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Review Article

# Dog and Cat Dermatomycoses in Regions Lining the North Atlantic Ocean

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**Abstract**

Among the whole specters of fungi, only a few dozen species are parasitic on animals, with the vast majority being merely saprophyte organisms. Superficial dermatomycoses of the skin encompass dermatophytoses and some yeast infections. These diseases are quite common in humans, dogs and cats. Other systemic mycoses are much less common, but include cryptococcosis, sporotrichosis, histoplasmosis and North American blastomycosis. We present a review of dermatomycoses common to dogs and cats in regions lining the Atlantic Ocean.

**Keywords:** Dermatophytosis; Candidiasis; Malasseziosis; Cryptococcosis; Sporotrichosis; Histoplasmosis; Blastomycosis

## Abbreviations

M: Microsporum; T: Trichophyton; C: Candida; spp: species; Cr: Cryptococcus; B: Blastomyces; H: Histoplasma; Ma: Malassezia

## Background

The North Atlantic Ocean is bordered by regions enriched in domestic animals, particularly dogs and cats. These pets are occasionally infected by fungi. The superficial dermatomycoses are the most frequent conditions, but systemic mycoses are occasionally encountered [1]. Dermatophytoses (ringworms) are skin fungal infections that have been on the increase in recent years. They are caused by dermatophyte infections that largely depend on two major genus of fungi, the Microsporum (M) and Trichophyton (T) spp. They represent important fungal infections that attack dogs and cats. Although Microsporum spp. and Trichophyton spp. infections are most often encountered but they do not usually alter the global health of dogs and cats. They are undesirable, because infections of the coat, skin, or nails detract from the appearance of these animals. Furthermore, these fungi are potentially infectious to both humans and animals [2]. In fact, Microsporum infections are notifiable in certain countries on account of the close frequent contact between these companion animals and humans, particularly between children and their pets [3,4]. Indeed, dermatophytoses in pets represent a major source of infection in humans. Their elimination from animals reduces their impact in human medicine.

The incidence of infections by Candida spp. and Malassezia spp. appears to be on the rise in dogs and cats. These yeast infections are promoted by the increasing use of antibacterial antibiotics, cytostatics, immunosuppressants, and similar drugs in small-animal veterinary practice. Systemic mycoses such as, cryptococcosis, sporotrichosis histoplasmosis and blastomycosis occur occasionally.

Dermatophytoses are occasionally under diagnosed given their clinical resemblance to other skin conditions including hormone-induced disorders, mite infestations, eczema, some dietary disturbances, reactions to flea bites, and some vitamin deficiencies [5]. Conversely, a set of conditions leading with a fungal appearance are incorrectly managed as dermatomycoses. It is therefore essential to carry out dermoscopy [6] a microscopic examination, and a fungal culture whenever a fungal infection is suspected in order to ensure a correct diagnosis. In some regions about 10-20% of the dogs and cats are symptom-free carriers of pathogenic dermatophytes [7]. They remain undisclosed until their owners themselves develop clinical signs [7]. Early diagnosis in these animals improves the chances of obtaining a quick cure and reduces further risk of infection spreading to humans [8].

## Dermatophytoses

Ringworm caused by Microsporum spp., affects any hairy part of human skin and the coat of animals. It is often recognized by typical ring-shaped lesions and by the absence of hairs longer than about a couple of millimetres above the skin surface. Cats are considered to be a major reservoir for M. canis [9].

M. canis occurs throughout the world in cats, dogs, and other animal species, as well as in humans. Approximately 10-20% of the cats and 5% of the dogs are affected by M. canis [7]. Its incidence seems to be on the increase not only in humans but also in dogs and cats [2,4]. Such ringworm affects horses, pigs, and goats. It is present in various zoo animals including apes, monkeys, jaguars, and tigers, as well as rodents such as rabbits, guinea-pigs, rats, and mice. M. canis is common in cat-breeding establishments [8]. It affects all the kittens, especially long-haired breeds such as angora and Persian cats. Some cats of other breeds are commonly symptom-free carriers of the fungus [10]. This dermatophyte is highly infectious and is easily transmitted from pets such as cats, dogs, and horses to humans, and vice versa. Thereby, Microsporum ringworm is so feared in zoos, animal clinics, and circuses.

