowa State Uni. Press., USA. pp 87-96.

Hinaidy, H.K. (1987): Blood parasites of wildliving ruminants in Austria.
J. Vet. Med. B. 34: 81-97.

Hoff, G.L.; Trainer, D.O. (1981): Hemorrhagic diseases of wild ruminants.
In Infectious diseases of wild mammals. Second Edition.
Ed J.W. Davis, L.H. Karstad, D.O. Trainer. Iowa State Uni. Press. pp 45-53.

Hoffmann, M.; Buscher, G.; Friedhoff, K.T. (1984): Stercorarian trypanosomas from deer (Cervidae) in Germany.
J. Protozool 31: 581-584.

Howe, D.L. (1981): Anaplasmosis.
In Infectious diseases of wild mammals. Second edition.
Eds J.W. Davis, L.H. Karstad, D.O. Trainer. Iowa State Uni. Press. USA pp 407-414.

Howe, D.L. (1981): Eperythrozoonosis.
In Infectious diseases of wild mammals. Second edition.
Eds J.W. Davis, L.H. Karstad, D.O. Trainer. Iowa State Uni. Press. USA pp 415-417.

Hrudka, F.; Cawthorn, R.J.; Haigh, J.C. (1985): The occurrence of coccidia (Eimeriidae) in epididymal semen of a wapiti (Cervus canadensis nelsoni)
Can. J. Zool. 61: 1693-1699.

International Zoo-Sanitary Code (1986): Fifth Edition Office International des Epizooties
12, rue de Prony - 75017 Paris, France.

Jones, R.H.; Luedke, A.J.; Walton, T.E.; Metcalf, H.E. (1981): Bluetongue in the United States.
World Animal Review 38: 2-8.

Jones, T.O.; Hussaini, S.N. (1982): Outbreak of Pasteurella multocida septicaemia in fallow deer (Dama dama).
Vet. Rec. 110: 451-2.

Kingston, N.; Drozdz, J.; Rutkowska, M. (1985): Trypanosoma sp. in red deer (C. elaphus) and elk (Alces alces) in Poland.
Proc. Helminthol. Soc. Wash. 52: 144-145.

Kingston, Morton and Dieterich (1982), J. Protozool 29: 588-591. (cited by Kingston et al., 1985).

Kocan, A.A.; Mukolwe, S.W.; Laird, J.S. (1987): Failure to detect infection in fallow deer (Cervus dama) exposed to Theileria cervi from white-tailed deer.
J. Wildl. Dis. 23: 674-676.

Kummeneje, K. (1980): Diseaes of reindeer in northern Norway.
In Proc. Second Int. Reindeer/Caribou Symp., Roros, Norway 1979.
Direktoret for vilt og ferskvannsfisk. Trondheim. pp 456-458.

Lane, R.S.; Burgdorfer, W. (1986): Potential role of native and exotic deer and their associated ticks (Acari : Ixodidae) in the ecology of Lyme Disease in California, USA.
Zbl. Bakt. Hyg. A. 263: 55-64.

Lawman, M.J.P.; Evans, D.; Gibbs, E.P.J.; McDiarmid, A.; Rowe, L. (1978): A preliminary survey of British deer for antibody to some virus diseases of farm animals.
Brit. Vet. J. 134: 85-91.

Long, G. (1987): Lyme disease : some facts and implications.
Deer 7: 186-187.

McAllum, H. (1981): Exotic Diseaes.
Proceedings of a deer seminar for veterinarians, Deer Advisory Panel NZVA. Queenstown, N.Z. pp 152-156.

McDiarmid, A. (1980): Threatened deer : disease implications, field work and management.
Deer 5: 14-21.

Muhlemann, M.F.; Wright, D.J.M. (1987): Emerging pattern of Lyme disease in the UK and Irish republic.
The Lancet 8527: 260-262.

Owen, I.L. (1985): Cattle blood parasites and rusa deer (Cervus timorensis).
Aust. Vet. J. 62: 428-429.

Reid, H.W.; Buxton, D.; Pow, I.; Finlayson, J. (1982): Experimental louping-ill virus infection in two species of British deer.
Vet. Rec. 111: 61.

Reid, H.W.; Nettleton, P.F.; Pow, J.; Sinclair, J.A. (1986): Experimental infection of red deer (C. elaphus) and cattle with a herpesvirus isolated from red deer.
Vet. Rec. 118: 156-8.

