

Overview

Squirrel leprosy is a chronic, bacterial infection that mainly affects the skin. Today, it has only been described in Eurasian red squirrels in the British Isles [1]. The infection is not life threatening, but advanced skin lesions may have a negative impact on individual animal welfare. No treatment is currently available for squirrels. Individuals with mild clinical signs are usually able to thrive for months or even years. The bacteria isolated from squirrels are closely related to those causing human leprosy [2]. However, no human leprosy cases have been reported where contact with squirrels could have been a potential source of infection, and any risk for human health is understood to be very low. Even so, good general hygiene practice should be followed during any contact with wild animals. Leprosy is known as the least infectious of all infectious diseases, and 90-95% of the human population, at least in Europe, is thought to be resistant to the pathogen and will not develop clinical disease even after having contact with leprosy-causing bacteria [3].

Cause/pathogen

Leprosy in squirrels is a bacterial infection. It is caused by two different mycobacterial species: *Mycobacterium leprae* and *Mycobacterium lepromatosis* [2]. Both are obligate intracellular pathogens, which means they are disease-causing agents that can only reproduce within certain cells of a host organism (squirrel).

Initial signs

Initial signs of disease occur months, sometimes years, after the initial infection. They usually constitute areas of shininess and hair loss on the ears, and less often the ankles (hocks), that are only a few millimetres in diameter. Often, they are only on one side of the animal at first, but become symmetrical on both sides as the disease progresses. They are sometimes difficult to see, particularly from a distance.

Clinical signs in detail

Leprosy is a chronic disease and clinical signs develop over months and years. In red squirrels leprosy mainly affects the skin, but in advanced cases bacteria have also been found in internal organs. Skin lesions usually first occur on the ears or hocks, in later stages the nose, eyelids and, in male squirrels, the scrotum can also be affected. The chest, upper back, and front feet are rarely affected.

With time, firm elastic swelling develops in the shiny hairless skin areas, and the lesions become round and bulging. They increase in size and volume over several months. They may ulcerate repeatedly, but ulcerations will usually heal without intervention. Advanced lesions may be more than a centimetre in diameter and have scarred lines on them as a result of repeated ulcerations. These give them a cauliflower-like appearance. When lesions are cut or their surface injured, the cut surface will protrude and is often slightly yellow. Occasionally, and currently observed only on the Isle of Wight, crusty lesions on the ears with wart-like protuberances have been described [4]. It is also possible that other presentations exist. The squirrel's general condition often remains good, even when clinical signs are present, as long as they do not mechanically impair the animal's ability to feed. Due to the slow progression of the disease, severe lesions are mainly seen in older red squirrels.

Mild leprosy lesions

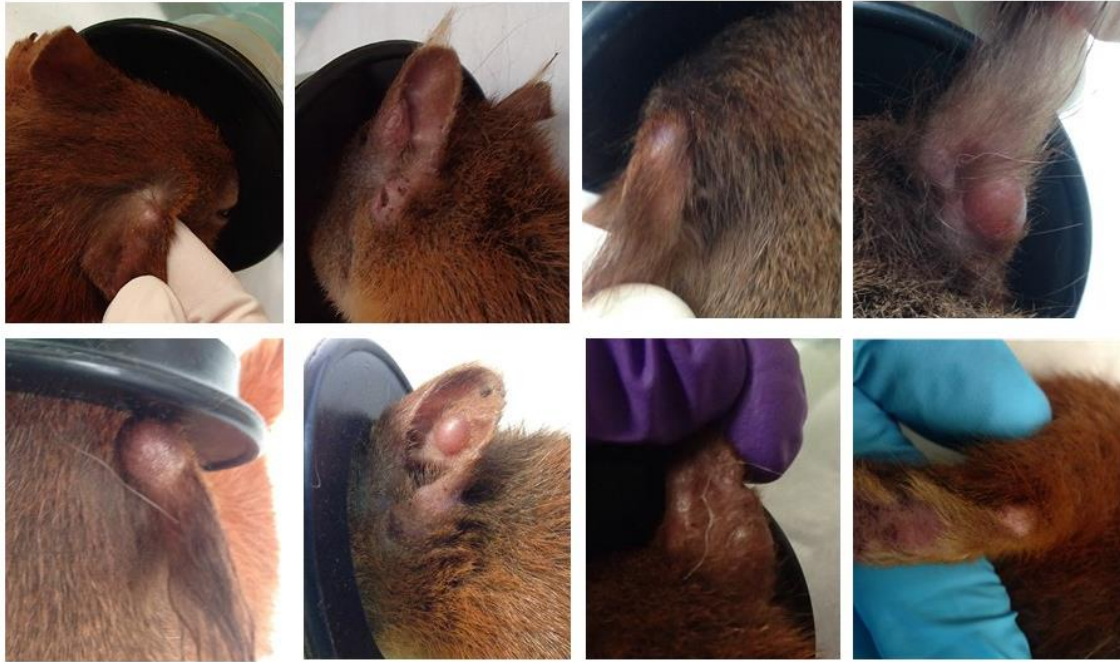


Figure 1: Mild lesions are usually less than 1cm in diameter and limited to one or two body areas

