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IMPORTATION OF RODENTS INTO AUSTRALIAN ZOOS – DRAFT POLICY

This Biosecurity Australia Advice (BAA) provides stakeholders with proposed quarantine measures for the importation of certain species of rodents into Australian zoos. Comments would be appreciated by 28 April 2008.

Quarantine requirements for the importation of rodents into Australian Quarantine and Inspection Service (AQIS)-registered zoos were adopted in July 1998 (Animal Quarantine Policy Memorandum 1998/61). In April 2002, stakeholders were advised of amendments to a number of import protocols for zoo animals, and the suspension of the zoo rodents protocol pending a review that would pay particular attention to blood parasites—trypanosomes and babesias (Animal Biosecurity Policy Memorandum 2002/15).

The Australasian Association of Zoological Parks and Aquaria has advised Biosecurity Australia that Australian zoos place a high priority on the importation of capybaras (*Hydrochoerus hydrochaeris*), Brazilian agoutis (*Dasyprocta leporina*), Patagonian maras (*Dolichotis patagonum*) and Cape porcupines (*Hystrix africaeaustralis*). These are all large rodents (order Rodentia) of the Suborder Hystricomorpha¹. The first three are native to Latin America and the last to South Africa. To simplify the review and to facilitate risk management, the proposed conditions will only apply to these species. New and Old World rats and mice, voles, etc.—the species most frequently reported as reservoir hosts of a number of zoonotic pathogens—are members of the Suborder Myodonta, Superfamily Muroidea and are not part of this review.

Furthermore, imports will be restricted to animals from zoos or wildlife parks in Canada, New Zealand, the United States of America or Member States of the European Union.

The review is based on relevant scientific literature and a review of suspended 2002 requirements. It also takes into account the following risk management measures, common to most of the current import policies for zoo animals, being applied:

- the animal must be resident in licensed or registered zoos or wildlife parks in the exporting country for at least 12 months immediately before export or since birth
- the premises of origin must be under veterinary supervision and have a health monitoring program
- the animal must be held in pre-export quarantine for a period of at least 30 days during which it is inspected at least daily for clinical evidence of disease, treated for internal and external

¹ Taxonomy according to Mammal Species of the World - <http://nmgoph.si.edu/msw/>

parasites (with a particular emphasis on ensuring freedom from tick infestation), and tested for diseases in accord with the recommendations arising from the review

- the animal must be transported to a Quarantine Approved Premises (QAP) in Australia in a manner that ensures the risk of exposure to disease agents is acceptably low, and undergo a period of post-arrival quarantine in accord with the recommendations arising from the review
- the receiving institution must be approved under relevant Australian State or Territory legislation to hold the species being imported.

The review considers a number of pests and diseases of quarantine concern, including those in the suspended conditions. The review concludes that for all but two of the diseases—babesiosis and tuberculosis—the quarantine risks associated with importation into Australian zoos of the rodents to which this review applies, under the measures above, is very low to negligible and thus meets Australia's appropriate level of protection (ALOP).

The risk of entry, establishment and spread of babesiosis is considered very low but uncertainty regarding the susceptibility to infection of the rodents to which the review applies and the competence of Australian ixodid ticks to act as vectors suggests some supplementary risk management is warranted. The review concludes that certification of premises of origin freedom for 12 months before export will provide additional assurance.

The risk of entry, establishment and spread of tuberculosis is assessed as low to very low. Although spread of bovine tuberculosis within Australia through the importation of an infected zoo rodent is considered unlikely, the potentially severe consequences of such spread suggest that risk management is warranted. The review concludes that certification of premises of origin freedom from bovine tuberculosis for three years prior to export will provide additional assurance.

The review report is at Attachment A. Proposed quarantine measures for the importation of zoo rodents are at Attachment B.

Consultation

Please pass this notice to other interested parties. If those parties wish to be included in future communications on this matter they should get in touch with the contact officer (details below).

Comments on the proposed new measures for the importation of zoo rodents should be submitted by 28 April 2008 to Biosecurity Australia at the following address:

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An electronic version of submissions would be appreciated. Biosecurity Australia will consider all stakeholder comments as it finalises the import requirements.

Information on risk assessments and policy reviews being conducted by Biosecurity Australia is available from our website www.biosecurityaustralia.gov.au.

Confidentiality

Stakeholders are advised that, subject to the *Freedom of Information Act 1982* and the *Privacy Act 1988*, all submissions received in response to BAAs will be publicly available. Comments may be listed or referred to in any papers or reports prepared on the subject matter of the Advice.

The Commonwealth reserves the right to reveal the identity of a respondent unless a request for anonymity accompanies the submission. Where a request for anonymity does not accompany the submission the respondent will be taken to have consented to the disclosure of their identity for the purposes of Information Privacy Principle 11 of the *Privacy Act 1988*.

The contents of the submission will not be treated as confidential unless they are marked 'confidential' and they are capable of being classified as such in accordance with the *Freedom of Information Act 1982*.

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REVIEW OF QUARANTINE MEASURES FOR THE IMPORTATION OF ZOO RODENTS

Introduction

Biosecurity Australia is responsible for developing and reviewing quarantine policy for the import of animals and plants and their products. It does this through a science-based risk analysis process. According to the World Organisation for Animal Health (OIE), a risk analysis comprises hazard identification, risk assessment, risk management and risk communication. At the completion of its process, Biosecurity Australia makes a recommendation for a policy determination to Australia's Director of Animal and Plant Quarantine. This determination is taken into account by the Australian Quarantine and Inspection Service (AQIS) when considering applications to import.