Rimler, R.B.; Rhoades, K.R.; Jones, T.O. (1987): Serological and immunological study of Pasteurella multocida strains that produced septicaemia in fallow deer.
Vet. Rec. 110: 300-301.

Seymour, C.; Yuill, T.M. (1981): Arboviruses.
In: Infectious Diseases of Wild Mammals. Second edition.
Eds: J.W. Davis, L.H. Karstad and D.O. Trainer. Iowa State Uni. Press, USA. pp 54-86.

Shelton, J.N. (1987): Prospects for the use of embryos in the control of diseases and the transport of genotypes.
Aust. Vet. J. 64: 6-10.

Soulsby, E.J.L. (1968): Helminths, arthropods and protozoa of domesticated animals. (Sixth Ed. of Monnigs Vet. Helminthology and Entomology). Balliere Tindall and Cassell, London.

Sundberg, J.P.; Nielsen, S.W. (1981): Deer fibroma : a review. Can. vet. J. 22: 385-388.

Tessara, S.V. (1986): The existing and potential importance of brucellosis and tuberculosis in Canadian wildlife: a review. Can. Vet. J. 27: 119-124.

Thorne, E.T.; Morton, J.K.; Thomas, G.M. (1978): Brucellosis in elk : I Serologic and bacteriologic surveys in Wyoming. J. Wildl. Dis 14: 74-81.

Williams, E.S.; Young, S. (1980): Spongiform encephalopathy of Rocky Mountain Elk. J. Wildl. Dis 18: 465-471.

Witter, J.F. (1981): Brucellosis. In Infectious diseases of wild mammals. Second edition. Eds J.W. Davis, L.H. Karstad, D.O. Trainer. Iowa State Uni. Press. USA pp 280-287.

TABLE I: Exotic* diseases of deer : Viral, Rickettsial, Bacterial, Protozoal

	Vector-borne	*Breeds of Deer*													*Regions*					
		Red	Wap	Sik	Rus	Sam	Fal	Roe	Wld	Btd/ Mul	Rei/ Car	Moo	Axis	Mun	Nth Am	UK	Eur	Mid East	Asia	Afr
Viral																				
Aujeszky's (pseudorabies)	-	x	-	-	-	-	-	x	θ	-	-	-	-	-	x	-	x	x	x	x
Bluetongue/Epizootic Haemorrhagic Dis	x	-	x	-	-	-	(x)	-	x	x	(x)	(x)	-	x	x	-	-	-	-	x
Bovine herpes virus-1 (IBR)	-	(x)	-	-	-	-	-	-	-	-	(x)	-	-	-	(x)	(x)	(x)	-	-	-
Cervine herpes virus-1 (CHV)	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x	-	-	-
Foot and Mouth Disease	-	x	x	θ	x	x	x	x	x	x	x	θ	-	θ	[x]	-	-	-	-	-
Rabies**	-	[x]	-	-	-	-	-	-	x	-	x	x	-	-	x	[x]	x	x	x	x
Rinderpest	-	x	-	-	-	x	-	x	x	-	-	-	-	-	-	-	[x]	x	x	x
Skin papillomas & fibromas	-	x	-	x	-	-	x	x	x	x	x	x	-	-	x	x	x	-	-	-
Vesicular stomatitis**	-	-	-	-	-	-	-	-	x	-	-	-	-	-	x	-	-	-	-	-
Louping ill**	x	(x)	-	(x)	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-
Other arboviruses**	x	-	-	-	-	-	-	-	x	-	-	-	-	-	x	-	x	-	-	-
Spongiform encephalopathy	-	-	x	-	-	-	-	-	x	x	-	-	-	-	x	-	-	-	-	-
Rickettsial																				
Q fever** (*Coxiella burneti*)	x	-	-	-	-	-	-	-	x	x	-	-	-	-	x	x	x	x	x	x
Rocky Mountain Spotted Fever** (*Rickettsia rickettsia*)	-	-	-	-	-	-	-	-	(x)	-	-	-	-	-	x	-	-	-	-	-
Tick-borne fever** (*Erlichiosis*)	x	x	-	-	-	-	x	-	-	-	-	-	-	-	-	x	x	x	x	x
Bacterial																				
Anthrax** (*Bacillus anthracis*)	-	x	-	-	-	-	x	x	x	-	-	x	-	-	x	x	x	x	x	x
Brucellosis**	-	-	x	-	-	-	-	x	-	-	x	x	-	-	x	x	x	-	-	-
Lyme Disease** (*Borrelia burgdorferi*)	x	x	-	-	-	-	x	(x)	x	x	-	-	x	-	x	x	x	-	x	x
Tularaemia** (*Francisella tularensis*)	-	-	-	-	-	-	-	-	(x)	(x)	-	-	-	-	x	-	x	x	x	-
Campylobacter hyointestinalis	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
Protozoal																				
Anaplasmosis	x	x	θ	-	-	-	-	-	x	x	-	θ	-	-	x	-	x	x	x	x
Babesiosis	x	x	-	-	-	-	θ	x	x	-	x	-	-	-	x	x	x	x	x	x
Besnoitia sp (cysts in fibrous tissue & skin)	x	-	-	-	-	-	-	-	-	-	x	-	-	-	x	-	-	-	-	-
Eperythrozoonosis	x	-	x	-	-	-	-	-	-	x	x	-	-	-	x	-	-	-	-	-
Theileriosis	x	x	-	-	x	-	x	x	x						x	-	x	-	x	-
Trypanosomiasis	x	x	-	x	x	x	x	x	x	x	x	x	x	x	-	x	-	x	x	-
Epididymal coccidiosis (*Eimeria*)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Diseases for which there is no evidence for their presence in New Zealand, ** Zoonoses, x Confirmed, θ Experimentally infected, (x) Serological evidence, [x] Has occurred, - Not currently present, not diagnosed or no information

