

Dermatophytosis

Ringworm, Tinea,
Dermatomycosis

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**Institute for International
Cooperation in Animal Biologies**
An OIE Collaborating Center
Iowa State University
College of Veterinary Medicine



IOWA STATE UNIVERSITY®

**Center for Food
Security and Public Health**
College of Veterinary Medicine
Iowa State University
Ames, Iowa 50011
Phone: (515) 294-7189
FAX: (515) 294-8259
E-mail: cfsph@iastate.edu
Web: <http://www.cfsph.iastate.edu>

Etiology

Dermatophytosis is caused by fungi in the genera *Microsporum*, *Trichophyton* and *Epidermophyton*. These organisms, called dermatophytes, are the pathogenic members of the keratinophilic (keratin digesting) soil fungi. *Microsporum* and *Trichophyton* are human and animal pathogens. *Epidermophyton* is a human pathogen.

The dermatophytes were all formerly classified as members of the phylum *Deuteromycota* (*Fungi imperfecti*). Some are now known to reproduce sexually and have been reclassified in the phylum *Ascomycota*, family *Arthrodermataceae*. Each of these fungi now has two species names, one for the stage found in vertebrate hosts, and one for the form that grows in the environment (the perfect state).

Formerly, the perfect states of *Microsporum* species were placed in the genus *Nannizia* and the perfect states of *Trichophyton* in the genus *Arthroderma*. Currently, the perfect states of both *Microsporum* and *Trichophyton* belong to the genus *Arthroderma*.

The most common system to classify dermatophytes:

- **Zoophilic** dermatophytes are mainly found in animals but can be transmitted to humans.
- **Anthropophilic** dermatophytes are mainly found in humans and are very seldom transmitted to animals.
- **Geophilic** dermatophytes are found mainly in soil, where they are associated with decomposing hair, feathers, hooves and other keratin sources. They infect both humans and animals.

It is now known that practically all dermatophytes have reservoirs in the soil; however, this classification system is still used to indicate the usual source/ epidemiology of dermatophyte species. Zoonotic species found in animals include:

- *Microsporum canis* (Perfect state – *Arthroderma otae*)
- *M. gallinae*
- *M. gypseum* (A complex containing at least two perfect states – *A. gypseum* and *A. incurvatum*)
- *M. equinum*
- *M. nanum* (Perfect state – *A. obtusum*)
- *M. persicolor* (Perfect state – *A. persicolor*)
- *Trichophyton equinum*
- *T. mentagrophytes* (A complex containing at least two perfect states – *A. benhamiae* and *A. vanbreuseghamii*).

Several varieties of *T. mentagrophytes* exist. Some are important pathogens in both animals and humans; others are mainly human pathogens.

- *T. simii* (Perfect state – *A. simii*)
- *T. verrucosum*

Geographic Distribution

Dermatophytes grow best in warm and humid environments and are, therefore, more common in tropical and subtropical regions. The geographic distribution varies with the organism. *M. canis*, *M. nanum*, *T. mentagrophytes*, *T. verrucosum* and *T. equinum* occur worldwide. *T. simii* (found in monkeys) occurs only in Asia, and *T. mentagrophytes* var. *erinacei* is limited to France, Great Britain, Italy and New Zealand.

Transmission

Infection occurs by contact with arthrospores (asexual spores formed in the hyphae of the parasitic stage) or conidia (sexual or asexual spores formed in the “free living” environmental stage). Infection usually begins in a growing hair or the stratum corneum of the skin. Dermatophytes do not generally invade resting hairs, since the essential nutrients they need for growth are absent or limited. Hyphae spread in the hairs and keratinized skin, eventually developing infectious arthrospores.

Transmission between hosts usually occurs by direct contact with a symptomatic or asymptomatic host, or direct or airborne contact with its hairs or skin scales. Infective spores in hair and dermal scales can remain viable for several months to years in the environment. Fomites such as brushes and clippers can be important in transmission.

Geophilic dermatophytes, such as *M. nanum* and *M. gypseum*, are usually acquired directly from the soil rather than from another host.

