Mycobacteriosis in Australian birds

Fact sheet

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Key points

- Avian mycobacteriosis is caused predominantly by bacteria in the *Mycobacterium avium* complex (MAC) and *M. genavense* (MG).
- The mycobacteria species most commonly associated with mycobacteriosis in birds can persist in the environment and are found worldwide.
- Mycobacterial infections can be expected to occur at a low level in both wild and captive bird populations.
- Infections have the most population level impact on captive birds, where they can cause slowly progressive, fatal disease.
- Predisposing conditions for infection likely include close confinement, high population density, immunosuppression and poor hygiene.
- In birds, infection with *Mycobacterium avium* is a nationally notifiable disease; you must notify animal health authorities if you suspect a bird is infected with *Mycobacterium avium* (see *Surveillance and management* below)

Aetiology

Order (Actinomycetales), family (*Mycobacteriaceae*), genus (*Mycobacterium*).

Mycobacteria are small rod-shaped bacteria that grow inside the host's cells [1]. Mycobacterial species are commonly grouped into descriptive categories according to how they manifest disease in humans. "Tuberculous mycobacteria", also known as the "MTB complex", cause serious disease in humans, characterised by granuloma (tubercle) formation (or "tuberculosis"). These include *M. tuberculosis, M. bovis,* and *M. africanum*, which rarely cause mycobacteriosis in birds [2, 3].

Mycobacterial species which do not cause tuberculosis in humans are often referred to as "atypical mycobacteria" or "nontuberculous mycobacteria" [3]. This includes the "*M. avium* complex" (MAC; *M. avium* subspecies *avium* [MAA], *M. avium* subsp. *hominissuis, M. avium* subsp. *paratuberculosis* and *M. intracellulare*), *M. genavense* (MG), and a range of other species that have been reported to cause avian mycobacteriosis, including *M. gordonae, M. nonchromogenicum, M. fortuitum* subsp. *fortuitum, M. peregrinum, M. intermedium, M. simiae* and *M. celatum* [2, 4].

The two most common mycobacterium species detected in diseased birds are MAA and MG [2]. *Mycobacterium avium* subsp. *avium* and MG can cause disease in heathy birds, while other species of atypical mycobacteria tend to only cause disease in immunocompromised birds. Atypical mycobacteria are the focus of this fact sheet.

One Health implications

Wildlife and the environment: atypical mycobacteria infect a wide range of bird species, although their prevalence in wild Australian populations is not known. A report of *M. avium*-associated mass mortality of wild flamingos highlights the potential for atypical mycobacteria to have large scale effects on avian populations [5].

Domestic animals: atypical mycobacteria have been known to cause disease outbreaks in commercial poultry and disease in pet birds [1]. *Mycobacterium avium* complex organisms can also infect a wide range of domestic mammals including cats, dogs, horses, cattle, pigs and sheep [6]. Wild birds are unlikely to be a significant source of infection for domestic animals, which are most likely to contract infection via environmental contamination.

Humans: atypical mycobacteria can cause disease in people that are immunosuppressed [7]. While the environment is the most likely source of infection in humans, birds that are shedding atypical mycobacteria could pose a risk of infection to immunosuppressed people [3]. While rare, atypical mycobacteria can also cause mild disease in non-immunosuppressed people [8].

Natural hosts

The mycobacterial species commonly affecting birds are environmental pathogens, with the environment being the source of opportunistic infection (an infection that does not normally cause disease but becomes pathogenic when the host is compromised) for birds. A wide range of bird species are known to be susceptible to mycobacterial infection. *Mycobacterium avium* subsp. *avium* infection is more common in waterfowl species, while MG infection is more common in Passeriformes (perching birds) [9]. *Mycobacterium genavense* may infect mammals, including humans [1].

World distribution

Atypical mycobacteria have a worldwide distribution [10].

Occurrences in Australia

Mycobacterial infections have been described mainly in avicultural collections, zoological collections, domestic and companion birds in Australia [11-13]. Infections have been diagnosed in Columbiformes, Psittaciformes, Passeriformes, Galliformes, Coraciiformes, Casuariiformes, Sphenisciformes, Falconiformes, Anseriformes, Gruiformes and Accipitriformes [12, 14-17]. There are only a few reports of mycobacterial infection in free-ranging wild birds from Qld, NSW, Vic, Tas and the NT (Table 1). Mycobacterial infections have been identified in four southern cassowaries in northern Qld (A. Olsson, pers. comm. 2013). *Mycobacterium avium* subsp. *avium* infection has been diagnosed in a captive cassowary overseas [18].