TABLE II: Exotic diseases of deer : Endoparasites

	Breeds of Deer													*Regions*					
	Red	Wap	Sik	Rus	Sam	Fal	Roe	Wtd	Btd/ Mul	Rei/ Car	Moo	Axis	Mun	Nth Am	UK	Eur	Aust	Asia	Afr
Nematodes																			
TRICHOSTRONGYLIDAE -																			
Marshallagia marshalli	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Nematodirus sp	x	x	-	-	-	x	-	-	-	-	-	-	-	x	-	x	-	-	-
Haemonchus similis	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
PROTOSTRONGYLIDAE -																			
Parelaphostrongylus sp (tissue/brain/blood vessels)		x	-	-	-	x	-	x	-	x	x	-	-	x	-	-	-	-	-
Protostrongylus macrotis (lungworm)	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Protostrongylus rufescens (lungworm)	x	x	-	-	-	-	-	-	-	-	-	-	-	x	-	x	x	-	x
Bicaulus sagittatus (lungworm)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
FILARIIDAE -																			
Elaeophora sp (blood vessels)	x	x	-	-	-	-	-	x	x	x	-	-	-	x	-	x	-	-	-
Wehrelikmansia sp } (subcutaneous	x	x	-	-	-	-	-	-	-	-	-	-	-	x	-	x	-	-	-
Onchocerca sp } fibrous lesions)	x	-	-	-	-	-	-	-	-	x	-	-	-	-	x	x	-	-	-
SETARIIDAE -																			
Setaria sp (peritoneal cavity)	x	x	-	-	-	-	-	-	-	x	x	-	-	x	-	x	-	x	-
THELAZIIDAE -																			
Gongylonema pulchrum (wall of oesophagus)	deer, species unknown													x	-	x	-	x	-
Gongylonema verrucosum (rumen)	deer, species unknown													x	-	-	-	x	-
Trematodes																			
Fascioloides magna (liver fluke)	x	x	-	-	-	x	-	x	x	-	x	-	-	x	-	x	-	-	-
Dicrocoelium dendriticum (bile ducts)	x	-	-	-	-	x	x	-	-	-	-	-	-	-	-	x	-	-	-
Parafasciolopsis fasciolaemorpha (bile duct, SI)	-	-	-	-	-	-	-	-	-	-	x	-	-	x	-	-	-	-	-
Paramphistomum sp (rumen flukes)	-	-	-	-	-	-	-	-	-	x	x	-	-	x	-	-	-	-	-
Cestodes																			
Thysanosoma actinioides (bile duct SI)	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Monieza sp	-	x	-	x	-	-	-	x	x	x	-	-	-	x	-	-	-	x	-
Cysticerrus tarandi (cyst in muscle)	-	x	-	-	-	-	-	-	-	x	-	-	-	x	-	-	-	-	-
(*Taenia krabbei* - tapeworm dogs)																			
Hydatids																			
(*Echinococcus granulosus borealis* -																			
tapeworm timber wolf)	-	x	-	-	-	-	-	x	x	-	x	-	-	x	-	-	-	-	-
(*E. granulosus canadensis* -																			
tapeworm dog)	-	-	-	-	-	-	-	-	-	x	-	-	-	x	-	-	-	-	-