Australia's science-based risk analysis process is consistent with Australian Government policy and Australia's rights and obligations under the World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement).

Australia has a long-standing conservative approach to quarantine risk. The level of risk Australia is prepared to accept is known as Australia's appropriate level of protection (ALOP) and is expressed as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Those risks that are very low or less meets Australia's ALOP and no risk management measures are required. For those quarantine risks that exceed Australia's ALOP, ie those risks that are greater than 'very low', risk management measures are recommended to reduce the level of risk in order to achieve the ALOP.

Background

Quarantine Requirements for the Importation of Rodents into AQIS-Registered Zoos were adopted in July 1998. Risk management measures were, in summary, certification that:

- the animals for export be continuously resident in a registered or licensed zoo or wildlife park for 12 months prior to export
- there has been no evidence of arenavirus infections (lymphocytic choriomeningitis [LCM], American haemorrhagic fevers, Lassa fever), hantavirus, plague (*Yersinia pestis*), rabies, surra, tuberculosis or tularaemia in the zoo or nearby wild rodent populations in that time
- the animals were held in pre-export quarantine (PEQ) for 30 days prior to export, remained healthy and were treated twice for ectoparasites during PEQ
- the zoo of origin was located in a country or part of a country free from hantavirus and arenavirus infections or were tested negative for these not less than 14 days after commencement of PEQ.

The requirements were suspended in April 2002 pending a review, in particular the re-assessment of potential quarantine risks associated with haemoparasites such as Trypanosomes and Babesias. The following is a report of a review encompassing babesiosis, trypanosomosis and other diseases that might be introduced into Australia through the importation of zoo rodents. The review focuses on risks that might be associated with the importation of the following species: capybaras (*Hydrochoerus hydrochaeris*), Brazilian agoutis (*Dasyprocta leporina*), Patagonian maras (*Dolichotis patagonum*) and Cape porcupines (*Hystrix africaeaustralis*). Furthermore, the review is

only considering importation of animals from zoos or wildlife parks in Canada, New Zealand, the United States of America or Member States of the European Union.

Babesiosis

Babesiosis is caused by infection with species of tick-borne, intra-erythrocytic and generally host-specific protozoan parasites of the genus *Babesia*.

Human babesiosis is a significant but uncommon disease caused by the rodent strain *Babesia microti* in the United States (US) where it is endemic in the north-eastern coastal and the upper mid-west regions. Infections are often asymptomatic but the disease may be severe in the elderly, or in splenectomised people or those with HIV/AIDS. The black-legged deer tick *Ixodes scapularis* is the principal vector of *B. microti* in the US and the principal host is the white-footed mouse *Peromyscus leucopus*. Sporadic cases of babesiosis occur elsewhere in the US, caused by hitherto unknown babesias. Two, designated WA-1 (detected on the west coast) and MO-1 (detected in Missouri), have been described but maintenance hosts have not been identified.

In Europe and Eurasia, human babesiosis is generally due to the cattle strain *Babesia divergens* although *B. microti* is widespread (Sinski et al. 2006). A number of rodents and small insectivorous mammals are hosts. *Ixodes ricinus* is the major vector; others are *I. trianguliceps* and *Dermacentor reticulatus* (Karbowski G. 2004). Several strains of *B. microti* have been identified using molecular techniques in Japan (Saito-Ito et al. 2000). Human cases in Japan have resulted from infection with strains similar to the US type.

B. microti has been detected in a number of rodents including the meadow vole and Norway rat (muroid rodents, Suborder Myodonta) and the eastern chipmunk (Suborder Sciuromorpha), and in the cottontail rabbit and short-tailed shrew (non-rodents). A literature search found no record of its isolation from any of the species to which this review applies (all in the Suborder Hystricomorpha). Although not reported, it is assumed for the purpose of this review that some of these animals may be susceptible to infection.

There are a number of ixodid ticks in Australia associated with Australian native muroid rodents (Roberts FHS. 1970). Although the risk of introduction, establishment and spread of *B. microti* through importation of the species to which this review applies is probably very low, certification of disease freedom provides additional assurance.

It is proposed that certification that no case of babesiosis has been diagnosed in rodents in the premises of origin during the previous 12 months be required.

Lyme disease (*Borrelia burgdorferi*)

A review of the scientific literature on babesiosis leads to consideration of the need to assess the risk of introduction of the spirochaete bacterium *Borrelia burgdorferi* sensu lato, strains of which are the causative agents of Lyme disease (so named following investigation into a geographical cluster of juvenile rheumatoid arthritis in the town of Old Lyme, Connecticut, US, in the mid-1970s). Co-infection with *B. microti* and *B. burgdorferi* is common and consequent disease in humans is generally more severe than disease due to infection with either agent alone.

Lyme disease (lyme borreliosis) is the most commonly reported tick-borne infection in Europe and the US and is much more prevalent than babesiosis. It has an almost identical epizootiology. As is the case with babesiosis, in the US *P. leucopus* (white-footed mouse) is by far the most significant

reservoir host, and the major vector in much of the country is *I. scapularis*. *I. pacificus* is a vector in western US. Both are ticks of the *I. ricinus/persulcatus* complex as are vector ticks in Europe.

