Brucellosis in wildlife

J. Godfroid

Department of Bacteriology and Immunology, Veterinary and Agrochemical Research Centre, Groeselenberg 99, 1180 Brussels, Belgium

Summary

Brucellae infections have been documented world-wide over the years in a great variety of terrestrial wildlife species. Recently, brucellae infections have also been reported in a wide variety of marine mammals. A very important consideration with regard to terrestrial brucellosis in wildlife is to distinguish between a spillover of infection from domestic animals and a sustainable infection in wild species. The probability of brucellosis becoming established and being sustainable in a species depends on a combination of factors including host susceptibility, infectious dose, contact with infected animals, management and environmental factors. In this context, the development of the game farming industry appears to have contributed to the re-emergence of brucellosis. The gold standard in brucellosis diagnosis remains the isolation of brucellae. If brucellosis is suspected in an animal or a wildlife population following positive serological results, attempts to isolate the organism should always be performed. The release of anti-brucellae vaccine strain in wildlife is of concern because this could lead to environmental contamination and infection of other wild species. Therefore, the appropriate dosage of the vaccine in target species as well as the safety of the vaccine in non-target species must be addressed in technical terms in order to assist decision-making regarding the management of wildlife brucellosis.

Keywords

Bacteriology – Brucella abortus – Brucella melitensis – Brucella suis – Brucellosis – Marine mammals – Serology – Sustainable disease – Wildlife.

Introduction

Brucellosis is an important zoonotic disease, widely distributed in both humans and animals. The occurrence of the disease in humans is largely dependent on the occurrence of brucellosis in animal reservoirs, including wildlife. Prior to the introduction of pasteurisation, milk was the principal source of infection in the human population. The disease is now primarily occupational (affecting workers in abattoirs, the animal industry and animal health occupations). Clinical symptoms, including undulant fever, tiredness, night sweats, headaches and chills may be present for as long as three months before the illness becomes so severe and debilitating as to require medical attention. Anxiety and depression are common in long-standing infection and some patients may present principally skeletal, neurological and cardiovascular complications (3).

Brucellae are Gram-negative, facultative, intracellular bacteria. Six species are recognised within the genus *Brucella*, namely: *B. abortus*, *B. melitensis*, *B. suis*, *B. ovis*, *B. canis* and *B. neotomae* (2). This classification is primarily based on differences in pathogenicity and host preference. The principal pathogenic species world-wide are *B. abortus* (responsible for bovine brucellosis), *B. melitensis* (the main aetiologic agent of ovine and caprine brucellosis), and *B. suis* (responsible for swine brucellosis). Infection usually leads to abortion in the host, which may result in massive direct economic losses and may also pose a potential barrier to international trade. The infection is principally transmitted through contact with foetal membranes, lochia, post parturient discharges and milk. *Brucella ovis* and *B. canis* are responsible for ram epididymitis and canine brucellosis, respectively, and are generally transmitted venereally. These species are seldom reported in wildlife. *Brucella neotomae* has only been isolated from desert rats (*Neotoma lepida*) in Utah, United States of America (USA), and has no known pathogenicity in any other animal species. Neither *B. ovis* nor *B. neotomae* are known to cause disease in humans (3).

Brucella abortus and *B. suis* have been isolated world-wide from a great variety of wildlife species, such as bison (*Bison bison*), elk/wapiti (*Cervus elaphus*), feral pigs (*Sus scrofa*), wild boar (*Sus scrofa*), European hares (*Lepus capensis*), foxes (*Vulpes vulpes*), African buffalo (*Syncerus caffer*), eland (*Taurotragus oryx*), waterbuck (*Kobus elipsiprymnus*), reindeer (*Rangifer tarandus tarandus*), and caribou (*Rangifer tarandus groenlandicus*) (11). Although *B. melitensis* is rarely reported in wildlife, cases were recently reported in Europe in chamois (*Rupicapra rupicapra*) and ibex (*Capra ibex*) in the Alps (21, 29).

Since the first description of an abortion due to brucellae in a captive dolphin in California, USA, in 1994 (18), several recent reports have described the isolation and characterisation of brucellae strains from a wide variety of marine mammals, such as seals, porpoises, dolphins, and a minke whale (*Balaenoptera acutorostrata*) (8, 25, 26, 39, 49). The overall characteristics of these marine mammal strains were different to those of any of the six currently recognised brucellae species (7, 8, 9, 35). The pathology and the zoonotic potential of marine mammal brucellosis are still largely unknown. New geographical distributions and target species are currently being reported.