Disinfection

Dermatophyte spores are susceptible to common disinfectants such as benzalkonium chloride, dilute (1:10) chlorine bleach, or strong detergents. Chlorhexidine is no longer considered to be a good environmental decontaminant for these fungi. The mechanical removal of any material containing keratin, such as shed skin and hairs, facilitates disinfection. Vacuuming is considered to be the best method in many cases.

Infections in Humans

Incubation Period

The incubation period in humans is 1 to 2 weeks.

Clinical Signs

Dermatophytes generally grow only in keratinized tissues such as hair, nails and the outer layer of skin; the fungus usually stops spreading where it contacts living cells or areas of inflammation. Mucus membranes are not affected.

The clinical signs may vary, depending on the region affected. In humans, pruritus is the most common symptom. The skin lesions are usually characterized by inflammation that is most severe at the edges, with erythema, scaling and occasionally blister formation. Central clearing is sometimes seen, particularly in tinea corporis; this results in the formation of a classic “ringworm” lesion. On the scalp and facial hair, there may be hair loss. Dermatophytes acquired from animals or the soil generally produce more inflammatory lesions in humans than anthropophilic dermatophytes.

In humans, dermatophytoses are referred to as “tinea” infections, and are named with reference to the area of the body involved. Infections can spread to other areas; tinea corporis in children, for example, is often the result of a tinea capitis infection that has spread to the face.

Tinea capitis

Tinea capitis, most often seen in children, is a dermatophyte infection of the hair and scalp. Tinea capitis begins with a small papule, which spreads to form scaly, irregular or well-demarcated areas of alopecia. The cervical and occipital lymph nodes may be enlarged. A kerion, a boggy, inflammatory mass, may also be seen; this reaction is usually followed by healing. Suppurative lesions are often seen

when the infection is caused by zoophilic dermatophytes. Both anthropophilic and zoophilic dermatophytes can cause tinea capitis. In the U.S., it is most often caused by the anthropophilic dermatophyte *T. tonsurans*.

Most common agents*: *T. tonsurans*, *M. audouinii*, *M. canis*. Other agents: *M. ferrugineum*, *M. gypseum*, *M. nanum*, *M. persicolor*, *T. megninii*, *T. mentagrophytes*, *T. schoenleinii*, *T. soudanense*, *T. verrucosum*, *T. violaceum*.

Tinea corporis

Tinea corporis, or ringworm, occurs on the trunk, extremities and face. It is characterized by single or multiple scaly annular lesions with a slightly elevated, scaly and or erythematous edge, sharp margin and central clearing. Follicular papules, pustules or vesicles may be found on the borders of the lesion. Lesions may be variably pruritic. Both zoophilic and anthropophilic dermatophytes are common in children, and on the neck and wrists of adults in contact with the child. In other adults, tinea corporis is often the result of chronic infection with *T. rubrum*, an anthropophilic dermatophyte. In many people, untreated tinea corporis resolves within a few months, particularly if it is caused by a zoophilic or geophilic organism.

Most common agents*: *T. rubrum*, *M. canis*, *M. tonsurans*, *T. verrucosum*. Other agents: *E. floccosum*, *M. audouinii*, *M. gypseum*, *M. nanum*, *M. persicolor*, *T. equinum*, *T. mentagrophytes*, *T. raubitschekii*, *T. schoenleinii*, *T. violaceum*.

Tinea barbae

Tinea barbae is an infection of the hairs and skin in the beard and mustache area, and is usually seen in men. The lesions may include scaling, follicular pustules and erythema. Tinea barbae can be caused by zoophilic or anthropophilic dermatophytes. Farm workers are often affected.

Most common agents*: *T. verrucosum*. Other agents: *M. canis*, *T. megninii*, *T. mentagrophytes*, *T. rubrum*, *T. violaceum*.

Tinea faciei

Tinea faciei is seen on the nonbearded parts of the face. The lesions are usually pruritic; itching and burning may become worse after exposure to sunlight. Some lesions may resemble those of tinea corporis; others may have little or no scaling or raised edges. In some cases, the areas of erythema are indistinct. Due to the atypical presentation, tinea faciei is often confused with other skin diseases that affect the face.

