

A REVIEW OF CAMEL DISEASES IN CENTRAL AUSTRALIA



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Contents	Page
Introduction	1
Executive Summary	3
OIE List A Diseases relating to camels	4
Bluetongue	4
OIE List B Diseases relating to camels	6
Bovine brucellosis (Australia is officially free)	6
Bovine tuberculosis (Australia is officially free)	7
Anthrax	8
Hydatidosis	8
Leptospirosis	8
Paratuberculosis	9
Q Fever	10
Bovine babesiosis & anaplasmosis	10
Dermatophilosis	11
Unlisted Diseases	11
Melioidosis	11
Sarcoptic mange	12
Nasal Bots	12
Skin and internal abscesses	13
Internal parasites	13
Clostridial diseases	14
Ringworm	14
Bibliography	15
Appendix 1- Slaughter Numbers of Camels in Australia to 12/05/03	16

INTRODUCTION

The camel (*Camelus dromedarius*) found in Australia is a hardy animal with a unique physiological constitution that enables it to thrive under arid conditions. It is well adapted to the hot, dry desert areas of interior Australia where it is isolated from many disease vectors and contagious diseases. The population of feral camels in Central Australia is estimated to be at least 270,000. The domesticated camel population is estimated to be less than 10,000, used in tourist enterprises and domesticated herds throughout Australia (P.Seidel, pers. comm.). For the purposes of this report, Central Australia includes the arid areas of the Northern Territory, Western Australia, South Australia and Queensland in the vicinity of the Simpson, Great Sandy and Tanami Deserts.

Edwards et al. (2003) estimated the population of feral camels to be at least 90,000 in the southern regions of the Northern Territory and 270,000 in Central Australia. By comparing with previous surveys (Short, 1987), they concluded that in the absence of significant disease or predators, camel numbers are increasing exponentially at the rate of 10% a year, so that the population doubles every eight years. The increasing feral camel numbers are a threat to the arid ecosystem of the interior and control measures are necessary.

There is demand from South East Asia, Europe and the Middle East for camels from Australia for slaughter and breeding. The demand is enhanced by the relatively disease free status of Australian camels. A viable live export industry and/or slaughter for export at Australian abattoirs is the preferred method for controlling increasing feral camel numbers in inland Australia. As the current abattoir capacity for camels in Australia is small, the live export market is a necessary alternative.

The aim of this Technical Bulletin is to summarise existing information on the health status of camels in Central Australia. The information is based on industry reports, abattoir monitoring and 267 recorded veterinary field investigations including some targeted field-testing by Northern Territory government officers. Northern Territory records are considered to be representative of the feral camel population in Central Australia, which as described earlier, includes the southern part of the Northern Territory, the eastern part of Western Australia, the western part of Queensland and the northern part of South Australia. Health records of camels located in other parts of Australia have not been included.

A large number of tests were conducted for the 48 consignments of camels shipped to the USA, Cuba and South East Asia. The results of these tests are included in the 267 investigations, which involved samples from 3492 Northern Territory camels.

In 2002, 935 camels were exported to four countries in Asia and the Middle East and 1404 were slaughtered at Australian export abattoirs. Since 1988, 4915 camels have been slaughtered at export abattoirs (Appendix 1). Officers of the Australian Quarantine and Inspections Service conduct ante-mortem examinations and supervise meat inspection at export abattoirs. Meat inspection is also carried out at domestic abattoirs.

Inferences from surveillance of cattle supplement our knowledge of the health status of camels in Central Australia. Although stocking rates of camels are low, some contact does occur with a small number of cattle on pastoral properties.

The Office International des Epizooties' (OIE), Terrestrial Animal Health Code does not include recommendations for trade in camels. The OIE lists transmissible diseases of serious socio-economic or public health importance under lists A and B in the International Animal Health Code. This Code is applied as the standard by the World Trade Organisation member countries to meet their obligations for world trade under the *Sanitary and Phytosanitary Measures* agreement. Diseases listed in these sections, most of which are exotic to Australia, are discussed as they relate to camels in Central Australia.