Spillover versus sustainable infection or disease

A very important issue in the study of brucellosis in terrestrial wildlife is to distinguish between a spillover of infection from domestic animals and a sustainable infection in wild species. In this latter case, the concern of the livestock industry is to prevent the re-introduction of the infection into livestock, particularly in regions or states that have active brucellosis eradication schemes or are officially 'brucellosis-free', due to the financial implications and the need to re-instate pre-movement testing for domestic animals.

Introduction of an infected individual is not a sufficient indicator of transmission of brucellae to other animals of the recipient species. The probability of brucellosis becoming established and being sustainable in a species will be equal to or less than the probability of infection and in some cases will be close to zero because a combination of factors must be taken into account, including host susceptibility (or resistance), infectious dose, (repeated) contacts with infected animals, seasonal (calving) infectivity, management and environmental factors (28). In this context, the development of the game farming industry has contributed to the re-emergence of brucellosis as an international concern for both livestock and wildlife, due to lack of pre-movement screening, an increase in the density of possibly infected game species, and the introduction of artificial feeding (46).

This review will not discuss brucellosis in those wildlife species where only anecdotal or circumstantial evidence of brucellosis exists, based on limited serological data. This does not mean that brucellosis was never or will never be a problem in these species. However, to date, the available data suggest that brucellosis is probably a marginal problem, if any at all, in such species, and poses little risk, either to the species in question or to domestic livestock. The following sections of this review will highlight situations in which brucellosis appears to be a sustainable infection in different wildlife populations. This creates a challenge for wildlife scientists, regulatory veterinarians and the animal industry, namely: to identify and to help overcome the threats due to brucellosis which may adversely affect many wild animal populations and their management.

In this context, a global approach has evolved to include the diagnosis of brucellosis as a disease and focus on the (early) detection of a preclinical or subclinical infection. This allows responsible officials to initiate a preventive management programme in order to minimise the disease risk to both domestic and free-ranging or captive wildlife, as well as the zoonotic potential of the infection.

Brucella abortus

As the brucellosis eradication efforts in the European Union and the USA focused on bovine brucellosis, the emphasis was placed on the identification of a possible reservoir of *B. abortus* in wildlife. When brucellosis was prevalent in cattle, numerous surveys identified occasional seropositive results in wild ungulates, particularly cervids (46). The infection was considered to be self-limiting or a spillover of the infection in cattle; for example, in 1995, *B. abortus* was isolated in 7/112 culled chamois, but brucellosis did not appear to be present in larger areas of the Alps of western Italy, where bovine brucellosis was absent (22).

In countries in which bovine brucellosis eradication programmes have succeeded or are in an advanced stage and eradication appears attainable, few sustainable reservoirs of *B. abortus* in wild species are known to be present. Exceptions are bison and elk in the National Parks of the Greater Yellowstone area, USA, and in the Wood Buffalo National Park, Canada. In addition, the African buffalo is considered to be a reservoir of *B. abortus* in southern Africa.

Brucellosis in bison

Brucellosis is thought to have been transmitted to the different bison herds in the National Parks of the Greater Yellowstone area of Wyoming, Montana and Idaho in the early 1900s by cattle providing milk for park employees. Although serological evidence of brucellosis and abortion were reported as early as 1917, *B. abortus* was isolated for the first time from an aborted female bison in 1993 (60). Recent isolation of *B. abortus* biovar 2 (47) as well as repeated isolation of *B. abortus* biovar 1 (44), suggest that more than one source of infection existed for bison. These observations were also found in the early 1990s in bison in the Wood Buffalo National Park (53). The distribution of *B. abortus* in bison was found to be similar to the distribution of the pathogen in cattle (47). Arthritis and hence lameness may also contribute to emaciation as observed in chronic bovine brucellosis (53).

The lack of reported abortions during the following decades led scientists to speculate that the incidence of *B. abortus* in free-ranging bison was related to that in cattle (43). However, different field studies have since demonstrated that abortions continue to occur and that the histopathology and bacteriology findings are the same in bison and cattle. Thus, bison can be considered to be maintenance hosts of infection, as confirmed by experimental studies (12). Transmission between bison and cattle has also been experimentally documented (46).