Microsporum ringworm is generally recognized by round patches on the skin, where the hair appears to be shaved off. Some thick and crust-like hair is present. In Microsporum ringworm, all hairs in the affected area are altered and they break off. The initial circumscribed patches enlarge, and the total body surface is ultimately affected by




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the process. Virtually all the Microsporum infections in the cats are caused by M. canis, and only few cases are due to M. gypseum. The clinical lesions appear mostly on the head, ears, tail, and front paws, but possibly affect the whole body [7]. The affected skin is generally not itching, but occasionally the cat licks or scratches itself. The characteristic patches with a shaved appearance that develop in other cats are an exception. Kittens show the symptoms the most clearly, while older cats often do not exhibit skin lesions, or only have slight and discrete cutaneous signs.

About a third of the lesions caused by Microsporum infections are detected under Wood's lamp. In fact, infections caused by M. gypseum do not fluoresce. Direct microscopic examination and Cyanoacrylate skin surface strippings [11-14] reveal hyphae and arthroconidia. Fungal cultures assume great importance for a diagnosis.

Ringworm is often restricted to a few annular lesions that heal spontaneously [15]. Hairs start to regrow within the lesion while the edges retain their shaved appearance. The animal experiences no itching, and its general condition is usually not impaired. The enlarging lesions are diverse in appearance, and the following clinical stages [7] are distinguished:

1. Fluorescence under Wood's lamp, without any visible lesion.

2. Hyperpigmented and slightly raised patches, with focal alopecia and broken-off hairs.

3. Lesions with gray crusts, broken-off hairs and a weeping erythematous base.

4. Crusts covering the entire body, without alopecia.

5. Onychomycosis when mycosis affects the claws.

After an incubation period of 10-15 days, circumscribed lesions appear over the affected area of the coat, with circular bald patches about 1-4 cm in diameter. In these areas, hairs are broken off at the skin surface, creating a tonsure-like shaved appearance. The centre of the lesions contains light scales and shows of powdery appearance, while the edges form an erythematous ring. The coalescence of individual lesions produces an irregular polycyclic pattern, but with the contours of the original rings being still remarkable.

Dermatophytosis caused by T. mentagrophytes is highly infectious for the glabrous skin. T mentagrophytes is a cosmopolitan fungus in humans and animals causing kerion in humans, and ringworm in various animals. It is common in rodents including rabbits, guinea-pigs, rats, and mice, as well as in wild animals. It affects regularly dogs and horses, but only occasionally cats, and rarely cattle and pigs [7].

T. verrucosum tends to have only animal spp. as the main reservoirs. The principal animals that are either infected by this fungus or act as symptom-free spore carriers are the rodents, whether they live in the wild (rats and mice) or are kept by man (rabbits, guinea-pigs, white rats and mice). People in rural areas are infected either by direct contact with animals or by handling grain, straw and feed following previous contamination with the spores by rodents. The fungus remains infectious in the hair and scales of skin for some extended periods.

It remains that clinical appearance of lesions caused by Trichophyton ringworm is not clearly distinct from other dermatophytoses including Microsporum ringworm. The lesions, hairs, and skin flakes do not fluoresce under Wood's lamp, and fungal cultures are needed for diagnosis.

Trichophyton ringworm in the dog commonly develops as a dry dermatophytosis. The initial stage, is however, characterized by vesicles and pustules with some crusting and scaling. A few healthy hairs remain dispersed inside the bald patches. Sites of predilection are the head, limbs, and neck, from where the fungus spreads to other parts of the body. The inflammatory eruptions are rounded and erythematous, with swollen border and a crusty cover. In the generalized form, dry scaly diffuse lesions predominate. In more advanced lesions, the inflamed lesions coalesce into larger patches covered by loose scales. Local nail infections occur, as well as clinically vague and undistinct forms. Itching is not associated with this condition. Trichophyton ringworms in the cat mainly affect the head, neck, and the front of the chest, with scabies-like or asbestos-like crusts, firmly adhering to the skin.

## Yeast Infections

### Candidiasis

Candidiasis is a yeast infection of the mucosa, skin, digestive duet and sometimes various other organs of dogs, cats, as well as calves, birds, foals, piglets, and man. It is commonly caused by the yeast C. albicans while other Candida spp. (C tropicalis and C krusei) are less common or less pathogenic. Candidiasis occurs all over the world. The predisposing factors in humans and domestic animals are diversified: modern lifestyle, intensive animal husbandry, prolonged use of drugs (such as corticoids, broad-spectrum antibacterial antibiotics, trichomonadicides, immunosuppressives, cytostatics, and contraceptives) and irradiations.

C. albicans is a round to oval organism that resides on the mucous membranes of the mouth and in the gastrointestinal tract of warm-blooded animals. Its biotope is the digestive system from the mouth to the anus in both humans and animals. However, it is also found in places where it is not native, such as the skin and the vaginal mucosa. C. albicans rarely occurs in the environment as a free-living organism. Under normal conditions and in absence of predisposing factors, C. albicans is not highly pathogenic provided that its amount remains limited. The infection spreads to the young from their mother's feces or saliva.