EXECUTIVE SUMMARY

The purpose of this review was to compile known information on the health of feral camels in Central Australia from published reports in the scientific literature and from departmental records from the Northern Territory Department of Business, Industry and Resource Development to facilitate trade in domestic and export markets.

The population of feral camels in Central Australia is estimated to be at least 270,000. Control of feral camels, preferably by increased turn-off, is necessary in order to protect the arid environment from these introduced grazing animals.

There is demand for Australian camels in South East Asia, Europe and the Middle East, particularly because they are healthy.

Both domestic and feral camels in Australia are free from most serious diseases of livestock. Camel diseases in Central Australia, such as those caused by internal parasites, sarcoptic mange, ringworm, nasal bots and *Corynebacterium* abscesses are common worldwide and readily treatable. There is no evidence that melioidosis occurs in Central Australia. The risk of melioidosis during export from endemic areas in the wet season can be managed.

Bluetongue is the only OIE list A disease in Australia. Feral camels live in Australia's bluetongue virus-free zone.

The OIE List B diseases are not known to occur in feral camels in Central Australia.

OIE LIST A - Diseases relating to camels

The OIE list A diseases are “transmissible diseases that have the potential for very serious and rapid spread, irrespective of national borders, that are of serious socio-economic or public health consequence and that are of major importance in the international trade of animals and animal products.” List A diseases which are known or suspected to affect camels are:

Bluetongue	<i>Present in Australia</i>
Foot and mouth disease	<i>Not present in Australia</i>
Vesicular stomatitis	<i>Not present in Australia</i>
Rinderpest	<i>Not present in Australia</i>
Rift Valley fever	<i>Not present in Australia</i>

BLUETONGUE

Bluetongue is caused by an arbovirus which affects ruminant animals with variable clinical severity, characterised by inflammation of the mucous membranes, widespread haemorrhages and oedema.

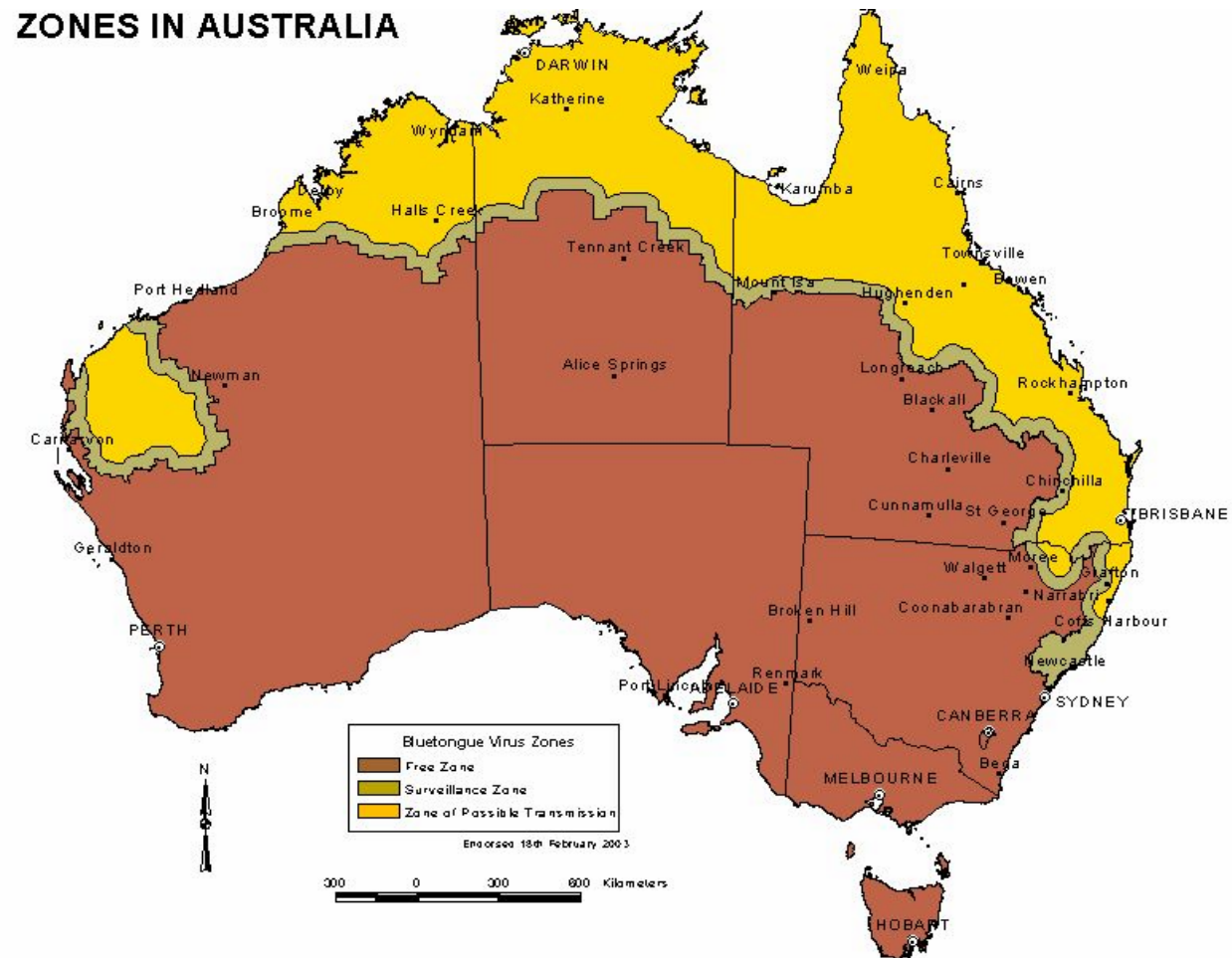
Eight of the 24 reported serotypes of bluetongue virus have been recorded in northern Australia. The virus serotypes which have been identified in Australia (20, 1, 3, 9, 15, 16, 21 and 23) have been isolated from the blood of healthy sentinel cattle (Animal Health Australia, 2002).