Most common agents*: *T. tonsurans* in North America; *T. mentagrophytes* and *T. rubrum* in Asia.

Tinea cruris

Tinea cruris is an infection of the groin, usually caused by anthropophilic dermatophytes. The symptoms include burning and pruritus. Pustules and vesicles at the active edge of the infected area, along with maceration, are found in a background of red, scaling lesions with raised borders.

Most common agents*: *E. floccosum*, *T. rubrum*. Other agents: *M. nanum*, *T. mentagrophytes*, *T. raubitschekii*

Tinea pedis and tinea manuum

Tinea pedis (Athlete's foot) is an infection of the foot, characterized by fissures, scales and maceration in the toe web, or scaling of the soles and lateral surfaces of the feet. Erythema, vesicles, pustules and bullae may also be present. It is usually caused by anthropophilic dermatophytes.

Most common agents*: *T. rubrum*, *T. mentagrophytes* var *interdigitale*, *E. floccosum*. Other agents: *M. persicolor*, *T. raubitschekii*, *T. violaceum*.

Tinea manuum is a dermatophyte infection of one or, occasionally, both hands. In this form, the palms become diffusely dry, scaly and erythematous. It is most often caused by anthropophilic dermatophytes (cases may be an extension of Athlete's foot) but is occasionally caused by zoophilic organisms.

Most common agent*: *T. rubrum*. Other agents: *E. floccosum*, *M. canis*, *M. gypseum*, *T. mentagrophytes*, *T. verrucosum*.

Tinea unguium

Tinea unguium is a dermatophyte infection of the nail. It is characterized by thickened, discolored, broken and dystrophic nails. The nail plate may be separated from the nail bed. It can be caused by anthropophilic or zoophilic dermatophytes.

Most common agents*: *T. rubrum*, *T. mentagrophytes* var *mentagrophytes*. Other agents: *E. floccosum*, *T. tonsurans*, *T. violaceum*.

Dermatophytes in AIDS patients

In AIDS patients, dermatophytes such as *T. mentagrophytes* and *M. canis* can cause disseminated mycoses. AIDS patients may also be extensively infected with species that rarely affect healthy people, including *M. gallinae*.

Communicability

Dermatophytes acquired from animals can be spread person-to-person, but this is uncommon. In contrast, anthropophilic dermatophytes are readily spread between people.

Anthropophilic dermatophytes are rarely transmitted to animals; however, rare infections with *T. schoenleinii*, *T. rubrum* and *T. tonsurans* have been seen in cats.

Diagnostic Tests

In humans, the diagnosis is similar to animals. A Wood's lamp examination can detect fluorescence in some dermatophytes, including some strains of the zoophilic organisms *M. canis* and *M. equinum* and some anthropophilic dermatophytes such as *M. audouinii*.

Potassium hydroxide (KOH) microscopy can detect hyphae and conidia in skin scrapings or hair. Fungal cultures are necessary for the identification of the organism. Skin or nail biopsies are also used in humans.

Treatment

Tinea capitis, tinea barbae and tinea faciei are generally treated with systemic antifungals. Topical lotions or shampoos are sometimes used to decrease shedding of fungi and spores. Tinea corporis can usually be treated with nonprescription antifungals. Prescription drugs may be required if the fungus infects the hairs and recrudescence occurs. Tinea manuum is usually treated with topical drugs and emollients.

Prevention

Control of the disease in animals can prevent some cases of dermatophytosis in humans. Infected animals should be treated and the premises and fomites should be disinfected. Gloves and protective clothing should be used during contact with infected animals. Such contact should be avoided as much as possible. Similar measures can prevent infections with anthropophilic dermatophytes.

Morbidity and Mortality

Although dermatophyte infections are known to be common, their prevalence is unknown as this disease is not notifiable and many infections are treated with over-the-counter drugs. In the United Kingdom, a survey found dermatophytosis to be the most common zoonosis; its prevalence was 24%. Infections are more common in children than adults.