x Reported, - Not present, not reported or no information

TABLE III: Exotic diseases of deer : Ectoparasites

	Breeds of Deer													*Regions*					
	Red	Wap	Sik	Rus	Sam	Fal	Roe	Wld	Bld/ Mul	Rei/ Car	Moo	Axis	Mun	Nth Am	UK	Eur	Aust	Asia	Afr
Warbles																			
Oedemagena sp	-	-	-	-	-	-	-	-	-	x	-	-	-	x	-	-	-	-	-
Hypoderma sp	x	-	-	-	-	x	x	-	-	-	-	-	-	-	x	x	-	-	-
Nasal bot																			
Cephenomyia sp	x	x	-	-	-	x	x	x	x	x	x	-	-	x	x	x	-	-	-
Pharyngomyia	x	-	-	-	-	x	x	-	-	-	-	-	-	-	-	x	-	-	-
Keds																			
Lipoptena cervi, L. depressa	x	x	x	-	-	-	-	-	-	-	-	-	-	x	x	x	-	-	-
Lice																			
Solenopotes sp	x	-	x	-	-	-	-	-	-	x	-	-	-	x	x	x	-	-	-
Damalinia sp	x	x	x	-	-	x	-	-	-	-	-	-	-	x	x	x	-	-	-
Bovicola sp	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Trichotipeurus sp	-	x	-	-	-	-	-	-	x	-	-	-	-	x	-	-	-	-	-
Ticks																			
Ixodes ricinus	x	-	x	-	-	x	-	-	-	-	-	-	-	-	x	x	-	-	-
Ixodes pacificus	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Dermacentor albipictus	-	x	-	-	-	-	-	x	x	-	-	-	-	x	-	-	-	-	-
Dermacentor andersoni	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Dermacentor occidentalis	-	-	-	-	-	-	-	-	x	-	-	-	-	x	-	-	-	-	-
Otobius megnini (ear tick)	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Mite																			
Psoroptes equi var *cervinae*	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-

x Reported, - Not present, not reported or no information

DISEASE CODE LIST *

LIST A DISEASES - DEFINITION : Communicable diseases which have the potential for very serious and rapid spread, irrespective of national borders, which are of serious socio-economic or public health consequence and which are of major importance in the international trade of livestock and livestock products. Reports are submitted to the O.I.E. as often as necessary to comply with Articles 1.2.0.2 and 1.2.0.3 of the International Zoo-Sanitary Code.

LIST B DISEASES - DEFINITION : Communicable diseases which are considered to be of socio-economic and/or public health importance within countries and which are significant in the international trade of livestock and livestock products. Reports are normally submitted once a year, although more frequent reporting may in some cases be necessary to comply with Articles 1.2.0.2 and 1.2.0.3.

LIST C DISEASES - DEFINITION : Communicable diseases with important economic influence at individual production level.

LIST A

A010 Foot-and-mouth disease (FMD)
A011 FMD - Virus O
A012 FMD - Virus A
A013 FMD - Virus C
A014 FMD - Virus SAT 1
A015 FMD - Virus SAT 2
A016 FMD - Virus SAT 3
A017 FMD - Virus Asia 1
A020 Vesicular stomatitis (VS)
A021 VS - Virus Indiana
A022 VS - Virus New Jersey
A030 Swine vesicular disease (SVD)
A040 Rinderpest
A050 Peste des petits ruminants
A060 Contagious bovine pleuropneumonia (CBPP)
A070 Lumpy skin disease
A080 Rift Valley fever (RVF)
A090 Bluetongue (BT)
A100 Sheep pox and goat pox
A110 African horse sickness (AHS)
A120 African swine fever (ASF)
A130 Hog cholera
A140 Teschen disease
A150 Fowl plague
A160 Newcastle disease (ND)
A161 ND - Velogenic Virus

LIST B

Multiple species diseases
B051 Anthrax
B052 Aujeszky's disease
B053 Echinococcocis/hydatidosis
B054 Filariasis
B055 Heartwater
B056 Leptospirosis
B057 Q fever
B058 Rabies
B059 Paratuberculosis