It is believed that all ruminants, including sheep, goats, cattle, buffaloes, camels, antelopes and deer are susceptible to bluetongue. However, no clinical signs or pathological lesions in camels caused by bluetongue virus have ever been reported, although some seropositive camels have been reported from a number of countries (Wernery and Kaaden, 2002).

Cattle are extensively grazed through the tropical and sub-tropical areas of northern Australia where the virus and vector *Culicoides* sp are endemic, but clinical disease has not been reported.

Bluetongue virus has not been detected in Central Australia where feral camels are found. Since 1977, 2374 camels from Central Australia have tested negative to the agar gel immunodiffusion test (AGID) or serum neutralisation test. Two camels tested in 1990-91 were reported to be positive to AGID but retested negative, one by AGID and the other by the competitive ELISA test. Bluetongue virus antibodies have never been detected in sentinel cattle herds in Alice Springs since 1979 (Animal Health Australia, 2002).

Figure 1.



Bluetongue virus zones in Australia

<<http://www.namp.com.au/#maps>>

OIE LIST B - Diseases relating to camels

The OIE list B diseases are “transmissible diseases that are considered to be of socio-economic and/or public health importance within countries and that are significant in the international trade of animals and animal products.” Those diseases known or suspected to affect camels are:

Not present in Australia

- Old world screw worm fly
- New world screw worm fly
- Rabies
- Trichinellosis
- Bovine brucellosis
- Bovine tuberculosis*
- Theileriosis
- Surra (trypanosomosis)
- Caprine and ovine brucellosis (*Brucella melitensis*)
- Haemorrhagic septicaemia

Present in Australia

- Anthrax
- Hydatidosis
- Leptospirosis
- Paratuberculosis
- Q Fever
- Bovine anaplasmosis
- Bovine babesiosis
- Dermatophilosis

* Officially free with a surveillance program. There are sporadic infections in cattle with eradication usually by de-population.

The above diseases are briefly discussed. Australia is officially free from two of the diseases, bovine brucellosis and bovine tuberculosis through eradication activity in the last 30 years.