Lyme disease has been recognised in Europe under a variety of names since the 1880s, and also occurs across the temperate regions of Asia. A number of species of small mammals and some species of birds have been identified as reservoir hosts. The ixodid tick *I. ricinus* is the main vector in Europe and *I. persulcatus* is primarily responsible for transmission in Asia. *I. hexagonus* is also a recognised vector in Europe.

Syndromes consistent with Lyme disease were reported in the Hunter Valley and South Coast of New South Wales in the 1980s but borreliosis was not confirmed. Vector competence studies on the Australian paralysis tick *I. holocyclus* failed to confirm that it is a competent vector (Piesman and Stone, 1991). There are no ticks of the *I. ricinus* complex in Australia.

No reports of isolation of *B. burgdorferi* from the large rodent species under consideration were found in the literature. Given this and the relatively high prevalence and profile of the disease, and the probable absence of competent vectors in Australia, the risk of introduction, establishment and spread through importing these species under the general measures specified in the covering Advice is assessed as very low. Specific risk management measures are thus not considered warranted.

Trypanosomosis

The trypanosomoses are diseases of humans and domestic animals that result from infection with the parasitic protozoa of the genus *Trypanosoma*.

. Surra (*Trypanosoma evansi*)

Surra is endemic in South–East Asia, the Indian subcontinent, parts of China, the Middle East, northern Africa, Brazil and some other countries in Latin America. The economic cost of the disease may be considerable in these areas. The main host species varies with the geographic region. They are camels in the Middle East and Africa, horses in South America, and buffalo, cattle and horses in South–East Asia.

T. evansi is pathogenic in most domesticated animals. Surra

- . is usually a chronic wasting disease in camels;
- . may be a subacute, acute or chronic, and often fatal, disease in horses, donkeys or mules;
- . is generally chronic in cattle and buffalo; and
- . is usually acute and fatal in dogs and cats.

Subclinical infection or mild, chronic disease may be seen in small ruminants, pigs and elephants.

Vampire bats are both reservoir hosts and vectors of *T. evansi* in South America where, germane to this review, capybaras are also reservoir hosts. *T. evansi* has also been isolated from coatis but no reference in the scientific literature to infection in wild rodents other than capybaras was found.

The usual mode of transmission is mechanically by biting flies, mainly of the genus *Tabanus*. Carnivores can also be infected by consumption of meat from infected animals.

The disease remains confined to tropical and sub-tropical areas of the world. Most countries in Europe, North America, southern Africa and Oceania are free of surra². The risk of introduction, establishment and spread of surra as a result of importing zoo agoutis, Patagonian caviés and porcupines under the general measures specified in the covering memorandum is negligible and specific risk management measures are not warranted.

The risk resulting from the importation of capybaras under these measures (ie from zoos or wildlife parks in Europe, North America or New Zealand, where surra has not been reported in any species) is assessed as very low. Specific risk management measures are not considered warranted.

. **Chagas disease (*Trypanosoma cruzi*)**

Chagas disease is a serious disease of humans caused by the protozoan parasite *Trypanosoma cruzi*. It is endemic in Latin America where it is transmitted to humans and other mammals by haematophagous triatomine bugs (Class Insecta, Order Hemiptera, Family Reduviidae, Subfamily Triatominae). Humans can also become infected through blood transfusions or by congenital transmission. Its distribution encompasses much of the Americas from southern US to southern Argentina. It was estimated that 16–18 million people were infected in 1990 with 120 million at risk (Scientific Working Group on Chagas Disease 2005). Following infection, symptoms are generally mild and may be unnoticed. The infection may then lay dormant for many years after which some people develop cardiac or enteric diseases which may be fatal.

In 1991 an international initiative was undertaken by the ‘Southern Cone’ countries in America—Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay—to control Chagas disease. This has resulted in elimination of the vector in many areas and a much reduced prevalence of disease (PAHO 2007). The successes of the Southern Cone Initiative spawned similar initiatives in Central America, the Andes (1997) and, more recently, the Amazon (Dorn and others, 2007). Mandatory blood screening of blood donors has also been introduced. It was estimated recently that 8 to 11 million people in Mexico, Central and South America had Chagas disease (CDC Fact Sheet 2007).

Humans are the major domestic reservoir of infection but dogs are reported to play a significant role in the dynamics of transmission in the human environment. The disease is mostly found in poor rural areas where the triatomine bugs can breed and feed on natural reservoirs such as opossums and armadillos. The bugs usually hide in crevices in walls and roofs of mud, adobe or thatch houses during the day and come out to feed at night. After feeding, the bugs defaecate and trypanosomes can then enter through mucous membranes or minor wounds and abrasions—often as a result of the victim rubbing or scratching the site of the bite. Sylvatic and peridomestic cycles involve small mammals. Opossums, armadillos and agoutis may be epidemiologically relevant, the opossum being the most important (Natural reservoirs of *Trypanosoma cruzi* 2000).

Chagas disease has occurred in a number of countries in people that have migrated from endemic areas. The disease has not, however, established outside the Americas despite the presence of potential triatomine vectors in Africa, Asia and Australia. There have been a few autochthonous cases in southern States of the US but the disease is not regarded as endemic in that country.