Other experimental studies shed light on the use in bison of different vaccines that have proven efficacy in cattle. The persistence of the S19 and the RB51 vaccine strains within lymph nodes was monitored in bison. Bison vaccinated with S19 or SRB51 developed granulomatous lymphadenitis. Neither S19 nor SRB51 were cleared as rapidly as in cattle (42). The S19 vaccine was found to be an unsuitable vaccine for pregnant bison because persistent antibody titres, abortions and chronic infections were induced, and vaccination of bison provided less protection against brucellosis, compared to vaccination of cattle (13). The safety of the RB51 was also assessed and although the strain was found to be safe in one study (16), vaccination induced abortions and placentitis in 2/8 pregnant bison in another study, although no foetal lesions were reported (43).

The potential shedding of the RB51 vaccine strain, which is a rifampicin-resistant strain, is of concern, due to the possibility of environmental contamination and infection of other wild species. Therefore, the appropriate dosage in bison as well as the safety of the strain in non-target species must be tested before use of the vaccine can be recommended (43).

Brucellosis in elk or wapiti

One fifth of the elk population in the Greater Yellowstone area is artificially fed during winter, resulting in significant congregations on the feeding grounds. This management practice increases the risk of elk being exposed to *B. abortus*-infected material and is believed to explain why brucellosis is a sustainable infection in this species. Serological surveys have demonstrated that the seroprevalence in artificially fed elk was much higher than seroprevalence in non-fed elk and provided scientific evidence to support this hypothesis (46). *Brucella abortus* was isolated for the first time in elk during the 1960s. *Brucella abortus* biovar 1 was again isolated during the 1990s from a seropositive animal (45).

Winter feeding, which is a questionable practice, not only from the brucellosis perspective, is not likely to be politically addressed in the coming years. Therefore, alternative control measures, such as vaccination, have been sought to prevent transmission between non-infected and infected elk herds and from infected elk to bison or cattle.

Experimental studies suggest that further evaluation is required to determine whether the RB51 vaccine will be safe and efficacious in free-ranging pregnant elk. In captive pregnant elk, mixed vaccine strain RB51 and *B. abortus* challenge strain were isolated from foetuses and vaginas of the vaccinated group (37).

Brucellosis in the African buffalo

In South Africa, several species of wildlife (African buffalo, hippopotamus [*Hippopotamus amphibius*], zebra [*Equus burchellii*], eland, waterbuck and impala [*Aepyceros melampus*]) have tested serologically positive for brucellosis, but these species are probably of minor importance in the epidemiology of bovine brucellosis in southern Africa. This is possibly due to the relatively infrequent contact between cattle and wildlife (32). As with bison, few records exist of abortions due to brucellosis in wildlife in southern Africa, although *B. abortus* biovar 1 has been isolated from the cotyledons of pregnant buffalo at slaughter (32), and experimental infection of pregnant buffalo resulted in late term abortions. Although serological surveys have revealed up to 23% positive reactors in buffalo from the Kruger National Park (33), the authorities in South Africa believe that these animals probably do not currently constitute a significant source of infection for cattle because of the strict control measures to prevent the spread of foot and mouth disease across the boundaries of the Park and from adjoining private nature reserves, which limit contact between buffalo and cattle. In Zimbabwe, in the early 1990s, 14 of 29 (48%) serum samples from buffalo were classified as positive. These samples were collected from game areas where contact with domestic cattle, sheep and goats could be excluded. It was concluded that brucellosis might be a sustainable infection in African buffalo populations, which consequently should be considered a possible source of reinfection for domestic stock (38).

Brucella suis

Although *B. suis* (biovars 1, 2 and 3) is still widely distributed in the world, prevalence in domestic pigs is low, with the exception of South-East Asia and South America. The infection has been eradicated in the domestic pig population for decades and is principally restricted to feral pigs in the USA and Australia (*B. suis* biovars 1 and 3) and wild boar in Europe (*B. suis* biovar 2). *Brucella suis* biovar 2 differs from *B. suis* biovars 1 and 3 in being restricted to Europe, and this biovar also has the ability to infect the European hare which may act as a reservoir. However, inquiries in Western Europe over the last decade show a dramatic reduction in hare hunting scores. This population regression is primarily due to intensive agricultural practices, the impact of diseases (principally coccidiosis and European brown hare syndrome) and predation (by foxes). Reports of *B. suis* biovar 2 infections in the European hare are now infrequent. Remarkably, *B. suis* biovar 2 is very rarely a human pathogen and has only once been reported as the cause of human brucellosis.