BRUCELLOSIS (*not present in Australia*)

Camels may be infected by *Brucella abortus* and *Brucella melitensis*, which cause abortion and infertility (Wernery and Kaaden, 2002, Manefield and Tinson, 1997). Serological surveys conducted in camels in Russia, Kuwait, India, the UAE and Kenya indicated that seroprevalence of *Brucella abortus* ranges from 2% to 15% (Manefield and Tinson, 1997). Refai (1992) summarised various surveys in Egypt with seroprevalence up to 24%, but he did not specify the species of brucella.

Australia was declared free from *Brucella abortus* in 1989. *Brucella melitensis* infection of animals has not been reported in Australia.

Many camel herds in Central Australia coexist on pastoral properties stocked with cattle. Throughout the Brucellosis and Tuberculosis Eradication Campaign (BTEC, 1974 -1997), none of these properties recorded brucellosis outbreaks subsequent to recording a free status following an eradication program in the cattle herd. If brucellosis had been endemic in the resident camel population, cross infection to cattle would have been likely.

Australian camels have been tested for brucella antibodies using the serum agglutination test (SAT), rose Bengal test (RBT) and complement fixation test (CFT) during BTEC and for export. Since 1978, 1,693 camels from Central Australia have been tested and all have been negative. Two camels tested by SAT as part of an export consignment during 1995 were positive but following a retest three months later, were negative to the SAT test. Necropsy and culture were not undertaken.

During BTEC, all slaughtered entire cattle and camels were tested at abattoirs for brucellosis by CFT. This continued until the end of 1992, even though Australia had been declared free from *Brucella abortus* in 1989. All the 526 camels from Central Australia tested negative.

BOVINE TUBERCULOSIS (Australia is officially free with ongoing surveillance)

Bovine tuberculosis (TB) is caused by *Mycobacterium bovis* which is the most common cause of TB in camels. The organism causes granulomatous abscesses in various tissues with a predilection for lymphoid tissues and lungs (Wernery and Kaaden, 2002). Australia officially met the OIE standard as a country free from TB in 1997.

TB is not common in camels but when established in a herd can have a significant prevalence (Wernery and Kaaden, 2002, Manefield and Tinson, 1997). Refai 1992 reported prevalence between 0.3 to 0.4% in camels in Egypt, but stated that TB only occurred in camels when they were in close association with infected cattle. No reports were found in the literature of TB in nomadic feral herds.

Comparative testing using avian tuberculin has been used to reduce the incidence of false positive reactors (Manefield and Tinson, 1997). Many camels showing non-specific reactions to tuberculin were infected with *Corynebacterium pseudotuberculosis* abscesses; such reactions also occur in sheep infected with the closely related *Corynebacterium ovis* (Shukla, 1970).

A number of sporadic surveys of feral camels for TB and brucellosis have been carried out including one in 1977 on a Central Australian station during a TB eradication program in which autopsies of 17 camels were carried out. In the past 20 years 1212 export camels from Central Australia have been tested for TB. Autopsies of nine reactors were negative.

Since 1988, 4915 camels from Central Australia (Appendix 1) have been slaughtered but no TB lesions were detected. Granulomas from five camels were subjected to culture and histopathology without evidence of TB. NT government laboratory records confirm that a considerable number of liquefactive abscesses were caused by *Corynebacterium pseudotuberculosis*. No *Mycobacterium bovis* infection has ever been reported in Australian camels.

ANTHRAX

Bacillus anthracis may affect camels in a similar manner as in cattle and other livestock. Infection of camels from environmental spores leads to sudden death (Wernery and Kaaden, 2002). There are no published reports of anthrax in camels in Australia.

There have been sporadic outbreaks of anthrax in other domestic livestock in Victoria, New South Wales and southeast Queensland. Quarantine and vaccination control the disease on properties in the known endemic zones in those areas. Outbreaks occur in one or more of these areas each year (Beveridge, 1983).

No anthrax cases have been recorded in areas inhabited by feral camels in the Northern Territory or in other arid regions in Central of Australia.