The risk of introduction, establishment and spread into Australia through importing large zoo rodents under the general measures specified in the covering Advice is assessed as negligible for imports from the EU, New Zealand or Canada and very low or negligible for imports from the US. Specific risk management measures are not considered warranted.

² Dourine, a disease of horses attributed to *Trypanosoma equiperdum*, has occurred sporadically in Europe through the last century. Recent work has led some researchers (Claes et al. 2005) to suggest stored stocks of *T. equiperdum* should be regarded as strains of *T. evansi* or *T. brucei* but this is disputed by others (Feng-Jun Li et al. 2005).

OTHER DISEASES

Other diseases subject to risk management conditions in the suspended protocol were also reviewed. Risks associated with pests and diseases of rodents not subject to risk management in the suspended conditions were re-assessed. The review/re-assessment was conducted against the intention to apply the general measures outlined in the covering Advice, and the limited range of rodent species to which this review pertains.

Arenavirus infections

Arenaviruses (viruses of the family Arenaviridae) are divided into two groups – the New World or Tacaribe complex and the Old World or LCM/Lassa complex. Each virus is associated with either one rodent species or a few closely related rodents (CDC Arenavirus Fact Sheet).

Arenaviruses cause chronic, usually subclinical, infections of small rodents, and serious rodent-transmitted diseases in humans including lymphocytic choriomeningitis (lymphocytic choriomeningitis virus [LCMV]), Lassa fever (Lassa fever virus), Argentine haemorrhagic fever (Junin virus), Bolivian haemorrhagic fever (Machupo virus), Venezuelan haemorrhagic fever (Guanarito virus), Brazilian haemorrhagic fever (Sabia virus) and others.

Each arenavirus is generally associated with a single small mammal host species in which it establishes a chronic infection involving shedding of virus in secretions and excretions (Mills et al. 1997). Reservoir hosts are murine rodents (Old World rats and mice) and sigmodontine rodents (New World rats and mice). Other rodents (e.g. pet hamsters and guinea pigs) can occasionally become infected—at least with LCMV—and pose a disease risk to humans (CDC MMWR 2005).

Serological evidence of lymphocytic choriomeningitis virus (LCMV) has been found in wild house mice in a limited geographic range in Australia (Smith et al. 1993).

A literature search found no record of the isolation of arenaviruses from any of the species to which this review applies. The risk of introduction, establishment and spread into Australia through importing animals of these species under the general measures specified in the covering Advice is assessed as very low or negligible and specific risk management measures are not considered warranted.

Brucellosis (*Brucella abortus*, *B. suis*)

Brucella abortus is the cause of bovine brucellosis, also known as contagious abortion, a major disease of cattle that was eradicated from Australia as a result of the Brucellosis and Tuberculosis Eradication Campaign. Australia was declared free of bovine brucellosis in 1989. *Brucella suis* is the cause of porcine brucellosis and is present in Australia, mainly in feral pigs in the north. A *B. suis* herd accreditation scheme has been adopted by all Australian States and Territories.

B. abortus and *B. suis* have been isolated from capybaras in Venezuela. A bacteriological and serological study of 201 wild capybaras from the plains to the east of the Andes in north-western South America was made to ‘isolate *Brucella* from spleen and lymph node tissues and determine the role of this rodent as a reservoir of this bacteria (*sic*)’. Of the 201 sera, 116 were seropositive and brucellae were isolated from 23 animals. Seven isolates were identified as *B. abortus* and 15 as *B. suis*. One was initially identified as *Brucella melitensis* but subsequently classified as *B. abortus* (Lord and Flores, 1983). The findings support similar results of surveys in Venezuela in the 1970s. The authors conclude that their findings indicate that capybaras may be an alternate host of *Brucella* spp. in Venezuela and that this may have implications for the cattle industry.

No reference was found to infection with brucellae of any of the rodents to which this review applies apart from capybaras. The likelihood of importing infected agoutis, Patagonian caviés or porcupines under the general measures specified in the covering Advice is considered negligible. The risk of entry, establishment and spread through the importation of capybaras under these measures is assessed as very low. Specific risk management measures are not considered warranted.

Hantavirus infections

The genus *Hantavirus*, family Bunyaviridae, comprises a number of viruses—some 25 have been identified including those that cause the serious human zoonoses, haemorrhagic fever with renal syndrome (HFRS) and hantavirus pulmonary syndrome (HPS) (also known as hantavirus cardiopulmonary syndrome [HCPS]).

HFRS occurs in Europe and Asia where the reservoir hosts are murine rodents (Old World rats and mice) and avicoline rodents (voles). Viruses that cause HFRS are Hantaan virus carried by the striped field mouse (*Apodemus agrarius*), Dobrava-Belgrade virus (in the yellow-necked field mouse *A. flavicollis*), Seoul virus (in the brown or Norway rat *Rattus norvegicus*) and Puumala virus (in the bank vole *Clethrionomys glareolus*). The hosts of these viruses are indigenous in Europe and Asia.

The host of Seoul virus, *Rattus norvegicus*, has a global distribution and Seoul virus ‘has spread worldwide’ [CDC Fact Sheet: Hemorrhagic Fever with Renal Syndrome; Schmaljohn and Hjelle, 1997]. However, no reference to its isolation in Australasia or Africa was found in the scientific literature.