Rangifer brucellosis (i.e. brucellosis in reindeer and caribou) is caused by *B. suis* biovar 4 throughout the Arctic region, Siberia, Canada and Alaska, and constitutes a serious zoonosis. *Brucella suis* biovar 4 may also infect moose (*Alces alces*) and occasionally various carnivores.

European wild boar

In 1994, an outbreak of enzootic brucellosis (*B. suis* biovar 2) in wild boar was reported in Belgium (31). During the 1990s, the number of wild boar reached record levels in south-eastern Belgium, with an estimated population of over 10,000 individuals (45 per 1,000 ha of forest). This tendency was also noticed in neighbouring countries (France, Germany and Luxemburg). Some of these animals were raised in enclosures before release for hunting. Fortunately, this practice, which potentially supported the maintenance of brucellosis, is no longer allowed. One of the most striking features of brucellosis in wild boar is that a very high percentage of infected animals can be detected in all age categories by bacteriological isolation, often in the absence of gross lesions (31). No definitive explanation has been provided, but this may be due to a lower pathogenicity of *B. suis* biovar 2 for wild boar compared to domestic pigs, or because of the lack of baseline work on the ecology of the infection.

Feral pigs

Brucella suis infections in feral pigs are regularly reported in Hawaii, the south-eastern states of the USA, and Queensland, Australia. Over the past few decades, an extension of the geographical range of feral pigs and spatial distribution of brucellosis has occurred due to the release of feral pigs infected with *B. suis* (57) in new hunting grounds in the central states of the USA (46). Due to their high numbers, feral pigs are considered by ecologists as a significant pest, and control of these populations has been advocated. However, other interest groups regard these animals as an important source of income for the hunting and sport industry. Human brucellosis is re-emerging in Queensland because of the recreational and occupational exposure to feral pigs infected with *B. suis* (48). Moreover, the number of humans at risk is increasing because of the expansion of an export industry based on feral pig meat (30). In 1994, *B. suis* biovar 1 was isolated from a butcher in Belgium who had been handling imported feral pig meat (31). *Brucella suis* biovar 1 infection had last been reported in a pig farmer in this country in 1983.

Caribou, reindeer and moose

Rangiferine brucellosis is enzootic in Siberia, Canada and Alaska in caribou and reindeer, and *B. suis* biovar 4 was isolated in both species in the 1960s. When clinical signs are present, abortions and metritis are seen in females and orchitis in males. In both sexes, abscess-formation in joints and often bursitis and lameness are observed (20). Human cases have been restricted to herders of diseased reindeer or caribou (23). Experiments demonstrated that cattle exposed to reindeer infected with *B. suis* biovar 4 can become infected, but the pathogenesis in cattle has yet to be studied (24). A recent serological study concluded that brucellosis was not present in reindeer in Finnmark, northern Norway (4).

In Canada, a natural *B. suis* 4 infection was confirmed in moose, for the first time, in 1993. Carpal pathology and osteomyelitis of subjacent bone was observed (34). Experimental infection (14) and serological evidence of *B. suis* biovar 4 in moose have been described in Alaska (15).

Brucella melitensis

Surprisingly, the known ecological range of *B. melitensis* in wildlife is more restricted than that of *B. abortus* and *B. suis*, although *B. melitensis* is still a significant problem in small farmed ruminants, and hence of major zoonotic concern. Spillover from infected small ruminants has been documented in a few wildlife species such as chamois and ibex in the Alps of France and Italy. Blindness and neurological signs, as well as thick-walled carpal joints and enlargement of the testicle characterised by necrosis and fibrosis were observed (21, 29).

In the Middle East, most *B. melitensis* infection in nomadic one-humped camels (*Camelus dromedarius*) occurs in those animals which have contact with sheep and goats. The organism has been isolated from the milk of camels, and therefore this species also constitutes a serious public health problem (1). Brucellosis has also been reported in llamas and other small camelids in some countries of South America (3).