Candida spp. is present on the healthy mucous membranes of the digestive tract both in humans and animals. However, isolation of a few Candida colonies from the sputum or the feces has no pathological significance. It is necessary to quantify the condition and to find out the amount of organisms residing in the oral cavity or the sputum. It is necessary to establish whether mycelium is present or not. Candida infection is present only if the yeast organisms are present in large numbers and if mycelia are present *in vivo*.

Candidiasis occurs in many human and animal organs under different presentations. In zoo animals and animals in the wild, infections occur both inside and outside the digestive system, areas that are constantly moist being particularly susceptible to infection [7]. The respiratory system is seldom involved.

In the small-animal practice, C. albicans is unfrequently encountered. The organism preferentially infects the mucous membranes and some skin areas that are moist or softened. The mucous membranes commonly develop a thick and white opaque coat, with a milky or cheesy pseudo-membrane presentation. The site is inflamed, the mucosa is erythematous, and epithelial cells are shed. This condition enables the yeasts to invade deeper into the tissues. The oral lesions consist of white or grey crusts that tend to coalescence into straight bands, surrounded by the inflamed mucosa. The skin commonly exhibits folliculitis the lesions are moist and erythematous, with eroded areas. Vesicles and papules are present covered with white and sometimes brownish crusts. Cutaneous lesions are generally secondary to oral, anal, or vaginal forms. Vaginal candidodis is mostly characterized by a white or creamy discharge and a white coating on the walls of the vagina. Candidosis is observed in the outer ear and the epidermis bordering the nail or claw (perionyxis).

C. albicans often multiplies by budding. The detection of mycelium and yeasts *in vivo* is a common finding, particularly when an active lesion is involved [11,14]. Scrapings of tissues or smears of sputum or feces are conveniently subjected to microscopic examinations either directly in water or after clearing the specimen in a potassium hydroxide solution. A positive sample shows small, round or oval, thin-walled yeast-like cells with a diameter of 2-4 µm and hyphae with budding yeast cells. Gram's stain imparts a deep violet colour to the yeasts.

A fungal culture and molecular typing are carried out to identify yeasts. C. albicans grows on Sabouraud's agar, but the use of a selective medium such as Nickerson's medium is convenient. Sabouraud's agar shows Candida colonies already after 24-28 h, whereas dermatophytes require at least 8-20 days of incubation. C. albicans grows both at room temperature and at 37°C. Its colonies are undistinguishable from other Candida spp. and other yeasts by the naked eye.

## Malasseziosis

Malasseziosis is caused by Malassezia (Ma) spp. In humans these microorganism spp. occur mainly in areas enriched with a high density of sebaceous glands [16]. In dogs and cats they are commonly present the ears and the skin. They cause otitis externa, loss of hair, and the scaling of skin between stubble-like hairs [7].

Ma spp. look as small oval or round lipophilic yeasts that multiply by unipolar budding. The yeasts are present at the skin surface in warm-blooded animals including dogs and cats. It is closely adapted to its host that it has not been encountered in other conditions. It represents a lipophilic opportunistic fungus that becomes pathogenic only in presence of some predisposing factors. In the case of ear inflammation, mixed infections with Gram-positive bacteria such as Staphylococci and Streptococci spp., as well as with other yeast types, are quite common.

Ma pachydermatis in the ear is a saprophyte that quickly turns pathogenic under some conditions [16]. It is not a common single micro-organism present in otitis externa, but mixed infections with Gram-positive bacteria and other yeasts are often common in ear inflammations. Ma.spp. penetrate into hair follicle, causing hairloss. It is generally present in skin folds. Dermatis caused by Ma pachydermatis mainly occurs on the abdomen of animals. In acute cases erythematous lesions develop, followed by pigmentation. Hyperkeratosis with scaling is formed in chronic stages. The condition is always accompanied by intense itching. Such lesions do not respond to corticosteroids or antibacterial antibiotics, but they are cured with antimycotics.

The location of the infection in the dog is often indicative of malasseziosis. Another sign is a dark brown aspect of the earwax. The diagnosis is confirmed by direct microscopic examination of the earwax or skin scales, and by subjecting them to a fungal culture. Ma pachydermatis is cultured on Sabouraud's agar containing cycloheximide. The fungal growth is promoted by incubation at 37°C. Certain strains of Ma pachydermatis found in the dog are slow and difficult to grow [7].