HYDATIDOSIS

Hydatidosis is caused by the tapeworm *Echinococcus granulosus* (Wernery and Kaaden, 2002). In Australia the usual cycle is dog/sheep, but this cycle can spill over into wildlife with a dingo/macropod cycle. Other animals such as pigs, cattle and humans can also act as intermediate hosts if they become involved in either of the cycles. In Africa and Asia hydatid cysts are frequently found in camels (Wernery and Kaaden, 2002). It has been suggested that humans may be resistant to camel strains of *Echinococcus granulosus* (Wernery and Kaaden, 2002). Hydatids were reported in imported camels in Australia, but this was in the 1900s.

No hydatid cysts were reported during meat inspection of 4915 camels from Central Australia slaughtered in Australian abattoirs (Appendix 1). Hydatidosis is recognised as widespread in many areas of Australia (Cole, 1986). A recent abattoir survey of cattle bred in the Northern Territory (Small and Pinch, 2003) did not detect hydatid cysts. This is indicative that a hydatid cycle does not occur in the Northern Territory.

Molecular studies have identified nine groups of *E. granulosus* (Bowles, et al. 1992). These groups are associated with different hosts. The two groups enzootic in Australia (G1 and G2) are both associated to sheep but the group usually found in camels (G9) has not been reported in Australia.

LEPTOSPIROSIS

This disease does not appear to have great importance for camel health, as clinical disease is rare. In dry environments, seroprevalence is very low (Manefield and Tinson, 1997; Wernery and Kaaden, 2002).

Leptospira interrogans is common in cattle and sheep populations in most areas of Australia. These bacteria are mostly serovars *pomona* and *hardjo*. The serovar *hardjo* is most widely distributed but the prevalence of *pomona* varies with rainfall (Beveridge, 1983).

In 65 veterinary investigations recorded over the past 20 years near Alice Springs of camel disease including ill-thrift, oedema, dysuria, abortion and death, leptospirosis was not suspected and no evidence of it was found from laboratory testing. Departmental files show no records of investigations of camels exhibiting haematuria.

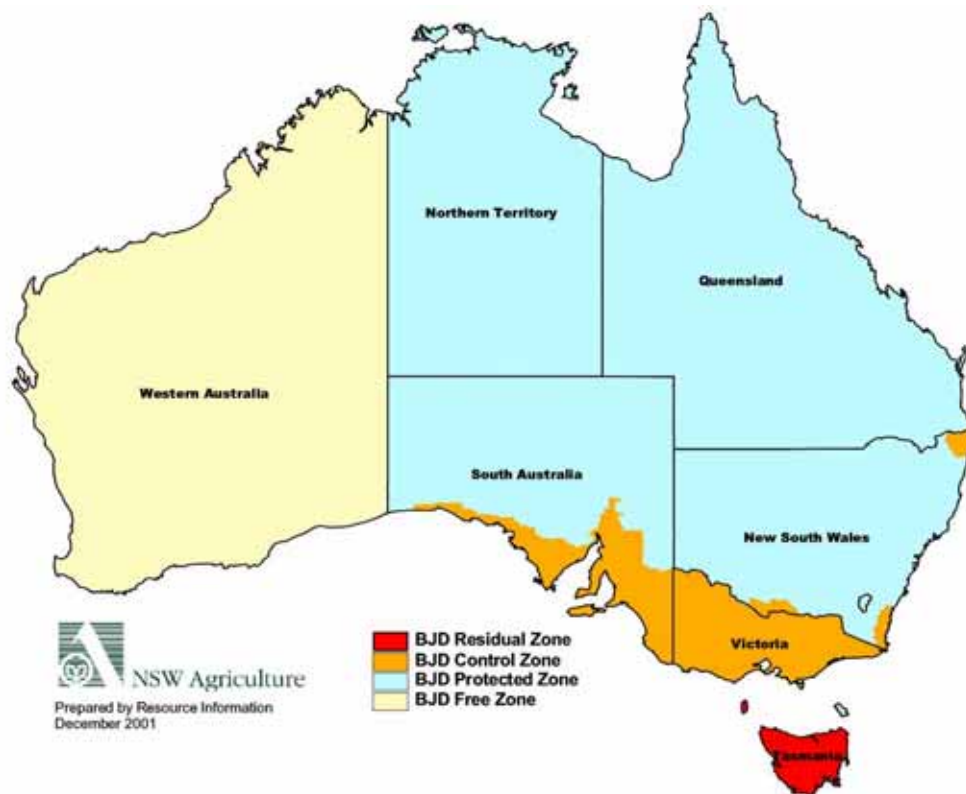
PARATUBERCULOSIS (JOHNE'S DISEASE)