Antibodies to Hantaan-related viruses have been found in 17 rodents of 64 sampled in all mainland States and the Northern Territory of Australia in a global survey conducted between 1981 and 1983 (LeDuc et al. 1986). There are no reports of infections of humans with hantavirus in Australia but, based on the finding of antibodies, it has been postulated that Seoul virus may have been introduced by rats through ports and could be present unrecognised in the human population (Bi P et al. 2005). Dr Bi has affirmed that there still has been no antibody or clinical evidence of human infection in Australia (Bi P pers. comm. 2007). Seoul virus normally causes a relatively mild form of HFRS.

Klempa et al have published evidence of two novel hantaviruses in Guinea, West Africa (Klempa et al. 2006; Klempa et al. 2007).

HPS occurs in the Americas where the reservoir hosts are sigmodontine rodents, the New World rats and mice. Viruses that cause HPS include Sin Nombre virus (in the deer mouse (*Peromyscus leucopus*), New York virus (in the white-footed mouse *P. leucopus*), Black Creek Canal virus (in the cotton rat *Sigmodon hispidus*), Bayou virus (in the rice rat *Royzomys palustris*), Andes virus (in the long-tailed pygmy rice rat *Oligoryzomys longicaudatus*) and others (CDC – All About Hantaviruses – Ecology; Schmaljohn and Hjelle, 1997).

A literature search found no record of the isolation of hantaviruses from any of the species to which this review applies. The risk of introduction, establishment and spread into Australia through importing these species is assessed as very low or negligible and specific risk management measures are not considered warranted.

Leptospirosis (*Leptospira* spp.)

Leptospirosis is a contagious disease of animals and humans caused by infection with the spirochaete *Leptospira*. There are more than 200 distinct leptospiral serovars recognised and these

are arranged in 23 serogroups. Leptospirosis occurs worldwide. Leptospire live in renal tubules of carrier animals and are excreted in urine. Leptospirosis is more prevalent in the hot wet tropics than in temperate areas. A number of serovars are endemic in Australia; others are exotic or unrecorded.

In Australia, there is a low sporadic incidence in humans, cattle and pigs and occasional disease occurrences in other species. Leptospirosis in humans is a notifiable disease. The number of cases reported annually is normally between 100 and 200, most in Queensland. Infections occur from direct exposure to urine or contaminated water. Human cases here, as in other countries, generally result from occupational exposure; most are in meat workers and farmers—banana growers, canecutters and, to a lesser extent than a decade ago, dairy farmers.

Rodents, particularly rats, are the main reservoir hosts. Some serovars are carried by livestock. Marsupials and bats are significant carriers in some places. There is evidence that some large rodents may be carriers—it has been reported that men who hunt and eat *Agouti paca* in Guyana are prone to leptospirosis (Silverman et al. 2004) and capybaras are considered a leptospira reservoir in Brazil (De Paula 2003). Large rodents may also succumb to disease. Nineteen Canadian beavers died from acute icterohaemorrhagiae infection over a period of 3.5 years in a Zurich zoo. Rats were considered the source of infection (Mettler 1975).

Australian quarantine measures have, for many years, only been applied to dogs which are subject to testing for *L. canicola* (*L. interrogans* serovar *canicola*). Dogs are recognised as the maintenance host in most countries. Serovar *Canicola* is found occasionally in coastal areas of North Queensland with a few cases detected in humans and notified each year. Rainforest animals are the main carriers (*Leptospira* serovar data sheet: WHO/FAO/OIE Collaborating Centre). There is little evidence of exotic serovars being introduced into Australia, establishing in reservoir hosts, and posing significant health risks to animals or humans.

The risk of introduction of exotic serovars through importing, under the general measures specified in the covering Advice, small numbers of the species to which this review applies is assessed as low to very low. The management of the animals post-arrival—the major zoos have pest control programs that reduce numbers of pest rodents—is likely to limit but not preclude exposure and transmission to rats. The risk of establishment and spread through such imports is assessed as very low. The historical record suggests that adverse consequences of importing these animals will be very low. The overall risk is assessed as very low and specific risk management measures are not considered warranted.

Plague (*Yersinia pestis*)

Plague (also known as bubonic plague), caused by the bacterium *Yersinia pestis*, a coccobacillus of the family Enterobacteriaceae, is an acute and sometimes fatal bacterial zoonosis. It is transmitted between animals and humans by the bite of infected fleas, direct contact, inhalation and, rarely, ingestion of infective materials.

Clinical plague manifests in three forms depending on the route of infection: bubonic, septicaemic and pneumonic [WHO Fact sheet No 267 – Plague].

The earliest (though unvalidated) account describing a possible plague epidemic, estimated to have occurred in the eleventh century BC, is found in I Samuel 5:6 of the Hebrew Bible (Tanakh) (Wikipedia: Bubonic plague). Various scholars postulate that the ‘plague’ described therein may have been tularaemia or another affliction rather than bubonic plague.

Plague has been responsible for the death of millions of people in three major ‘pandemics’. The first is held to have commenced with the Justinian’s plague (AD 541 to 546) and continued, eventually affecting all the ‘known world’ through a number of epidemics occurring in 8- to 12- year cycles until about AD 654. The second was deemed to have commenced in 1347 with the introduction of plague, probably from central Asia via eastern Europe, into Sicily. This epidemic, which became known as the Black Death, continued until 1351. Epidemics continued into the 17th century.