Microscopic examination of the lesions or the fungal cultures reveals characteristic oval or bottle-shaped yeast cells with budding [17]. Groups of oval or bottle-shaped cells with a diameter of 2-4µm are observed. The fungus multiplies by unipolar budding. A clear broad septum is formed between the mother and daughter cell before the bud is released.

## Systemic mycoses

Deep or systemic mycoses are serious diseases caused by various fungi invading the subcutaneous tissues and becoming systemic. There is growing concern about the rising incidence of such infections in animals [7]. This increase is linked in part to improved diagnostic methods.

**Cryptococcosis:** Cryptococcosis is a subacute and sometimes chronic mycosis occurring in humans and in domestic animals including dogs, cats, cattle, and horses. It is caused by Cryptococcus neoformans [18-20].

Cryptococcosis has a worldwide distribution, but is more frequent in the tropics than in the temperate climates, where it occurs only sporadically. Cr. neoformans is ectosaprophytic yeast, with wood as a natural biotope. It develops in the excrement of birds, particularly pigeons and aviary birds, but the birds themselves are rarely diseased. The conidia survive in the bird's crop and are dispersed with the feces. They are inhaled with dust and find their way to the lungs where they cause some local reactions, turning into an infection whenever the immune system of the host is impaired or when other predisposing factors are present [7]. The spores possibly enter the human or animal body through skin wounds or injuries. It is recommended to avoid any contact with infected animals or to respect adequate preventive measures. Cryptococcosis affects mainly animals with an impaired immune system [7]. The clinical aspect is not specific. The diagnosis is hampered by other disorders that are present simultaneously, particularly in the generalized forms of cryptococcosis.

The fungus affects the brain, the meninges and the paranasal sinuses, causing lack of co-ordination, turning round and round rotation of the head, changes in behavior, paralysis, and a flow of nasal discharge. The skeletal system is frequently altered, and arthritis develops. Autopsy reveals a mucopurulent inflammation of the paranasal sinuses and nasal cavities, as well as small granules in the brain and meninges. Subcutaneous granulomas develop around the ears, on the face, and on the feet.

Cryptococcosis occurs more often in cats than in dogs. Cats with compromised cell-mediated immunity (e.g. after feline leukaemia) are susceptible. Cryptococcosis is suspected in older cats that exhibit chronic discharge from the nose or eyes, are blind, show lack of co-ordination, and have a fever, a swelling in the nasal or pharyngeal cavity, and a cough. Inhaled Cryptococcus cells are present in tumoral-like lesions of the throat. The infection progresses to the nasal cavities and the cranial cavity when it attacks the optic nerve, leading to blindness. In general, however, in the cat the disease is restricted to the lungs and the upper respiratory tract. Subcutaneous granulomatous tumor-like swellings are sometimes present; these lesions are filled with a gelatinous exudate.

Cryptococcosis is suspected whenever a dog or a cat has any inexplicable respiratory or neural disorder, or some granulomatous suppurating skin lesions. Biopsies are taken for microscopic examinations. Cr. neoformans appears as round as oval yeast cells, with a thick capsule reaching a 5-20 µm diameter, budding being optional. The fungal capsules present in fresh preparations are conveniently stained with India ink and stains red with mucicarmine. The fungus grows on Sabouraud's agar containing is antibacterial antibiotics, but certainly not cycloheximide, because Cr. neoformans is very sensitive to this drug. The culture is incubated between 25 and 37°C.

**Sporotrichosis:** Sporotrichosis is usually a subcutaneous mycosis with localized, disseminated, and systemic localizations in both humans and animals [7]. The incubation period lasts 3-21 days, or even longer. The clinical signs vary according to the duration of the disorder. A painless reaction starts with inflammation, and purulent abscesses. There are some firm spherical nodules, from where the disease spreads following the lymphatic vessels. When sporotrichosis becomes chronic, the presentation shows structures resembling epithelioid cells and granulomas. The disseminated form is more common in the dog and the cat. In the non-cutaneous form of the dog, the liver and the lungs are involved.

The cutaneous nodules should be subjected to histopathology and mycological examination for Sporothrix. In humans, microscopic examination for the parasitic form in the pus rarely gives any useful information. However, after a Gomori-Grocott stain in cats and dogs, cigar-shaped or round yeast cells, as well as star-shaped forms, become visible [7]. Hyphae are not observed unless a fungal culture is carried out. The latter is performed on Sabouraud's agar containing both antibiotics and cycloheximide.