Johne's Disease (JD) is caused by *Mycobacterium paratuberculosis* and affects camels worldwide causing characteristic clinical illness of severe diarrhoea ending in death (Manefield and Tinson, 1997; Wernery and Kaaden, 2002). The course of disease is often more rapid than that in cattle (Higgins 1986). Wilson (1980) regards infection in camels to be of minor importance.

There are no published reports of JD in camels in Australia. It is unlikely to exist within the Central Australian feral camel herd because the area is declared to be either free or protected for bovine and ovine JD.

Figure 2.

Bovine Johne's Disease Zones in Australia as at
14 December 2001



From January 1996 to December 2002, 24 camels from Central Australia with diarrhoea were tested for JD and no evidence of the disease was found.

Table 1. Tests for JD in camels in Central Australia

Date	Reason	Number Camels	Tests	Results	Comments
17/01/96	Diarrhoea /colic	2	CFT and faecal culture	Negative	
22/02/96	Diarrhoea/ weight loss	1	Blood smear	Negative	
04/03/96	Diarrhoea	2	CFT	Negative	
08/08/96	Diarrhoea	2	CFT and faecal culture	Negative	
12/07/97	Diarrhoea at Camel Cup	7	CFT	2 anti-complementary.	Anti-complementary at 1/8 and 2/8, rest neg.
19/11/98	Diarrhoea/ weight loss	4	CFT	1 anti-complementary	Anti-complementary at 1/32, rest neg
10/07/99	Diarrhoea at Camel Cup	6	faecal culture	Negative	

In 1985, 74 young (nine month-old) feral camels from Central Australia were tested for JD using CFT. Eleven were positive in the first test and seven in a second. The specificity of CFT for JD in camels is not known. The importing country permitted entry because there was no evidence of the disease in Central Australia in any species, the age of the tested camels and the lack of validation of the CFT in camels (Taffy Williams, pers. comm.).

There are no validated tests for JD in camels for use in import risk management measures.

Q FEVER

Q fever is a rickettsial disease caused by *Coxiella burnetii*. Infection is not apparent in camels but the disease poses an increased risk of abortion.

Q fever is recorded worldwide including in camels (Wernery and Kaaden, 2002). The organism infects a wide range of species including livestock, rabbits, mice and some birds.

No published reports were found of Q fever testing in camels in Central Australia.

BOVINE ANAPLASMOSIS AND BOVINE BABESIOSIS

Anaplasma marginale causes bovine anaplasmosis, while *Babesia bovis* and *Babesia bigemina* cause bovine babesiosis. Babesia are relatively host-specific and bovine babesiosis is only considered to affect cattle and buffalo (Callow, 1984). However, *Anaplasma marginale* is considered capable of infecting camels as well as cattle (Callow, 1984). These organisms are transmitted by the cattle tick *Boophilus microplus*. Cattle ticks can infest camels but cattle are the preferred host (Manefield and Tinson, 1997). There are no published reports of

babesiosis in camels and anaplasmosis is reported to be a sub-clinical disease in camels (Wernery and Kaaden, 2002).

The feral camels in Central Australia range within the tick-free zones.

DERMATOPHILOSIS

Dermatophilosis, caused by *Dermatophilus congolensis*, occurs worldwide in all common livestock including cattle, sheep, goats, deer, horses and camels (Wernery and Kaaden, 2002) with clinical disease more common in the wet tropical areas or during unseasonal wet periods in the more arid areas.

Dermatophilosis has not been reported in camels in Central Australia, probably due to climatic factors.

UNLISTED DISEASES

A number of diseases not listed in the OIE International Animal Health Code that occur in Australia are discussed.