Table 1. Captive and wild Australian birds reported with mycobacteriosis

State of Origin	Species	Individual status
NT	Pied imperial pigeon (*Ducula spilorrhoa*)[1]	Wild
Qld	Laughing kookaburra (*Dacelo novaeguineae*)[1]	Wild
	Cassowary (*Casuarius casuarius*)[1,3]	Captive and wild
	Little penguin (*Eudyptula minor novaehollandiae*)[1]	Captive
	Budgerigar (*Melopsittacus undulatus*)[1]	Captive
	Rose-crowned fruit dove (*Ptilinopus regina*)[1]	Captive
	Crested pigeon (*Ocyphaps lophotes*)[1]	Captive
NSW	Australian hobby (*Falco longipennis*)[1]	Wild
	Pacific black duck (*Anas superciliosa* [1]	Wild
	Dusky moorhen (*Gallinula tenebrosa*)[1]	Wild
	Little penguin (*Eudyptula minor novaehollandiae*)[1]	Captive
	Metallic starling (*Aplonis metallica*)[1]	Captive
	Sacred kingfisher (*Todiramphus sanctus*)[1]	Captive
	Superb parrot (*Polytelis swainsonii*)[1]	Captive
	Australasian figbird (*Sphecotheres vieilloti*)[1]	Captive
	King quail (*Coturnix chinensis*)[1]	Captive
	Topknot pigeon (*Lopholaimus antarcticus*)[1]	Captive
	Brown cuckoo-dove (*Macropygia amboinensis)*[1]	Captive
Vic	Nankeen kestrel (*Falco cenchroides*)[2]	Wild
	Orange-bellied parrot (*Neophema chrysogaster*)[1]	Captive
	Brolga (*Grus rubicundus*)[1,4]	Captive
	Eastern rosella (*Platycercus eximius)*[6]	Captive
	Golden-shouldered parrot (*Psephotus chrysopterygius*)[6]	Captive
	Gouldian finch (*Erythrura gouldiae)*[6]	Captive
	Hooded parrot (*Psephotus dissimilis*)[6]	Captive
	Scarlet-chested parrot (*Neophema splendida*)[6]	Captive
	Brush turkey (*Alectura lathami*)[6]	Captive
	Buff-banded rail (*Gallirallus phillipensis*)[6]	Captive
	Common bronzewing (*Phaps chalcoptera*)[6]	Captive
	Rose-crowned fruit dove (*Ptillinopus regina*)[6]	Captive
Tas	Swamp harrier (*Circus approximans*)[1]	Wild
	Wedge-tailed eagle (*Aquila audax*) [1]	Wild
	Orange-bellied parrot (*Neophema chrysogaster*)[1]	Captive
SA	Diamond dove (*Geopelia cuneata*)[1]	Captive
WA	Gouldian finch (*Erythrura gouldiae*)[5]	Captive

[1] National Wildlife Health Information System (eWHIS).
[2] Reece et al. 1992 [15]
[3] Moore 2007 [16]; (Olsson, pers. comm. 2013)
[4] Hodge et al. 2019 [12]
[5] Vitali et al. 2006 [19]
[6] Rourke 2006 [20]

Epidemiology

Atypical mycobacteria are commonly found in the environment in large quantities and are shed in the faeces of infected birds and other infected animals [7]. Once in the environment, mycobacterial organisms can persist for long periods of time, opportunistically infecting avian hosts. Infection is likely to be the result of ingestion or inhalation of the aerosolised organism in contaminated soil or water [21]. For raptors, ingestion of infected prey species may also be an exposure source [22].

Little information is available on prevalence and incidence of atypical mycobacterial infections in Australian native birds. Whether exposure results in infection will depend upon the number of organisms to which the bird is exposed and the host's immune response to infection [23]. Age, stress, malnutrition and other factors impacting the immune system may make birds more susceptible to infection. It can be common for birds infected with atypical mycobacteria to have co-infections with other pathogens [24].