**Histoplasmosis:** Histoplasmosis is a systemic fungal disorder affecting humans and animals [21-23]. It is caused by dimorphic fungi of the Histoplasma genus. H. capsulatum is responsible for classic or American histoplasmosis. By contrast, H. duboisii causes African histoplasmosis, and H. farciminosum affects mostly the horses. In the dog and the cat, histoplasmosis does not follow the generally characteristic pathological course, but rather chronic coughing, dysentery, emaciation, and pulmonary nodules represent typical manifestations.

Histoplasmosis is endemic primarily in the Mississippi valley. However, cases have been reported in other countries [7]. In Europe, it has been described in Italy and Romania, while elsewhere the disease is due to imported cases. In endemic areas, H. capsulatum lives as a soil saprophyte, particularly where animal feces accumulate, such as henhouses, pigeon-lofts, places where birds nest and sleep in city parks, and caves inhabited by bats. The infection occurs when dust containing spores is inhaled or contaminates small wounds or injuries. Apart from humans and dogs, infection occurs in cats, cattle, horses, rats, and mice, but histoplasmosis is not a problem in these species. Extreme caution is needed when handling infected material or cultures of Histoplasma spp.

Primary pulmonary histoplasmosis and generalized histoplasmosis occur in dogs, cats, cattles, horses, as well as in rodents living in the wild. Acute histoplasmosis is practically always fatal after a few weeks [7]. Dogs up to three years of age are especially susceptible to contamination signs. The symptoms and the pathological alterations caused by pulmonary histoplasmosis closely resemble those observed in tuberculosis. The dogs have a persistent chronic cough, dysentery, or both. The deep dry cough is related to the enlarged bronchial lymph modes and to pulmonary nodules. Similar to tuberculosis, histoplasmosis develops a "primary complex". Caseous and calcified alterations are present in the affected tissues. Dysentery is due to due to ulceration of the gastrointestinal mucosa. Other clinical manifestations include anorexia, loss of weight, vomiting, skin ulcers, lumps in the subcutaneous tissues, irregular fever, and enlarged visceral lymph nodes. Abdominal palpation often reveals swollen mesenteric lymph nodes. Ulceration of the oral mucosa and enlarged tonsils are sometimes present.

In endemic areas histoplasmosis must be suspected, especially in young dogs, with chronic coughing and dysentery. The chest X-ray reveals enlarged bronchial lymph nodes and nodules. The latter vary from granulomatous fibrotic foci with a diameter of 2-5 mm to miliary calcifications. The tubercles do not calcify in canine tuberculosis. The presumptive diagnosis is confirmed by microscopic examinations and fungal cultures, because histoplasmosis resemble nocardiosis and coccidioidomycosis. Histopathological examination is a valuable aid to reaching the correct diagnosis.

**North American blastomycosis:** North American blastomycosis is a systemic fungal infection caused by Blastomyces dermatitidis. The disease occurs in humans and the dog, but only exceptionally in the cat [24-29]. This fungal disease is particularly endemic in the eastern United States. In addition, it is reported particularly in Africa. In Western Europe, however, it is confined to imported animals. Blastomycosis is mainly a disease of young dogs of about two years of age, and dogs are involved more easily than bitches [7]. They are infected following inhalation conidia growing as saprophytes in the soil and similar grounds. It has rarely been possible to isolate the causative organism form the soil, although cases in humans and animals have been reported. Blastomycosis is not transmissible between humans and animals, but the infection is contracted from the surroundings. In the host with a body temperature of 37°C the organism is present in its yeast phase, with a single bud, formed on the mother cell along a broad base.

The inhaled B. dermatitis conidia pass into the alveoli, where they are phagocytized. They are modified into parasitic budding yeast cells, and local pulmonary lesions are produced. The disease spreads to other organs following the lymphatic route. Secondary infections, leading to the skin, eyes, and bones, occasionally occur, depending on

the immune resistance of the host. The clinical manifestations remain vague including loss of weight, dyspnea, bronchial rales, and fever.

The origin area o the imported animal, its age, the clinical signs, and the X-ray aspect contribute to suggest blastomycosis. The diagnosis is mainly based on cytological and histopathological investigations, combined with a fungal culture. It is confirmed by direct microscopic examination of pus, urinary sediment, or material that has been coughed up or obtained by tracheal flushing. B. dermatitidis is easily distinguished from other yeasts by having a size of 8-15 µm, a fragile cell wall, and broad unipolar buds [7].

## Conclusion

Diagnoses of dermatomycoses are increasing in the West, both in humans and pets. Domestic animals play a prominent role as a reservoir of zoonoses. In pets the clinical cause of dermatomycoses follows a similar pattern to infection in humans [7]. With human infection, the clinical cause is often more dramatic in immunosuppressed individuals [30,31].

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