Marine mammal brucellosis

Prior to the first reports, in 1994, of brucellae isolations from stranded harbour seals (*Phoca vitulina*), harbour porpoises (*Phocoena phocoena*) and common dolphins (*Delphinus delphis*) on the coast of Scotland (49) and from an aborted foetus of a captive bottlenose dolphin (*Tursiops truncatus*) in California (18), brucellosis was not only unrecognised, but was not even suspected in marine mammals. In the 1990s, strains of brucellae which were biologically and genetically different from the classical six recognised species of *Brucella* were isolated from cetaceans and pinnipeds inhabiting seas and oceans of Europe and North America (8, 9, 25, 26, 39, 49, 50) or kept in captivity (18). Anti-brucellae antibodies have also been detected in serum samples from several species of marine mammal from the Northern and Southern Hemispheres (36, 40, 54, 56).

The high number of sero- or culture-positive marine mammals raises the possibility of a common source of brucellae in the marine food chain. In a recent study concerning experimental infections of Nile catfish with *B. melitensis* biovar 3, the bacteria were successfully cultured from visceral organs, suggesting that these fish are susceptible to brucellae (52). Infections may also be acquired from contact with infected material in areas where birth takes place. The spread of bacteria may also be venereal, or the calves/pups may be infected congenitally or as neonates by infected milk, as seen in other mammals.

A further question is whether brucellosis induces disease in marine mammals. The detection of early brucellae infections is possible by direct or indirect techniques. The detection might occur in a preclinical or subclinical phase and it is necessary to determine whether these infections are responsible for clinical disease, pathology without lesions or any pathology. The primary impact of brucellosis in domestic animals is reduced reproductive success, which in general, is difficult to assess in wild populations, as observed in bison, African buffalo or wild boar, and obviously also in marine mammals. Clinical symptoms, if present, may be cryptic, gross pathology may be absent, and as a rule, mortality and morbidity are low. The finding of Ewalt *et al.*, who isolated brucellae from an aborted bottlenose dolphin foetus, indicates that brucellae may cause abortion in this species (18). If brucellae infections lead to reproductive disorders in marine mammals, then brucellosis may play an important role in the population dynamics of these species (39). The majority of marine mammal brucellae have been isolated from subcutaneous lesions or from organs with no obvious sign of pathology. Organs and tissues were sampled from stranded animals but also from by-catches or during scientific whaling. However, a crucial observation was recently made in stranded dolphins on the coast of Scotland. Three animals showed meningo-encephalitis at necropsy and brucellae were cultured from the brains (G. Foster, personal communication). The potential impact of brucellosis on cetacean echolocation is of concern.

In Norway, a long tradition exists of consumption of meat from harp seals (*Phoca groenlandica*), hooded seals (*Cystophora cristata*) and minke whales, all species that have been found to be infected with brucellae. However, brucellosis has never been reported in humans at risk in Norway (whale- and seal-hunters, veterinarians controlling the meat, other meat handlers, or consumers). However, in one case, exposure of a laboratory worker to a marine mammal brucellae revealed that such bacteria may also be pathogenic to humans (6).

The polar bear (*Ursus maritimus*) is the apex predator in the marine food chain of the Arctic, and in the Svalbard area, ringed seals (*Phoca hispida*), bearded seals (*Erignathus barbatus*) and harp seals are the main prey of the polar bear. Anti-brucellae antibodies were found in ringed seals and harp seals in the Svalbard area (54). A seroprevalence of anti-brucellae antibodies of 5.4% was found in plasma samples taken from 297 polar bears from Svalbard and the Barents Sea (55). To date, no indication of disease caused by brucellae has been detected in the polar bear population at Svalbard. Therefore, the potential impact of brucellae exposure on individuals or the population is unknown.

Serology versus bacteriology

A variety of brucellosis serological investigations has been performed in both wildlife and zoo collections, aiming to assess the presence or the spread of brucellae within different wild species and to classify species or individuals as exposed or non-exposed.

Brucellosis serology in wildlife is usually performed using the same antigens as in domestic ruminant serology, because the brucellae immunodominant antigens are associated with the surface smooth lipopolysaccharide (LPS) and are to a large extent shared by all the naturally-occurring biovars of *B. abortus*, *B. melitensis* and *B. suis* (2). Most brucellosis serological tests have been directly transposed, without validation, from their use in domestic livestock populations, although the test may not perform identically in wild species. Some assays, such as the enzyme-linked immunosorbent assay (ELISA), rely on species-specific reagents which are not commercially available. This limitation, due to the lack of polyclonal or monoclonal antibodies to the immunoglobulins of many wildlife species, can be partly overcome by the use of either protein A or protein G conjugates (54, 55, 56). Other techniques, such as competitive ELISA or the fluorescent polarisation assay (FPA), which do not rely on species-specific reagents, have already proven useful in bison (27) and marine mammals (56).