Cattle diseases
B101 Anaplasmosis
B102 Babesiosis
B103 Bovine brucellosis (B. abortus)
B104 Bovine genital campylobacteriosis
B105 Bovine tuberculosis
B106 Cysticercosis (C. bovis)
B107 Dermatophilosis
B108 Enzootic bovine leucosis
B109 Haemorrhagic septicaemia
B110 Infectious bovine rhinotracheitis (IBR/IPV)
B111 Theileriasis
B112 Trichomoniasis
B113 Trypanosomiasis (tsetse borne)

Sheep and goat diseases
B151 Brucella ovis infection
B152 Caprine and ovine brucellosis (B. melitensis)
B153 Caprine arthritis/encephalitis
B154 Contagious agalactia
B155 Contagious caprine pleuropneumonia
B156 Enzootic abortion of ewes

Sheep and goat diseases (cont'd)
B157 Pulmonary adenomatosis
B158 Nairobi sheep disease
B159 Salmonellosis (S. abortus ovis)
B160 Scrapie
B161 Maedi-Visna

Horse diseases
B201 Contagious equine metritis
B202 Dourine
B203 Epizootic lymphangitis
B204 Equine encephalomyelitis
B205 Equine infectious anaemia
B206 Equine influenza (Virus type A)
B207 Equine piroplasmosis
B208 Equine rhinopneumonitis
B209 Glanders
B210 Horse pox
B211 Infectious arteritis of horses
B212 Japanese encephalitis
B213 Mange
B214 Salmonellosis (S. abortus equi)
B215 Surra (includes pathogenic trypanosoma infections transmitted by insects other than tsetse fly)
B216 Venezuelan equine encephalomyelitis

Pig diseases
B251 Atrophic rhinitis
B252 Cysticercosis (C. cellulosae)
B253 Porcine brucellosis (B. suis)
B254 Transmissible gastroenteritis of pigs
B255 Trichinosis

Poultry diseases
B301 Avian infectious bronchitis
B302 Avian infectious laryngotracheitis
B303 Avian tuberculosis
B304 Duck hepatitis
B305 Duck virus enteritis
B306 Fowl cholera
B307 Fowl pox
B308 Fowl typhoid (S. gallinarum)
B309 Infectious bursal disease (Gumboro disease)
B310 Marek's disease
B311 Mycoplasmosis (M. gallisepticum)
B312 Psittacosis and ornithosis
B313 Pullorum disease (S. pullorum)

Rodent diseases
B351 Myxomatosis
B352 Tularemia

Fish diseases
B401 Haemorrhagic septicaemia of salmonids
B402 Infectious pancreatic necrosis in trout
B403 Myxosomiasis of salmonids
B404 Spring viraemia of carp

Bee diseases
B451 Acariasis of bees
B452 American foul brood
B453 European foul brood
B454 Nosemosis of bees
B455 Varroasis

Diseases of other animal species
B501 Leishmaniasis

LIST C

Multiple species diseases
C611 Listeriosis
C612 Toxoplasmosis
C613 Melioidosis
C614 Blackleg
C615 Botulism
C616 Other clostridial infections
C617 Other pasteurelloses
C618 Actinomycosis
C619 Intestinal Salmonella infections
C620 Coccidiosis
C621 Distomatosis (liver fluke)

Cattle diseases
C651 Bovine malignant catarrh
C652 Mucosal disease/Bovine virus diarrhoea
C653 Vibrionic dysentery
C654 Warble infestation

Sheep and goat diseases
C701 Contagious pustular dermatitis
C702 Foot-rot
C703 Contagious ophthalmia
C704 Enterotoxaemia
C705 Caseous lymphadenitis

Horse diseases
C751 Equine coital exanthema
C752 Ulcerative lymphangitis
C753 Strangles

Pig diseases
C801 Swine erysipelas

Poultry diseases
C851 Infectious coryza
C853 Avian encephalomyelitis
C854 Avian spirochaetosis
C855 Avian salmonellosis (excluding Fowl typhoid - B308 and Pullorum disease - B313)
C856 Avian leucosis

Dog and cat diseases
C921 Canine distemper

Fish diseases
C941 Infectious dropsy of carps
C942 Furunculosis of salmonids

*Animal Health Yearbook 1985 FAO-WHO-OIE