The geographic distribution of the various dermatophyte species, as well as their animal hosts, influences the zoonoses found in humans. *M. canis*, usually transmitted by cats and dogs, is more common in people living in urban areas. *T. verrucosum* is more often found in rural environments. In Switzerland, one study reported that 14% of those working with cattle had been infected.

Most dermatophyte infections are not serious in healthy persons; however, opportunistic bacteria can cause cellulitis in skin damaged by interdigital fungal infections. These infections are a particular concern in diabetics. Dermatophytosis is more serious in those who are immunosuppressed. These individuals may have atypical and locally aggressive dermatophyte infections, including extensive skin disease, subcutaneous abscesses, and disseminated disease.

Infections in Animals

Species Affected

All domestic animals are susceptible to dermatophytes. The most common fungi vary with the host.

- **Dogs and cats:** *M. canis* is the most common species, particularly in cats. *M. gypseum* and *T. mentagrophytes* are found occasionally. Other species are rare.
- **Cattle:** *T. verrucosum* is the most important species. Species found occasionally include *T. mentagrophytes*, *T. equinum*, *M. gypseum*, *M. nanum* and *M. canis*.

- **Sheep and goats:** *T. verrucosum* is the most common species but *M. canis* outbreaks have also been reported.
- **Horses:** *T. equinum* and *M. equinum* are the most important species. *M. gypseum*, *M. canis* and *T. verrucosum* are seen occasionally.
- **Swine:** *M. nanum* is the most important agent. This dermatophyte is rarely zoonotic.
- **Rodents:** Varieties of *T. mentagrophytes* are common in rodents. *Microsporum* species, including *M. persicolor*, are seen occasionally.
- **Rabbits:** *T. mentagrophytes* is the most important species.
- **Birds:** *T. gallinae* is the usual agent in birds, including poultry, canaries and pigeons. This dermatophyte is rarely zoonotic. *M. gypseum* and *T. simii* infections are seen occasionally.

Incubation Period

Fluorescence produced by some dermatophytes (*M. canis*) can appear on the fur within 7 days of exposure and clinical signs within 2 to 4 weeks.

Clinical Signs

Dermatophytes usually grow only in keratinized tissues such as hair, nails and the outer layer of skin; the fungus usually stops spreading where it contacts living cells or areas of inflammation. Mucus membranes are not affected.

Dermatophyte lesions are characterized by areas of alopecia, scaling, crusts, erythema and pruritus, present to varying degrees. Occasionally, the dermatophytes die at the center of a lesion and that area resolves, leaving a circular “ringworm” lesion. In animals, this pattern is relatively uncommon. Hairs in the affected area are usually brittle and break near the skin surface, often giving the lesion a “shaved” appearance; truncated hair shafts may be seen through the scales and crusts. Hair loss is not permanent unless the follicle has been destroyed by inflammation. Some degree of folliculitis occurs in most cases; papules or pustules involving the hair follicle or conical dilation of the hair follicle ostium are suggestive of dermatophytosis in small animals. In animals, dermatophytosis may or may not be pruritic. Young animals are affected most often. Asymptomatic infections are common, particularly in adult animals.

Dogs

In dogs, dermatophytosis is seen most often in puppies. It is uncommon in adult dogs unless they are immunosuppressed. The lesions may appear on any part of the body and usually consist of small circular areas of alopecia; the hairs are typically broken at the base, giving the appearance of the area having been shaved. The center of the lesion usually contains pale skin scales, giving it a powdery appearance, and the edges are generally erythematous. In later stages, the lesion is often covered by a crust and the edges are swol-

len. Individual lesions may coalesce to form large, irregular patches. Vesicles and pustules may be seen early in the infection. A focal nodular form (kerion reaction), characterized by localized severe inflammation with swollen, boggy skin oozing pus, may also be seen. Onchomycosis can occur concurrently. Dermatophytosis is usually self-limiting in dogs.