To validate serological tests, results should be analysed according to the true infectious status of an animal. The presence of anti-brucellae antibodies suggests exposure to the bacteria, but does not necessarily mean that the animals have a current or active infection at the time of sampling. The presence of antibodies may be a result of past infections resulting in a 'self-limiting' disease, as demonstrated in *B. suis* biovar 1 experimental infections in bison (5). On the other hand, carrier animals may lose their antibody titres as reported from experimental and natural infections in almost every brucellae susceptible animal species, leaving the possibility that the actual prevalence of brucellosis may be higher than indicated by antibody screening. Latent infection without sero-conversion further complicates the problem, particularly in pre-pubertal animals.

It is not appropriate to propose a single serological test as a reference test to assist veterinarians in the diagnosis of wildlife brucellosis. With the shift to the detection of a preclinical or subclinical disease, the ecology of brucellae has become very important in the interpretation of serological results. Brucellosis ecology can be divided into infection rate, attack rate (progression to clinical disease) and mortality/morbidity rate (chronic carrier state) (17). Therefore, the emphasis is no longer placed on intrinsic values of a test, but on the predictive value of the test, which relates to the clinical utility of the result (41). In an initial screening programme, a parallel interpretation of the first line of tests should be chosen to improve the specificity of the detection of anti-brucellae antibodies (55). Classical brucellosis screening tests and/or the newly developed ELISAs and the FPA should be used first. Cross-reactive bacteria such as *Yersinia enterocolitica* O:9 may induce serological cross-reactions in the brucellosis serological tests that are almost indistinguishable from true brucellosis serological reactions (51, 59). Other known or unknown cross-reactive bacteria may exist in wildlife. The detection of specific antibodies directed against brucellae cytoplasmic proteins, as in samples from elk (37), moose (15) or polar bears (55), strongly suggests that the anti-LPS antibodies detected by the other brucellosis serological tests are probably due to a brucellae infection. Another approach is to assess the cell-mediated immunity, either *in vivo* (skin tests) or *in vitro* (proliferation assays or cytokine detection assays) against specific brucellae cytoplasmic proteins. These approaches were successful in domestic animals, particularly cattle (51, 59), and should be encouraged in wildlife, where possible. Although brucellosis tests are usually adequate for the detection of an infected group of animals, it is also important to acknowledge that the tests have significant limitations in detecting every infected individual animal.

The gold standard in brucellosis diagnosis remains the isolation of brucellae. If brucellosis is suspected in an animal or a wildlife population following positive serological results, attempts to isolate the organism should always be performed.

Conclusions

In 1991, Professor Paul Nicoletti from the College of Veterinary Medicine at the University of Florida said during an interview: 'I encourage my veterinary students to pick a "survivor", a disease that will provide a lifetime of challenging and rewarding work. Brucellosis is notorious for being a survivor'. From the first description of *B. melitensis* as an agent of Malta fever, by David Bruce in 1887, to the discovery of a new world-wide ecological niche of brucellae in marine mammals, brucellosis has always been a cause for concern. With particular reference to wildlife brucellosis, the lack of understanding of the ecology of the infection in the past and present is surprising; for example, scientists speculated for decades about whether brucellosis induced abortion in bison (43). Little is known about the pathology of *B. suis* biovar 2 in wild boar (31) and marine mammal brucellosis research is still in its infancy; it is suggested that marine mammal brucellae comprise at least two new species named *B. cetacea* and *B. pinnipediae* (8). The pathology in marine mammals (18, 39) and domestic animals is relatively unknown, as is the zoonotic potential (6) of these newly identified species of *Brucella*.

Emphasis should be placed on multidisciplinary research to address the ecology of the infection (absence or presence of clinical signs, pathology without lesions), particularly in identifying whether a brucellae infection is sustainable in a population and in analysing the factors that are of crucial importance for maintenance of infection in this population. Serology is the first tool in detecting a preclinical or subclinical infection. Although improved tests and testing strategies should be developed, the gold standard in brucellosis diagnosis remains the isolation of brucellae and this operation is thus mandatory.