The third pandemic probably started in China in 1855, reached Hong Kong and Shanghai in 1894 and spread globally from there by the end of the 19th century (Perry and Fetherston 1997). Other authors consider the late 1890s, or cite 1894, as the start of the third pandemic (CDC WHOCC – Plague; 2007). The mortality rate and dissemination of sporadic plague outbreaks that continue unto the present day are greatly reduced compared to previous pandemics. There are enzootic foci in Asia, Africa and the Americas but incidence of disease is now relatively low; in 2003, 9 countries reported 2,118 cases and 182 deaths, most in Africa (WHO Fact sheet No 267 – Plague).

Plague is maintained in a natural cycle between susceptible small mammals and fleas. Important hosts include a number of rodent species—rats, mice, chipmunks, squirrels, voles, gerbils, prairie dogs and others. *Y. pestis* has been isolated from a native hedgehog in Madagascar but rodents are the major reservoir hosts. The disease is normally transmitted to humans by the bite of infected fleas although pneumonic plague may be transmitted by aerosol.

A literature search found no reference to plague in any of the species to which this review applies. Guinea pigs (*Cavia porcellus*) are recognised as a reservoir host in Peru where they are kept in homes in the Andean region as a source of food (Ruiz 2001). Capybaras and Patagonian cavies are related species and are probably susceptible to infection but there is no evidence they are a source of infection to other species.

Natural foci of plague in Europe still exist only in fringe areas of the Caspian depression and the eastern slopes of the Caucasus (WHO Plague Manual). The risk of introduction, establishment and spread of *Y. pestis* through importing large rodents from zoological collections in Europe is assessed as negligible and specific risk management measures are not considered warranted.

Plague is endemic in wild rodents in much of the US. A hooded capuchin monkey was found to have died of plague in Denver Zoo, Colorado, US in May 2007 (Denver Zoo News. 2007). It is considered likely the monkey was infected through ingestion, probably of an infected squirrel. No reference to the infection of large rodents in zoos—in the US or anywhere else—has been found in the scientific literature. The risk of introduction, establishment and spread of *Y. pestis* through importing large rodents from zoological collections in the US is assessed as very low to negligible and specific risk management measures are not considered warranted.

Rabies

Rabies is a viral disease of warm-blooded animals. There are seven genotypes of rabies-related viruses in the genus *Lyssavirus* family Rhabdoviridae. The most important and widespread is classical rabies virus—genotype 1, serotype 1—which is enzootic in most of continental Europe, Asia, Africa and the Americas. It is normally transmitted by the bite of an infected animal. The incubation period varies from a few days to months. Once symptoms develop, it is invariably fatal.

Most rabies cases occur in Asia, Africa and South America; high vaccination rates in domestic animals and various control strategies keep the incidence of urban rabies, and exposure of humans, low in Europe, Canada and the US. Dogs are by far the most important animals involved in the transmission of rabies. It is estimated that they are responsible for more than 95% of human cases worldwide. Vampire bats are important in transmission, particularly to livestock but also to people, in parts of Latin America. Red foxes play a major role in perpetuating rabies in Europe and, along with other wild canids, in North America.

Examination of tens of thousands of wild and synanthropic rodents in endemic rabies areas in North America and Europe has revealed only rare instances of rodent rabies infection, indicating that these animals do not serve as reservoirs of the disease (WHO 2004).

Australian quarantine policy for the exclusion of rabies has long been directed primarily at carnivores. The risk of introduction, establishment and spread of rabies viruses through importing large rodents from zoological collections is assessed as negligible and specific risk management measures are not considered warranted.

Tuberculosis

The causative agent of tuberculosis in wild rodents, commonly known as vole tuberculosis, is *Mycobacterium microti*, a member of the *Mycobacterium tuberculosis* complex. Vole tuberculosis has been reported in a number of rodent species including field voles, bank voles and wood mice. *M. microti* has also been isolated from rock hyraxes, shrews and, in recent years, llamas, pigs, cats, a cow, a ferret and a wild badger (Cavanagh et al, 2002; Oevermann et al, 2004). Historically, *M. microti* was considered non-pathogenic to humans but has now been reported as a cause of tuberculosis in a few people, both immunocompromised and immunocompetent, in Europe (Niemann et al, 2000; Horstkotte et al, 2001).

Comparison of spoligotype patterns for *M. microti* isolates shows three separate strain types—a 'vole' type, a 'llama' type and a 'dassie/rock hyrax' type. The first two have been isolated in the Netherlands, Belgium, the United Kingdom and France, the latter in South Africa and in imported hyraxes in the Perth Zoo and a Canadian zoo (Cousins et al, 1994; Lutze-Wallace et al, 2006).

M. bovis, the cause of bovine tuberculosis (bTB), also infects a range of species. bTB was successfully eradicated from Australia as a result of the Brucellosis and Tuberculosis Eradication Campaign. Australia was declared free in 1997. Cervids are important wildlife hosts in North America and New Zealand, and Australian brushtail possums play a major role in the epidemiology of the disease in New Zealand. Badgers are a source of infection to cattle in the United Kingdom and Ireland. White-tailed deer are recognised as a wildlife source in the US, particularly in Michigan (USDA National Wildlife Research Center). *M. bovis* was found to be the cause of tuberculosis in two capybaras in a zoo in the Czech Republic (Pavlik et al, 2002) and *M. tuberculosis* in an agouti in Poland (Pavlik et al, 2003).