A relatively high prevalence of infections has been seen in captive settings compared to wild populations [25]. The higher prevalence of infection in captive birds may be the result of poor hygiene, high population density or exposure to large numbers of organisms in the environment. This is not always the case with some bird species appearing more susceptible to mycobacterial infections than others including the Gouldian finch (*Erythrura gouldiae*) [19], canary (*Serinus canaria domestica*), Venezuelan siskin (*Carduelis cucullata*) [26], grey-cheeked parakeet (*Brotogeris pyrrhoptera*) [27], white-winged duck (*Asarcornis scutulata*) [28] and Mauritius pink pigeon (*Columba mayeri*)[29].

Clinical signs

Mycobacteria can infect a wide range of tissues in the body and birds may present with many different non-specific signs, depending on the location and severity of the infection [3]. Infections are typically slowly progressive, and birds may have no clinical signs of disease in the early stages [24], but develop wasting in many chronic cases [23]. Most birds that die as the result of a mycobacterial infection are in poor body condition, and may have diarrhoea [27]. The first detectable signs of disease may be lethargy and increased time sleeping [30]. Poor feathering, weight loss and abdominal distention are common signs [3] Dermatitis associated with MG infection has been reported in zoological collections [20]. Infection of the bone may result in lameness and occasionally bones will break spontaneously [23]. Birds with lung infections may have abnormal respiration [3]. Granulomas within the spine can result in neurologic disorders and weakness [31]. Birds can die from mycobacterial infections with no obvious preceding clinical signs [3].

Clinical pathology

Haematology: birds typically have an elevated white blood cell count (commonly > 50,000 cells/µl) with an increase in heterophils, lymphocytes and monocytes. Birds are typically anaemic [23, 30]. Total plasma protein may be low or elevated [32]. Birds with localised infection may not have haematological abnormalities [3].

Biochemistry: changes will depend on the organs affected and the severity of disease. Albumin concentrations are low in birds that are not eating well and those with advanced liver disease. Aspartate aminotransferase concentrations will be elevated with liver or muscle disease [23]. Creatinine phosphokinase may also be elevated with muscle disease [30]. Biochemical parameters may remain normal in some cases [3].

Pathology

Mycobacteria can infect a wide range of organs and cause characteristic enlargement of the infected organ [3]. Inflammation and enlargement of the liver and spleen is common. Intestinal thickening may occur a cobblestone appearance to the lining of the intestine. There may be free fluid within the body cavity [2].

Mycobacteriosis in birds can cause granulomas or 'tubercles' (a mass composed of inflammatory cells and mycobacteria), although this is not always the case. Granulomas can develop anywhere in the body, including the skin, the beak, in the sinuses around the eye, and internal organs, particularly liver, spleen, intestine, lung, air sacs and bone. Compared to MAA, MG is more likely to occur in the heart and kidney, and form nontuberculous lesions [14].

Microscopically, granulomas present as a central core of necrosis, surrounded by multinucleated giant cells, plasma cells and lymphocytes and varying degrees of fibrosis around the inflammatory cell layer [27]. There may be replacement of normal tissue with sheets of histiocytes and other inflammatory cells [25]. The numbers of bacteria in these lesions can vary from massive to very few.

Diagnosis

Diagnosis of mycobacteriosis in birds can vary in difficulty depending on the tissues affected. Intradermal tuberculosis testing, as used in humans and hoofstock, is not a useful diagnostic tool for birds [3].

Culture: culture of affected tissues is considered the gold standard for confirming a diagnosis of mycobacteriosis [33], however it is a difficult and time consuming process which is not routinely offered by diagnostic laboratories.

Molecular detection: PCR of infected tissues is highly sensitive and specific, providing a fast and accurate means of determining the species of *Mycobacterium* [34]. PCR of cloacal and oropharyngeal swabs can be a highly sensitive tool in detection of mycobacteria in live birds [35]. PCR examination of faeces can be used to confirm infection, although this requires the bird to be shedding a sufficient quantity of mycobacteria at the time of testing [36]. Currently, mycobacterial PCR is not readily available in many laboratories.

Microscopy: mycobacteria are 'acid fast' organisms that stain bright pink with Ziehl-Neelsen stain. [30]. False positives can occur, so this cannot be considered a definitive diagnostic test [23]. Acid-fast organisms may be identified in faeces, although not all infected birds will shed the organism, particularly if the gastrointestinal system is not affected, and shedding is often sporadic [3]. Acid-fast stains of aspirates or biopsies of affected organs will in many cases detect mycobacteria.