Cats

Many infected cats have few or no lesions. Longhaired adult cats, in particular, can be subclinical carriers; in some cases, the cat may have minimal lesions consisting of patchy areas of short stubble, alopecia, scaly patches or erythematous plaques, visible only on close inspection.

Symptomatic cases tend to be seen in kittens, with the early lesions found on the face, ears and paws. Generally, the lesions consist of areas of focal alopecia, with scaling and crusting containing only a few broken hairs. The area may develop a thin, grayish white crust or a thick, moist scab, and may or may not be pruritic. The cat’s grooming behavior can spread the infection to the entire body. In some cats, dermatophytosis may appear as pruritic miliary dermatitis, or as one or more ulcerated cutaneous or subcutaneous nodules (pseudomycetomas). Pseudomycetomas occur mainly in long haired cats. Onchomycosis may also be seen concurrently; the nails may be opaque, with whitish mottling, and shredding of the nail surface. The lesions are usually self-limiting within a few weeks to a few months in short-haired cats but may persist, either symptomatically or asymptotically, in long-haired cats.

Cattle

In cattle, the severity of disease varies, from small focal 1 cm lesions to extensive generalized skin involvement. Most often, the disease appears as nonpruritic periocular lesions in calves. Cows and heifers may have lesions more often on the chest and limbs, and bulls on the dewlap and intermaxillary skin. The initial lesions are discrete, grayish-white, crusty dry areas with a few brittle hairs. Some areas may become suppurative and thickly crusted. Lesions resembling light brown scabs may also be seen; when these scabs fall off, they leave an area of alopecia. The lesions usually resolve spontaneously in 2 to 4 months.

Horses

In horses, most dermatophyte lesions are found in areas of contact with saddles or other tack. *T. equinum* lesions are usually pruritic, with exudative lesions and areas of hairless, thickened skin. *M. equinum* lesions are usually less severe and consist of small scaly areas with brittle hairs. Early dermatophyte lesions may resemble papular urticaria.

Sheep and goats

Dermatophytosis is common in show lambs, but uncommon in production flocks. The most noticeable lesions are usually circular, alopecic areas with thick scabs on the head and face; however, widespread lesions may be found under

the wool when animals are sheared. In healthy lambs, the lesions are usually self-limiting.

Swine

Pigs develop a wrinkled lesion covered by a thin, brown, easily removed scab, or a spreading ring of inflammation. Dermatophyte infections are often asymptomatic in adult swine.

Rodents

Most rodents infected with *T. mentagrophytes* are asymptomatic or have few clinical signs. In mice, partial or complete areas of alopecia, erythema, scales, and scabs may be seen, often on the tail. In rats, the lesions are usually found on the back. Guinea pigs usually develop pruritic, ovoid, hairless, raised areas, with crusts or scales; these lesions first appear on the face then spread to the back and limbs.

Rabbits

In rabbits, dermatophytosis most often occurs in young, newly weaned animals. Focal alopecia, with erythema, crusts and scabs, is seen around the eyes, nose and ears, with secondary lesions appearing on the feet. The disease is usually self-limiting.

Birds

In birds, there may be alopecia, particularly on the face and neck, scaling, auto-mutilation and feather plucking. Some lesions may be ring-shaped or pruritic.

Communicability

Most animal dermatophytes are readily transmitted to other susceptible hosts, including humans, by contact and contamination of the environment. *M. nanum* of pigs and *T. gallinae* of birds are rarely transmitted to humans.

Diagnostic Tests

Some (but not all) strains of *M. canis* and *M. equinum* exhibit green fluorescence when stimulated by certain wavelengths of UV light. A Wood's lamp can be used to examine the fur for these fungi. Certain topical preparations may mask the fluorescence, and alcohol can either suppress the fluorescence or cause non-specific fluorescence.

Microscopic examination of skin scrapings or hairs in potassium hydroxide (KOH) may reveal hyphae or conidia. A potassium hydroxide-calcofluor white (CFW) mixture can also be used to visualize dermatophyte structures, using a fluorescence microscope.