While it is clear the importation of the large rodents to which this review applies entails some risk of the introduction of pathogenic mycobacteria, the paucity of reports in these species indicates the likelihood is low to very low.

Establishment and spread of *M. bovis* within zoos would have low to moderate consequences depending on how well established and how far dispersed infection was before control and eradication measures were instituted, and on the reactions of trading partners. Spread beyond zoo boundaries and infection of cattle is highly unlikely but would potentially have severe consequences arising from loss of trade until well after eradication had been achieved.

Given the consequences of spread of *M. bovis* within bovids in Australia, some specific risk management is warranted. Reliable, validated tests for live, apparently healthy animals of most non-domesticated species are not available. Certification that no case of bovine tuberculosis has occurred in the zoo of origin in the previous three years is proposed.

The risk of introduction, establishment and spread of *M. tuberculosis* through the import of the species to which this review applies is assessed as very low and specific risk management measures are not considered warranted.

The risk of introduction of *M. microti* is assessed as negligible—no reports of infection of these animals have been found in the scientific literature—and the consequences of establishment and limited spread would be low to moderate. Specific risk management measures are not considered warranted.

Tularaemia (*Francisella tularensis*)

Tularaemia is a highly contagious, zoonotic, bacterial disease caused by the coccobacillus *Francisella tularensis*. The disease appeared, until recently (see below), to be confined to the Northern hemisphere where it occurs in Canada, the US and Mexico, and in a number of Eurasian countries. It affects many species of wild and domestic mammals, birds, reptiles and fish, as well as humans.

There are two predominant subspecies of *F. tularensis*, *F. tularensis* subsp. *tularensis* (Jellison type A) and *F. tularensis* subsp. *holarctica* (Jellison type B). Type A is the main subspecies in North America where it is transmitted by ticks from rabbits to humans and by direct contact with infected animals. The incidence of infection in the US has been very low in recent years. Type B is spread more widely and is the main subspecies in European countries. It is associated with rodents and hares and is transmitted to humans by direct contact, inhalation, ingestion of contaminated food and water, or by arthropod bites (Tärnvik and Berglund, 2003). Type A strains are highly virulent and, before the advent of effective antibiotics, a mortality rate of 5–10% was reported in humans. Type B is less virulent and is normally non-lethal in humans.

There are two other subspecies, *F. tularensis* subsp. *novicida*, endemic in the US but reported—albeit as an atypical strain—in Australia (Whipp et al, 2003), and subsp. *mediasiatica* reported only from central Asian republics of the former Soviet Union (Farlow et al, 2005). The distribution of less virulent subspecies of *F. tularensis* may be considerably greater than hitherto recognised.

The natural reservoir for *F. tularensis* is unknown. In general, rodents and lagomorphs do not survive the infection. *F. tularensis* survives in water and mud for months and the distribution of tularaemia in Eastern Europe and Sweden is related to natural water (Tärnvik and Berglund, 2003).

The risk of introduction of *F. tularensis* through the importation of the species in question is assessed as negligible—no reports in the literature incriminating these species in spreading infection have been found. Specific risk management measures are not considered warranted.

Pathogens of laboratory rats and mice

There are a number of pathogens not listed above that are found in laboratory rodent colonies. More common and important ones include Sendai virus, *Mycoplasma pulmonis*, *Clostridium piliforme* (Tyzzer's disease), mouse hepatitis virus, ectromelia virus (mouse pox) and *Yersinia pseudotuberculosis* and *Y. enterocolitica*.

Laboratory mice and rats, hamsters, guinea pigs and swine are the hosts of Sendai virus. Young mice are most affected; the disease is mostly subclinical in older animals and the other species. Rats and mice are the principal natural hosts of respiratory and genital infections caused by *M. pulmonis*. Rabbits and guinea pigs may occasionally carry the organism but are not affected clinically (Harkness and Wagner, 1995). Infection with these organisms has not been reported in the species to which this review applies.

Clostridium piliforme has been recorded worldwide in guinea pigs, hamsters and gerbils and a wide range of other animals, as well as rats and mice (Harkness and Wagner, 1995). It has been reported in Australian marsupials (Canfield and Hartley, *J Comp Pathol*, 1991 105(2):167-73), and was implicated in the death of a captive colony of the Spinifex hopping mouse at Taronga Zoo in Sydney (Hill et al, *Aust Vet J* 2007, 85(1-2):62-64). It is highly likely to be present in other rodents.

Mouse hepatitis virus, which is not a single virus (up to 25 strains have been recognised), infects mice only. Similarly, ectromelia virus, the cause of mouse pox, infects mice only (Harkness and Wagner in: *The Biology and Medicine of Rabbits and Rodents*).

Y. pseudotuberculosis and *Y. enterocolitica* are found in a number of animal species including some rodents—agoutis, chinchilla, guinea pigs and hamsters. Agoutis are among the species to which this review applies. These *Yersinia* species are both endemic in Australia.

Specific risk management measures are not considered warranted for any of these pathogens.