Supportive diagnostics: physical, radiographic, biochemical, and haematological findings in live birds will generally be suggestive of a mycobacterial infection, depending on the organs affected, but are rarely definitive. The majority of mycobacterial infections are diagnosed during post-mortem examination [3]. Histopathology and gross post-mortem findings are often suggestive of mycobacteriosis, particularly when supported by positive Ziehl-Neelson staining of affected tissues.

Differential diagnoses

Clinical signs in the live bird are non-specific and could be caused by a range of chronic diseases including other bacterial infections, systemic fungal infections, chronic parasitic infections, metabolic disease, malnutrition and neoplastic disease [23].

Treatment

There is very little evidence-based data to guide the choice of treatment options in birds with mycobacteriosis and to predict their outcome [37]. Appropriate drugs used to treat infections are often expensive, need to be given for months, have low cure rates and potentially negative side effects including drug resistance [38]. In a captive situation, treatment may not be a viable option given the risk that infected birds may be a source of environmental contamination for other birds and therefore euthanasia may be the preferred option.

Control and prevention

Control of mycobacterial infections in wild and captive birds is challenging. Since atypical mycobacteria are found in the environment, any bird could become infected if it is exposed to sufficient numbers of organisms and is otherwise susceptible [7]. In most captive and domestic situations, culling of infected birds is the most common and effective option for disease control [39].

Mycobacteria are resistant to a number of disinfectants [4]. The most important element of mycobacterial hygiene is to remove all organic material from the environment when cleaning. This can be difficult in many captive settings with naturalistic furniture and substrate, and impossible in free-ranging situations. Specific control measures that have been used in captive settings include treating the soil within contaminated enclosures with lime or a mycobacterial disinfectant; leaving contaminated enclosures unoccupied for a year or more; and draining and cleaning of exhibit pools or water sources using cleaning agents and disinfectants twice a week [12, 40].

Completely preventing the introduction of atypical mycobacteria into a collection of birds is not feasible given the organisms are environmental pathogens. It is possible to avoid heavy contamination of the environment, and thereby reduce clinical impact, by practising excellent hygiene (including regular substrate changes), optimising husbandry (avoid overcrowding, provide good nutrition), and by detecting and isolating infected and shedding birds. Best practice suggests that infected birds should be either euthanased or kept in isolation from people and other birds. All incoming birds should be routinely screened for signs of illness that might indicate mycobacterial disease. More specific screening testing, such as acid-fast staining and PCR testing of the faeces may also be considered.

Research

Much is still to be learned about mycobacterial infections in birds. There is a need to identify environmental and animal reservoirs. Pharmacological studies of the common drugs used to treat mycobacterial infection need to be undertaken in a range of bird species, so that appropriate treatment protocols can be developed. Factors predisposing certain species of birds to mycobacterial infections also need to be defined.

Surveillance and management

In birds, infection with *M. avium* is a nationally notifiable disease (see www.agriculture.gov.au/biosecurity-trade/pests-diseases-weeds/animal/notifiable). By law you must notify animal health authorities in your jurisdiction if you know or suspect that an animal has a notifiable pest or disease. Refer to advice in your jurisdiction (www.agriculture.gov.au/biosecurity-trade/pests-diseases-weeds/animal/state-notifiable) and on outbreak.gov.au on how to report.

Wildlife Health Australia administers Australia's general wildlife health surveillance system, in partnership with government and non-government agencies. Wildlife health data is collected into a national database, the electronic Wildlife Health Information System (eWHIS). Information is reported by a variety of sources including government agencies, zoo based wildlife hospitals, sentinel veterinary clinics, universities, wildlife rehabilitators, and a range of other organisations and individuals. Targeted surveillance data is also collected by WHA. See the WHA website for more information: https://wildlifehealthaustralia.com.au/ProgramsProjects/eWHIS-WildlifeHealthInformationSystem.aspx.

We are interested in hearing from anyone with information on this condition in Australia, including laboratory reports, historical datasets or survey results that could be added to the National Wildlife Health Information System. Negative data are also valuable. If you can help, please contact us at admin@wildlifehealthaustralia.com.au.

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Wildlife Health Australia recognises the Traditional Custodians of Country throughout Australia. We respectfully acknowledge Aboriginal and Torres Strait Islander peoples' continuing connection to land, sea, wildlife and community. We pay our respects to them and their cultures, and to their Elders past and present.