Definitive diagnosis usually relies on culture. Skin scrapings or plucked hair samples may be cultured, or the fur may also be brushed with a disinfected toothbrush to collect hairs. Species found in dogs and cats will grow in about 4 to 7 days at 25-28°C, on a variety of commercial media. Dermatophyte Test Medium (DTM) contains a pH indicator (phenol red) that will turn the medium red when a dermatophyte is growing; however, bacteria and fungi other than

dermatophytes can also produce a pH change. Therefore, the growth must be examined further to differentiate the organism. Dermatophytes are traditionally identified using a "slide culture" to observe the reproductive structures (conidia) and hyphae. Species can be identified by the colony structure and color, microconidia, macroconidia and other microscopic structures.

Treatment

Animals often have self-limiting infections that resolve within a few months, but treatment can speed recovery, decrease the spread of lesions on the animal, and decrease the risk of transmission. Treatment may include topical antifungal creams or shampoos, and/or systemic antifungals. Onchomycosis can be very difficult to cure; long term treatment or surgical declawing may be necessary. Animals should be isolated until the infection resolves. The environment and fomites should be cleaned to remove hair and skin flakes, and disinfected.

Prevention

To prevent transmission, infected animals should be isolated until the infection has resolved. Animals that have been in contact with the patient should also be checked for asymptomatic infections. Some veterinarians use antifungals prophylactically for in-contact animals. The premises should be cleaned (vacuumed) and disinfected to help prevent infections in other animals or humans.

To prevent the introduction of dermatophytes into herds or kennels, newly acquired animals should be isolated and cultured. Rodent control can decrease exposure to *T. mentagrophytes*. Access to infected soil should be prevented, particularly with geophilic species.

Vaccines are available in some countries for *T. verrucosum* in cattle and *T. equinum* in horses. A killed *M. canis* vaccine (Fel-O-Vax) is available for cats from Fort Dodge. It can prevent or decrease clinical signs, but has not been shown to eliminate the fungus.

Eradication of some dermatophytes seems to be possible. In Norway, *T. verrucosum* is being eradicated from cattle by vaccination, disinfection of contaminated stables, isolation of infected animals and good hygiene.

Morbidity and Mortality

Among small animals, the prevalence rates reported in various studies vary widely. In general, dermatophytes are thought to be carried asymptotically more often by cats than dogs. Infection rates between 6% and 88% have been reported in felines. In one University of Wisconsin study, however, dermatophytes were found in none of 182 asymptomatic pet cats that lived alone with their owners. Some authors conclude that, overall, very few pets are asymptomatic carriers. Others feel that subclinical dermatophyte infections are very common, particularly in cats.

Among livestock, dermatophytoses are particularly common in cold climates where animals are stabled for long periods of time. In cattle, ringworm is seen most often in winter. Infections are rare in sheep and goats, with the exception of show lambs, but outbreaks of *M. canis* that affected 20-90% of the herd have been reported in Australia.

Whether an animal becomes infected, after contact with a dermatophyte, may depend on the animal's age, the condition of its exposed skin, and grooming behavior. Young animals are more likely to have symptomatic infections. Dermatophytosis is also more common when animals are immunosuppressed, have poor nutrition or are kept in high density populations. Most infections in healthy animals heal spontaneously within one to a few months. Infections can be more persistent or widespread in young or sick animals, and in some longhaired cats.

Post-Mortem Lesions [Click to view images](#)

Post-mortem lesions are identical to those in live animals; dermatophytes are restricted to hair, nails and superficial skin.

Internet Resources

- Centers for Disease Control and Prevention (CDC)
<http://www.cdc.gov/healthypets/diseases/ringworm.htm>
- Canadian National Centre for Mycology. World of Dermatophytes: A Pictorial
<http://www2.provlab.ab.ca/bugs/webbug/mycology/dermhme.htm>
- The Merck Manual
<http://www.merck.com/pubs/mmanual/>
- The Merck Veterinary Manual
<http://www.merckvetmanual.com/mvm/index.jsp>
- Recent Advances in Canine Infectious Diseases
http://www.ivis.org/advances/Infect_Dis_Carmichael/toc.asp

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