Mild-moderate leprosy lesions

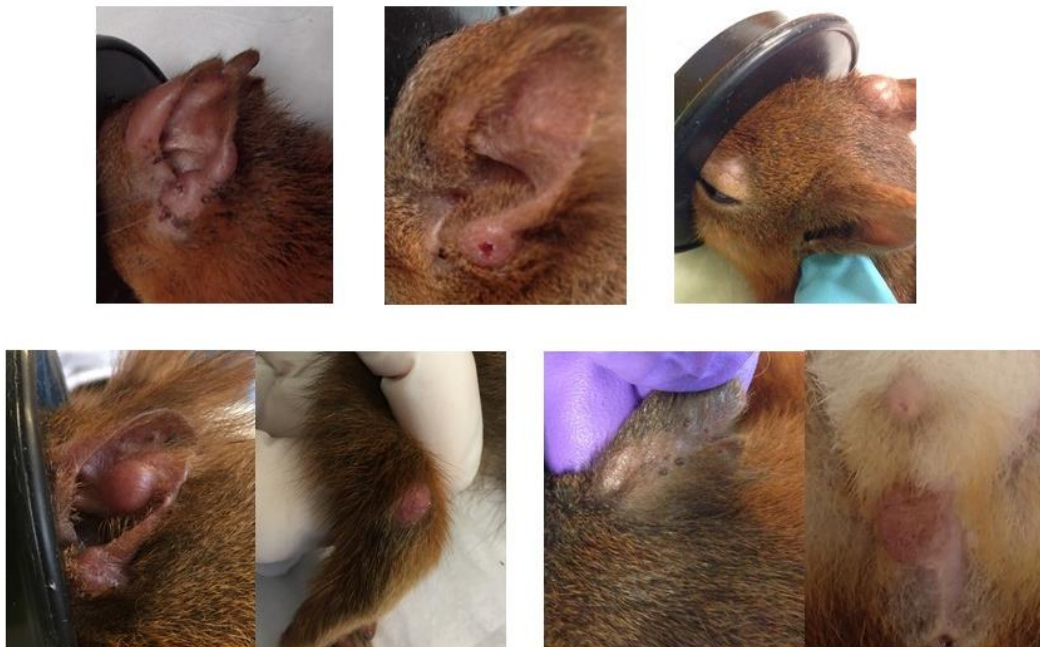


Figure 2: Mild-moderate lesions are rarely larger than 1cm in diameter and affect no more than three body areas. Moderate lesions look similar, but are larger and may affect up to four body areas.

Severe leprosy lesions



Figure 3: Severe lesions often are more than 1cm in diameter and affect four or more body areas. They may be ulcerated or lined by scars, resulting from previous ulceration.

Transmission

The exact route of transmission remains unknown. Prolonged close contact with other infected squirrels is believed to be necessary for disease transmission. It is likely that the pathogen is excreted with nasal secretions and from ulcerated lesions at later stages of the disease. The most likely routes of entry are the respiratory tract and small skin injuries.

Diagnosis

Laboratory tests to confirm the suspicion of leprosy in squirrels have been developed, but are not yet commercially available. No single existing test can identify the pathogen in all infected animals. In animals that show clinical signs of disease the identification of leprosy-specific antibodies in a serum sample (from blood) can confirm the infection [5], as can the isolation of bacterial DNA from skin samples with molecular methods (PCR) [2]. Skin biopsies from the ear (min. 2mm diameter) are suitable in live squirrels, while the whole ear can be used where an animal has already died. Serum samples can be stored frozen, while biopsies are ideally stored in 70% ethanol.

It is also possible to confirm the presence of the acid-fast rod-shaped bacilli in infected cells under the microscope, using special staining techniques (Ziehl-Neelsen or Fite-Faro). In animals that are found dead this can be done from sections cut from lesions, while it can be attempted in live squirrels by taking a fine needle aspirate from the lesion. Lesion tissue for microscopic assessment can initially be stored frozen or immediately placed in 10% formalin. Fine needle aspirates should be air dried.

Occurrence and geographic distribution

Red squirrel leprosy has only been described in the British Isles so far. Initial screening efforts in red squirrels and other members of the Sciuridae family on the European continent did not identify the bacteria there. None of the Eastern grey squirrels tested so far carried the bacteria [1].

Mycobacterium leprae has been identified in red squirrels in the South of England, in Wales and in the West of Scotland, while *Mycobacterium lepromatosis* has been identified in Scotland, Ireland and the South of England [2], [6], [7]. While leprosy in squirrels was first described in 2014 [8], it is likely that the disease has been present in the squirrel populations for much longer. Based on genetic information available for the bacterial strains, it appears to be feasible that leprosy bacilli have been circulating in red squirrel populations for hundreds of years [2].