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References

1. Converse KA (2007) Avian tuberculosis. *Infectious diseases of wild birds*: 289-302
2. Shivaprasad H and Palmieri C (2012) Pathology of mycobacteriosis in birds. *Veterinary Clinics: Exotic Animal Practice*, **15**(1): 41-55
3. Lennox A (2016) Mycobacteriosis. In 'Current Therapy in Avian Medicine and Surgery.' pp. 94-98. (Elsevier: St Louis)

4. Dhama K, Mahendran M et al. (2011) Tuberculosis in birds: insights into the *Mycobacterium avium* infections. *Veterinary Medicine International*,

5. Kock N, Kock R et al. (1999) *Mycobacterium avium*-related epizootic in free-ranging lesser flamingos in Kenya. *Journal of Wildlife Diseases*, **35**(2): 297-300

6. WOAH (2014) Avian Tuberculosis Chapter 3.3.6. Available from: https://www.woah.org/fileadmin/Home/eng/Health_standards/tahm/3.03.06_AVIAN_TB.pdf

7. Hoefsloot W, van Ingen J et al. (2013) *Mycobacterium genavense* in the Netherlands: an opportunistic pathogen in HIV and non-HIV immunocompromised patients. An observational study in 14 cases. *Clinical Microbiology and Infection*, **19**(5): 432-437

8. Aubry A, Chosidow O et al. (2002) Sixty-three cases of *Mycobacterium marinum* infection: clinical features, treatment, and antibiotic susceptibility of causative isolates. *Archives of Internal Medicine*, **162**(15): 1746-1752

9. Witte C, Fowler JH et al. (2021) Social network analysis and whole-genome sequencing to evaluate disease transmission in a large, dynamic population: A study of avian mycobacteriosis in zoo birds. *Plos One*, **16**(6): 18

10. Soler D, Brieva C et al. (2009) Mycobacteriosis in wild birds: the potential risk of disseminating a little-known infectious disease. *Revista de Salud Pública*, **11**(1): 134-144

11. Feizabadi MM, Robertson ID et al. (1996) Genetic characterization of *Mycobacterium avium* isolates recovered from humans and animals in Australia. *Epidemiology and Infection*, **116**(1): 41-49

12. Hodge P, Sandy, Jr. et al. (2019) Avian mycobacteriosis in captive brolgas (*Antigone rubicunda*). *Australian Veterinary Journal*, **97**(3): 81-86

13. Sangster C (2012) Non-mamallian mycobacteriosis in a zoo setting—pathological and epidemiological findings. In '11th International Colloquium on Paratuberculosis. Sydney, Australia'.

14. Tong LJ (2018) Who, What, When, Where, & Why: Dissecting the molecular, epidemiological & pathological features of avian mycobacteriosis in an Australian zoological collection. thesis

15. Reece RL, Scott PC et al. (1992) Some unusual diseases in the birds of Victoria, Australia. *Veterinary Record*, **130**(9): 178-185

16. Moore L (2007) Population ecology of the southern cassowary *Casuarius casuarius johnsonii*, Mission Beach north Queensland. *Journal of Ornithology*, **148**(3): 357-366

17. Wildlife Health Australia (2023) eWHIS. Available from: https://wildlifehealthaustralia.com.au/ProgramsProjects/eWHIS-WildlifeHealthInformationSystem.aspx

18. Krajewska M, Czujkowska A et al. (2015) Avian tuberculosis in a captive cassowary (*Casuarius casuarius*). *Journal of Veterinary Research*, **59**(4): 483-488

19. Vitali SD, Eden PA et al. (2006) An outbreak of mycobacteriosis in Gouldian finches caused by *Mycobacterium peregrinum. Veterinary Clinics: Exotic Animal Practice*, **9**(3): 519-522

20. Rourke NL (2006) Diagnosis of *Mycobacterium genavense* in caged birds. PhD thesis, University of Melbourne, Faculty of Veterinary Science

21. Whiley H, Keegan A et al. (2012) *Mycobacterium avium* complex - the role of potable water in disease transmission. *Journal of Applied Microbiology*, **113**(2): 223-232

22. Tell LA, Ferrell ST et al. (2004) Avian mycobacteriosis in free-living raptors in California: 6 cases (1997-2001). *Journal of Avian Medicine and Surgery*, **18**(1): 30-40