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DRAFT QUARANTINE MEASURES FOR THE IMPORTATION OF CERTAIN SPECIES OF RODENTS INTO AUSTRALIAN ZOOS FROM CANADA, NEW ZEALAND, THE UNITED STATES OF AMERICA AND MEMBER STATES OF THE EUROPEAN UNION

Conditions of Administration

Importation under these conditions is restricted to certain species of rodent (Order Rodentia) of the Suborder Hystricognathi. Each animal must have been resident in a zoo or wildlife park in Canada, New Zealand, the United States of America or a Member State of the European Union for 12 months prior to export or since birth. Species that will be permitted importation are capybaras (*Hydrochoerus hydrochaeris*), Brazilian agoutis (*Dasyprocta leporina*), Patagonian maras (*Dolichotis patagonum*) and Cape porcupines (*Hystrix africaeaustralis*). Applications to import other species within the Suborder Hystricomorpha may be considered on a case by case basis. Importation is only permitted into Australian zoos.

Permission to import must be obtained in writing from the Australian Quarantine and Inspection Service (AQIS) prior to the export of the rodent. A full description of the animal (including species, sex, age, microchip number and site of implantation) must be provided with the permit application.

Other conditions of administration, including details of import permit requirements and transport arrangements, are available from AQIS. Contact details are:

Live Animal Imports

AQIS

GPO Box 858

Canberra ACT 2601

Fax +61 2 6272 3110

E-mail animalimp@aqis.gov.au

Phone +61 2 6272 4454

The full requirements can also be viewed on AQIS' Import Conditions database (ICON) at www.aqis.gov.au.

Permission to import must also be obtained from the Australian Government Department of Environment, Water, Heritage and the Arts. Details are available from the Department's website: <http://www.environment.gov.au/biodiversity/trade-use/index.html>.

Documentation

An original international veterinary certificate signed by an Official Veterinarian* of the country of export, and the original of the permit to import, must accompany each animal.

*Note: Official Veterinarian means a veterinarian authorised by the Veterinary Administration of the country to perform certain designated official tasks associated with animal health and/or public health and inspections of commodities and, when appropriate, to certify in conformity with the Certification Procedures of the World Organisation for Animal Health (OIE) Terrestrial Animal Health Code.

Format of the veterinary certificate

1. The veterinary certificate must:

- be written in English
- meet all requirements of the veterinary certification section of these conditions
- provide the identification for each animal including species, sex, age, microchip number and site of implantation
- include the name and address of the exporter and importing Australian zoo, and the AQIS Import Permit number.

2. An Official Veterinarian of the Government Veterinary Administration must:

- provide a separate veterinary certificate for each animal
- sign, date and stamp each page of the veterinary certificate and all documents, eg laboratory reports that form part of the extended health certification with the stamp of the Government Veterinary Administration
- record his/her name and contact details on the veterinary certificate.

3. AQIS will only accept copies of documents where each page bears the original signature, date and stamp of the Official Veterinarian.

Veterinary certification for the importation of rodents into Australian zoos

1. The animal for export has been continuously resident in a government licensed or registered zoo or wildlife park for the 12 months immediately prior to export or since birth. The premises of origin is under veterinary supervision and the animals held in the premises are subject to a health monitoring program.

2. No case of bovine tuberculosis (*Mycobacterium bovis*) has been diagnosed in the premises of origin during the past three years. No case of babesiosis has been diagnosed in rodents in the premises of origin during the past 12 months.

3. The animal has been held in pre-export quarantine (PEQ) for a period of at least 30 days. During this time it has been isolated from animals not of the same certifiable health status, and housed in accommodation which precluded access by animals and was screened to prevent insect entry.

4. During PEQ, the animal remained free from signs of infectious and contagious disease.

5. During the first week of PEQ, the animal was treated for endoparasites using parasiticides effective against nematodes, cestodes and trematodes, and tested by appropriate parasitological techniques 7-14 days later. The animal was re-treated if there was evidence of parasites:

Date(s) of treatment:

Active ingredients and dose rate:

6. During PEQ, the animal was treated twice at an interval of 14 days for ectoparasites using parasiticides effective against ticks, mites and lice.

Dates of treatment:

Active ingredients and dose rate:

7. The animal was examined by an Official Veterinarian within 24 hours prior to leaving the PEQ premises for the port of export and was found to be free from signs of communicable disease, free from external parasites and fit to travel.

8. The container for the transport of the animal to the port of export was new or was cleaned and disinfected to the satisfaction of the Official Veterinarian prior to loading the animal.

9. During transport to the port of export the animal had no contact with animals except those of the same export consignment and with the same certified health status.

10. I am satisfied, after due enquiry, that the preparations for transport, and the container in which the animal is carried, are of a standard not less than those required by the International Air Transport Association (IATA) Live Animals Regulations.

Transport

The animal must be consigned to Australia by a route approved by AQIS. It may be accompanied by other animals only with the approval of AQIS. Any transshipment requires the approval of AQIS. Stops on route will need approval from relevant authorities in the countries of transit and transshipment.

Post-arrival quarantine measures for the importation of approved species of rodents into Australian zoos

1. Each imported animal must undergo post-arrival quarantine (PAQ) in a quarantine approved premises (QAP) for 14 days.

2. During PAQ, the animal may be subject to testing and/or treatment for disease or parasites. If any animal fails a test or shows signs of disease or does not meet these requirements, that animal and any other animal in the QAP may be:

- detained in quarantine for further testing and observation
- exported at the importer's expense
- destroyed without recompense.