Present in Australia

- Melioidosis
- Mange
- Bots
- Corynebacteria abscesses
- Internal parasites
- Clostridial diseases
- Ringworm

MELIOIDOSIS

Melioidosis is a disease of the wet tropical regions of the world affecting a wide range of animals including man, sheep, goats, cattle, camels, cats and dogs. It is a potentially fatal disease caused by the gram negative bacterium *Burkholderia pseudomallei*.

During 1990, seven out of 13 camels died from the disease near Cooktown, Queensland (Bergin and Torenbeck, 1991). These were the first published records of camel deaths from melioidosis in Australia. Since then, at least four incidents of melioidosis related camel deaths have been diagnosed in the northern areas of the Northern Territory. Camels appear especially vulnerable to melioidosis when moved to moist tropical areas. *Burkholderia pseudomallei* do not occur in camels' natural arid habitat. (Bergin and Torenbeck, 1991).

Stress resulting from transport, pregnancy, lactation or debilitating disease can precipitate acute episodes of melioidosis, characterised by bronchopneumonia with septicaemia.

Melioidosis is not a contagious disease and transmission to animals and man usually occurs when contaminated soil or water enters the body through skin abrasions (Bergin and Torenbeck, 1991). The organism is readily isolated from wet clay in tropical zones and can survive for six weeks in tap water (Beveridge, 1983) and at least seven months in mud

(Stevenson and Hughes, 1980). With the onset of rains *Burkholderia pseudomallei* multiply in the soil and are brought to the surface with the rising water table.

In the Alice Springs region one camel died from melioidosis in 1992, after returning from the Darwin area where *Burkholderia pseudomallei* is endemic. There is no evidence that melioidosis occurs in Central Australia

During December 2001, melioidosis killed 29 out of 39 camels in two consignments during the pre-export period in Darwin and during the voyage. Stress and torrential rains in yards, which had an earthen base, were considered predisposing factors. Management practices have overcome the risks posed by this infection. These practices include spelling in covered yards with a concrete base and feeding in troughs and not from the floor in regions where melioidosis may occur (Peter Seidel, pers. comm.)

SARCOPTIC MANGE

Manefield and Tinson, (1997) list sarcoptic mange caused by *Sarcoptes scabiei* var *cameli* mites as a major cause of death in young feral Australian camels. Pegram and Higgins (1992) rank sarcoptic mange second only to surra in terms of its effect on production in camel herds across the world.

Mange in camels is highly contagious and spreads quickly through a herd. In Central Australia it develops quickly in camels (particularly young camels) when yarded for a period. The stress of yarding may be as important a factor as high levels of physical contact. *Sarcoptes* larvae burrow into the epidermis forming tunnels. Symptoms of the disease include intense pruritis leading to weight loss, hair loss, and exudative dermatitis. Subcutaneous oedema occurs in some cases. Chronic infections lead to dark and thickened skin.

Traditional treatments topically applied such as coal tar based preparations, chlorinated hydrocarbons and organophosphates require repeated application and are often not completely effective (Kumar et al. 1992). The recent emergence of macrocyclic lactones, applied by injection or pour-on treatment, has revolutionised the elimination of mite infestation. Camels in Central Australia marketed by the Central Australian Camel Industry Association are all routinely treated with eprinomectin pour-on when assembled for drafting and marketing (Peter Seidel, pers. comm.)

NASAL BOTS

The camel nasal bot fly, *Cephalopina titillator*, occurs worldwide and is commonly found in camels in Central Australia. The larvae are commonly found at post-mortem inspection and up to 80% of consignments have been reported to be infested. Nasal bots may cause irritation of the nasal cavity and may predispose to bacterial infections.

Wernery and Kaaden (2002) report 85% efficacy from treatment with Ivermectin subcutaneously.

SKIN AND INTERNAL ABSCESES

Skin abscesses are common in feral camels in Central Australia. At ante-mortem and post-mortem inspection of feral camels at Australian abattoirs, pus-filled abscesses are commonly detected. These are often infected with *Corynebacterium pseudotuberculosis (ovis)* but may also be caused by infection with *Streptococcus* sp., *Staphylococcus* sp., *Actinomyces pyogenes*, *Escherichia coli* or other *Corynebacterium* sp. Abscesses are often associated with external lymph nodes (Manefield and Tinson, 1997).