Wildlife brucellosis is also a political issue; the livestock industry, the hunting and the game farming industry, wildlife conservation and welfare institutions, may have conflicting interests. In locations where *B. abortus* has been eradicated in a cattle population, *B. melitensis* and *B. suis* have later been isolated in the cattle, and the sources of infection were found to be infected sheep (58) and feral pigs (10, 19), respectively.

Nevertheless, certain issues, such as artificial feeding practices which modify the ecology of the infection, and the release of vaccines of unknown efficacy and safety (particularly for non-target species), must be addressed in technical terms in order to assist decision-making regarding the management of wildlife brucellosis.

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La brucellose chez les animaux sauvages

J. Godfroid

Résumé

Les infections dues à *Brucella* ont été décrites chez de nombreuses espèces sauvages terrestres dans le monde entier. Récemment, des infections à *Brucella* ont également été signalées chez plusieurs espèces de mammifères marins. Pour les animaux sauvages terrestres, il convient de distinguer une contamination brucellique résiduelle résultant d'une transmission à partir d'animaux domestiques, d'une infection brucellique affectant de manière durable les espèces sauvages. La probabilité que la brucellose affecte durablement une espèce animale dépend de plusieurs conditions, dont la sensibilité de l'hôte, la dose infectante, le contact avec d'autres animaux infectés, la gestion de la faune et de son environnement. À cet égard, le développement de l'élevage du gibier a favorisé la ré-émergence de la brucellose. La confirmation du diagnostic de la maladie repose sur l'isolement de *Brucella*. En cas de suspicion de brucellose chez un animal ou une population d'animaux sauvages à la suite de résultats positifs aux épreuves sérologiques, il convient de procéder systématiquement à des essais d'isolement de l'agent pathogène. La distribution de vaccins anti-brucelliques aux animaux sauvages est problématique, en raison des risques de contamination environnementale et de transmission de l'infection à d'autres espèces sauvages. Il convient donc de déterminer sur base scientifique, la dose vaccinale appropriée pour les espèces cibles ainsi que l'innocuité pour les espèces non visées, afin d'aboutir à des décisions rationnelles dans les programmes de prophylaxie de la brucellose chez les animaux sauvages.

Mots-clés

Bactériologie – Brucella abortus – Brucella melitensis – Brucella suis – Brucellose – Faune sauvage – Maladies durables – Mammifères marins – Sérologie.

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Brucelosis en la fauna salvaje

J. Godfroid

Resumen

A lo largo de los años se ha descrito en todo el mundo la infección por brucelas de un gran número de animales salvajes terrestres. Recientemente se han comunicado además casos de brucelosis en muy diversos mamíferos marinos. Por lo que respecta a la brucelosis en la fauna salvaje terrestre, es fundamental distinguir entre la extensión secundaria de la infección a partir de animales domésticos y una infección que se mantiene de forma autónoma en poblaciones salvajes. La probabilidad de que la brucelosis afecte a una especie y logre mantenerse en ella depende de una combinación de factores, principalmente la susceptibilidad del huésped, la dosis infecciosa, el contacto con animales infectados y una serie de factores ligados a la gestión de la fauna salvaje y de su entorno natural. En este sentido, el desarrollo de la cría a gran escala de especies cinegéticas parece haber contribuido al resurgimiento de la infección. El criterio básico para identificarla sigue siendo el aislamiento de brucelas. De ahí que, cuando haya resultados serológicos positivos que lleven a sospechar la presencia de brucelosis en un animal o una población salvaje, sea conveniente intentar sistemáticamente el aislamiento del microorganismo. La diseminación entre animales salvajes de una cepa de vacuna antibrucela es un proceder arriesgado, ya que puede contaminar el medio natural y causar la infección de otras especies salvajes. Por ello, y a fin de apoyar la adopción de decisiones racionales en materia de gestión de la brucelosis en la fauna salvaje, es preciso estudiar detenida y científicamente la dosis de vacuna apropiada para las especies destinatarias y el grado de seguridad que presenta para otras especies.

Palabras clave
Bacteriología – Brucella abortus – Brucella melitensis – Brucella suis – Brucelosis – Enfermedad automantenida – Fauna salvaje – Mamíferos marinos – Serología.

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