Management and treatment

Not all red squirrels are equally susceptible to an infection with leprosy bacilli. Infection rates are estimated to be between 1% and 40% in populations, but only some of these squirrels will develop skin lesions. In other squirrels the disease remains asymptomatic or they may die from other causes before clinical signs of leprosy develop.

The multi drug antibiotic treatment that is well established and highly successful in humans is not suitable for squirrels. Infected squirrels, who are in good general condition apart from the presence of leprosy lesions, thrive as well as unaffected animals and continue to reproduce. Currently, squirrels showing clinical signs of leprosy are divided into four severity groups (mild, mild-moderate, moderate, severe). For squirrels with mild and mild-moderate lesions, a negative impact on general condition and welfare does not usually occur. Moderate symptoms may occasionally have welfare implications and monitoring these squirrels from a distance may be useful to spot any deterioration in their condition early. Where severe lesions are observed, it is possible that the general condition and welfare of the squirrel may be negatively affected. This should be assessed, ideally seeking veterinary advice. Important factors to note are whether the squirrel is still able to feed normally and if its movement patterns and behaviour are normal. In advanced cases a leprosy infection may lead to visual impairment. In individual cases, it may be in the best interest of the animal to consider humane capture and euthanasia by a veterinarian.

Where obviously diseased squirrels visit feeders, these should be disinfected on a regular basis, or be removed to reduce the risk of bacterial transmission. Squirrels showing clinical leprosy lesions under human care should be kept in a clean environment that is easy to disinfect. Single use materials (e.g. gloves) that can be disposed of as clinical waste after use should preferably be used for handling. Squirrels with severe lesions that are suffering and in ill health should not be kept in captivity, as a recovery is unlikely. Red squirrels showing clinical signs of leprosy, or in which the presence of leprosy bacilli has been confirmed with other diagnostic methods, should not be translocated.

Disinfectants

Disinfectants with mycobactericidal/tuberculocidal, i.e. mycobacteria killing, properties should be used and manufacturer's recommendations should be followed closely. Approved disinfectants can be found in the DEFRA list of approved disinfectants

(http://disinfectants.defra.gov.uk/DisinfectantsExternal/Default.aspx?Module=ApprovalsList_SI).

Co-infections

Currently, no other infections are known that would be particularly likely to co-occur with leprosy. However, leprosy squirrels are still susceptible to all pathogens that healthy squirrels could be infected by. Conditions that alter a squirrel's immune status, such as acute infections or pregnancy, can result in a faster progression of leprosy lesions.

Similar looking conditions

Leprosy lesions can be confused with other skin conditions that result in hair loss or round and bulging swelling. This typical pattern of lesions initially occurring on ears and hocks appears to be fairly unique to leprosy. Severe lesions may look similar to atypical histiocytosis [9] or non-infectious tumours [10]. The occasionally described crusty lesions may look similar to parasitic skin infection, exudative dermatitis or even squirrel pox.

Other species susceptible to leprosy

Humans appear to be the main host for leprosy bacilli. *Mycobacterium leprae* DNA has been isolated from human remains that are over 1000 years old. Today, human leprosy cases mainly occur in South East Asia, South- and Middle-America and in Africa. Occasional cases are reported in Europe, mainly in immigrants from or travellers to countries where human leprosy still regularly occurs [11]. In the Americas leprosy infections do also occur in armadillos. Nine-banded armadillos are the species most commonly infected and they are also used in leprosy research [12]. Occasional cases of leprosy have been reported in primates. Leprosy bacilli have also been sporadically isolated from samples of other animals species [3].

Leprosy strains identified in animals are closely related to those present in humans [13]. It is assumed that animals first became infected from a human source, but bacteria can now also circulate within animal populations. In the Americas human leprosy cases occur both in regions in which nine-banded armadillos are present and in areas where they are absent. No human leprosy cases in the British Isles have been thought to be linked to squirrel contact today. All human leprosy cases registered in the British Isles in the past decades could be linked to migration from or travel to areas where human leprosy is endemic [14].

Who to contact if you see a sick squirrel?

Where sick squirrels are observed, it can be very useful to take photographic images to show to veterinarians or veterinary pathologists, with experience in diagnosing squirrel leprosy or access to the relevant scientific publications.

Squirrel leprosy was initially identified by scientists from the Royal (Dick) School of Veterinary Studies, University of Edinburgh, and the Moredun Research Institute. Experts from these institutions will be able to offer advice. The author of this information sheet can be contacted via email (squirrelleprosy@gmail.com) if additional information on squirrel leprosy is required.

Individuals who are worried that they may be infected with leprosy bacilli are advised to consult their GP.

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