In Central Australia, since 1978, 60 camels have been investigated on 33 occasions for abscesses. In only five cases were bacteria other than *Corynebacterium* sp cultured.

INTERNAL PARASITES

Manefield and Tinson (1997) reported that the camel is the least likely of all domestic livestock to suffer from heavy burdens of helminths. The arid climate and dung beetle activity in arid Central Australia are not conducive to heavy worm burdens, although low grades of nematode infestation are common. When camels are kept in higher rainfall areas or intensively stabled, parasitic gastroenteritis may result.

Since 1978, 59 investigations have been conducted in Central Australia, involving worm egg counts usually in animals with weight loss or diarrhoea. The whipworm *Trichuris* sp has been commonly found in stabled camels and is likely to be responsible for some diarrhoea and weight loss. *Trichuris* eggs have a high specific gravity, are not detected on routine faecal worm egg counts and require zinc sulphate solutions to float them during faecal testing. Because of their coprophagic behaviour, infestations develop rapidly in intensively kept camels. It is suggested that anthelmintics, including macrocyclic lactones, have limited efficacy against this parasite. Camels treated with injectable Ivermectin will build up a worm population of *Trichuris* (Anon, 2003).

Manefield and Tinson, (1997) describe worm egg counts from camels of up to 2000 eggs per gram from clinically normal animals. The highest worm egg count recorded during Central Australian investigations was 560 eggs per gram and all others were less than 100 eggs per gram. Parasitic eggs identified were as those of *Haemonchus* sp, *Trichostrongylus* sp, *Cooperia* sp and *Nematodirus* sp. Manefield and Tinson (1997) view that any recording of *Nematodirus/Nematodirellas* eggs in worm egg counts is significant and these were commonly found from samples in Central Australia.

Eimeria camellii, a coccidian parasite, was found infrequently and at low levels in faecal flotation tests. A more common protozoan parasite found at times in very high numbers was *Balantidium coli*. Wernery and Kaaden (2002) report that this parasite may potentially cause chronic diarrhoea.

Tapeworm infestation has not been reported in camels in Central Australia. Hydatidosis is discussed under List B diseases. Cysts of other taeniid parasites have not been reported in camels in Australia.

CLOSTRIDIAL DISEASES

Clostridial diseases do occur in camels (Wernery and Kaaden, 2002); however have never been diagnosed in camels in Central Australia. They do cause sporadic disease in cattle in Central Australia

RINGWORM (DERMATOPHYTOSIS)

Wernery and Kaaden (2002) report dermatophytosis to be a common disease of camels worldwide.

Ringworm caused primarily by *Trichophyton mentagrophytes* is a common skin disease in Australian camels, especially in the young - those under three years of age (Manefield and Tinson, 1997). The species found in Central Australia is contagious to humans. Skin lesions on camels are characteristically circular crusty areas of alopecia, which may coalesce.

Veterinary investigations of skin lesions in 31 camels were conducted in Central Australia, which included laboratory testing. *Trichophyton* sp was considered to have caused 15 of them.

Chlorinated or iodine based topical treatments are effective (Manefield and Tinson, 1997).

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Appendix 1 - Slaughter numbers of camels from Central Australia from 1 January 1988 to 31 December 2003

Information sourced from registry files in Alice Springs, industry enquiry and waybill databases. The total number of camels slaughtered during the period was 4915.

Year	Wamboden	Strath Meats	Peterborough	Other abattoir
1988	10	0	0	0
1989	120	0	0	0
1990	132	0	0	0
1991	136	0	0	0
1992	261	0	0	0
1993	300	0	0	0
1994	284	0	0	0
1995	224	0	145	0
1996	212	0	135	117
1997	163	295	0	0
1998	0	338	0	0
1999	5	223	0	0
2000	0	144	0	44
2001	0	277	0	80
2002	0	193	0	1211
Total	1714	1470	280	1451