23. Dahlhausen B, Soler-Tovar D et al. (2012) Diagnosis of mycobacterial infections in the exotic pet patient with emphasis on birds. *Veterinary Clinics: Exotic Animal Practice*, **15**(1): 71-83

24. Schmitz A, Rinder M et al. (2018) Retrospective evaluation of clinical signs and gross pathologic findings in birds infected with *Mycobacterium genavense. Journal of Avian Medicine and Surgery*, **32**(3): 194-204

25. Saggese MD, Tizard I et al. (2008) Mycobacteriosis in naturally infected ring-neck doves (*Streptopelia risoria*): investigation of the association between feather colour and susceptibility to infection, disease and lesions type. *Avian Pathology*, **37**(4): 443-450

26. Manarolla G, Liandris E et al. (2009) Avian mycobacteriosis in companion birds: 20-year survey. *Veterinary Microbiology*, **133**(4): 323-327

27. Palmieri C, Roy P et al. (2013) Avian mycobacteriosis in psittacines: a retrospective study of 123 cases. *Journal of Comparative Pathology*, **148**(2-3): 126-138

28. Saggese MD, Riggs G et al. (2007) Gross and microscopic findings and investigation of the aetiopathogenesis of mycobacteriosis in a captive population of white-winged ducks (*Cairina scutulata*). *Avian Pathology*, **36**(5): 415-U102

29. Phalen D, Grimes J et al. (1995) Serologic diagnosis of mycobacterial infections in birds (a preliminary report). In 'Proc. Assoc. Avian Vet'.

30. Saggese MD, Tizard I et al. (2010) Comparison of sampling methods, culture, acid-fast stain, and polymerase chain reaction assay for the diagnosis of mycobacteriosis in ring-neck doves (*Streptopelia risoria*). *Journal of Avian Medicine and Surgery*, **24**(4): 263-271

31. Sadar MJ, McRuer D et al. (2015) Multifocal respiratory and vertebral mycobacteriosis in a red-tailed hawk (*Buteo jamaicensis*). *Journal of Zoo and Wildlife Medicine*, **46**(1): 150-154

32. Mayahi M, Khajeh G et al. (2013) Serum protein profiles in domestic pigeons naturally infected with *Mycobacterium avium* subsp *avium. Veterinary Clinical Pathology*, **42**(2): 212-215

33. Sattar A, Zakaria Z et al. (2018) Evaluation of six decontamination procedures for isolation of *Mycobacterium avium* complex from avian feces. *PLoS One*, **13**(8): e0202034

34. Schrenzel MD (2012) Molecular epidemiology of mycobacteriosis in wildlife and pet animals. *Veterinary Clinics: Exotic Animal Practice*, **15**(1): 1-23

35. Baquião AC, Luna JO et al. (2014) Optimized nested polymerase chain reaction for antemortem detection of mycobacteria in Amazon parrots (*Amazona aestiva*) and orange-winged Amazons (*Amazona amazonica*). *Journal of Zoo and Wildlife Medicine*, **45**(1): 161-164

36. Gray PL, Saggese MD et al. (2008) Humoral response to *Mycobacterium avium* subsp *avium* in naturally infected ring-neck doves (*Streptopelia risoria*). *Veterinary Immunology and Immunopathology*, **125**(3-4): 216-224

37. Buur J and Saggese MD (2012) Taking a rational approach in the treatment of avian mycobacteriosis. *Veterinary Clinics: Exotic Animal Practice*, **15**(1): 57-70

38. Saggese MD, Tizard I et al. (2014) Evaluation of multidrug therapy with azithromycin, rifampin, and ethambutol for the treatment of *Mycobacterium avium* subsp *avium* in ring-neck doves (*Streptopelia risoria*): an uncontrolled clinical study. *Journal of Avian Medicine and Surgery*, **28**(4): 280-289

39. Gavier-Widén D, Chambers M et al. (2012) Mycobacteria infections. In 'Infectious Diseases of Wild Mammals and Birds in Europe.' pp. 265-292.)

40. Rivas AE, Hollinger C et al. (2019) Diagnosis and management of mycobacteriosis in a colony of little penguins (*Eudyptula minor*). *Journal of Zoo and Wildlife Medicine*, **50**(2): 427-436

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