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Diversity of Keratinophilic Fungi with Special Reference to Dermatophytes in Ujjain Soil

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ABSTRACT: Keratinophilic fungi are a group of fungi that colonize various keratinous substrates degrading them to components of low molecular weight. These include a variety of filamentous fungi comprising mainly hyphomycetes and several other taxonomic groups³. Hyphomycetes include dermatophytes and a variety of non-dermatophytic keratinophilic fungi. Most species of dermatophytes are anthropophilic or zoophilic in their natural habitat, while some occur in soil as saprophytes and are termed geophilic, for example, *Microsporium gypseum* and *Trichophyton terrestre*. Non-dermatophytic keratinophilic fungi, including species of *Chrysosporium* and other genera of fungi, are known to occur as saprobes in soil; some of them are potential pathogens of humans and animals. Studies on keratinophilic fungi of soils of varying habitats in different soils in Ujjain have demonstrated frequent occurrence of *Chrysosporium* spp and dermatophytes like *Microsporium gypseum* complex (*M. gypseum* and *M. fulvum*), *Trichophyton terrestre*, and *Trichophyton ajelloi*. Other dermatophytes known to occur infrequently or sporadically in soils in Ujjain are *M. cookei*, *M. vanbreuseghemi*, and *T. gloriae*³. *Trichophyton simii*, *T. mentagrophytes*, *M. nanum* and *M. persicolor*, well-known zoophilic dermatophytes, have also been frequently recovered from soil in Ujjain.

KEYWORDS-Ujjain,soils,dermatophytes,keratinophilic,fungi,diversity

I. INTRODUCTION

The term dermatophyte is a label used for three types of keratinophilic fungi responsible for the majority of fungal skin infections in humans. The three genera, *Trichophyton*, *Microsporium*, and *Epidermophyton*, together comprising about 40 different species, can be transmitted in many different ways, including person-to-person contact, contact with geophilic organisms in the soil, spread via animal vector, and even indirectly through inanimate objects carrying the fungi. Infections are primarily localized to the hair, nails, and outer layers of the skin, reflecting the affinity of the fungi for keratin and the inability of the fungi to invade deeper tissues or organs in immunocompetent skin. Infections can cause a number of symptoms, including extensive inflammation, itching, and discolored, scaly skin lesions. These infections, referred to as dermatophytoses or tinea infections, are named for the body sites involved, through

soils in Ujjain.[1] Dermatophytosis is an infection of hair shafts and stratum corneum caused by keratinophilic fungi. It occurs commonly in dogs and cats, with highest incidences reported in kittens, puppies, immunocompromised animals, and long-haired cats.

Skin involvement may be localized, multifocal, or generalized. Pruritus, if present, is usually minimal to mild but occasionally may be intense. Lesions usually include areas of circular, irregular, or diffuse alopecia with variable scaling. Remaining hairs may appear stubbled or broken off. Other symptoms in dogs and cats include erythema, papules, crusts, seborrhea, and paronychia or onychodystrophy of one or more digits. Rarely, cats present with miliary dermatitis or dermal nodules (see "Dermatophytic Granulomas and Pseudomycetomas"). Other cutaneous manifestations in dogs include facial folliculitis and furunculosis resembling nasal pyoderma, kerions (acutely developing, alopecic, and exudative nodules) on the limb or face, and truncal dermal nodules (see "Dermatophytic Granulomas and Pseudomycetomas"). Asymptomatic carrier states (subclinical infection) are common in cats, especially among long-haired breeds. Asymptomatic disease, although rare in dogs, has been reported by transfer through soils in Ujjain.

Dermatophytosis (ringworm or tinea) is a superficial cutaneous infection with one or more of the keratinophilic fungi that belong to the genera *Microsporium*, *Trichophyton*, or *Epidermophyton*. Transmission of dermatophytes occurs by close contact with other infected animals or through contact with contaminated fomites (which includes the haircoats of animals and arthropods such as fleas or houseflies). Dermatophyte spores survive more than a year in the environment under optimal conditions of temperature and humidity, and they resist most routinely used hospital disinfectants, which facilitates transmission. Dermatophytes are somewhat host species specific and are classified

as *geophilic*, *zoophilic*, or *anthropophilic*.³ Geophilic dermatophytes are soil saprophytes. The most common geophilic dermatophyte that infects dogs or cats is *Microsporum gypseum*, which is most prevalent in warm, humid tropical and subtropical environments. Zoophilic dermatophytes are adapted to animal hosts and are rarely found in soil. The most common zoophilic dermatophyte that infects dogs and especially cats is *Microsporum canis*; this organism accounts for more than 90% of dermatophyte isolates from cats worldwide and more than 60% of isolates from dogs. Sylvatic dermatophytes are zoophilic dermatophytes that are adapted to rodents or hedgehogs. The most common sylvatic dermatophyte that infects dogs and cats is *Trichophyton mentagrophytes*. Anthropophilic dermatophytes are adapted to human hosts and do not survive in the soil; they include *Microsporum audouinii*, *Trichophyton tonsurans*, *Trichophyton rubrum*, and *Epidermophyton floccosum*. Rarely, these species infect or contaminate dogs or cats that have a history of close contact with infected humans. Mixed infections with multiple dermatophyte species occur rarely in dogs.

Risk factors for dermatophytosis in dogs and cats include young age and concurrent immunosuppressive disorders, especially endogenous or iatrogenic hyperadrenocorticism. Dermatophytosis is more common in cats than in dogs, but the prevalence varies with geographic location, maximum in Ujjain soils the infection is transferred.[2]

II. DISCUSSION

Nail dermatophytosis (*tinea unguium*) is the most common nail infectious disorder and may have several clinical presentations according to the type of fungal invasion of the nail plate. Five major presentations are described: distal and lateral subungual, proximal subungual, white superficial, endonyx, and total dystrophic onychomycosis. The Distal and Lateral Subungual Onychomycosis (DLSO) is usually associated with *tinea pedis* because fungi reach the nail through the hyponychium invading the undersurface of the nail plate and spreading proximally. It usually affects one or both great toenails and it is usually caused by *T. rubrum*. The White Superficial Onychomycosis is usually caused by *T. mentagrophytes*, which invades the dorsal nail plate forming white opaque lesions, easily scraped away. The Proximal Subungual Onychomycosis (PSO) typically occurs in the ventral nail plate, producing a proximal leukonychia and it is rarely related to dermatophytes, being more observed in immunocompromised patients or related to non-dermatophyte infection. Endonyx Onychomycosis is very rare, caused by *T. soudanense* or *T. violaceum*, and is characterized by massive nail plate invasion without nail bed involvement. Total Dystrophic Onychomycosis occurs after long-term DLSO or PSO presenting severe subungual keratosis, transferred by soils of Ujjain, Madhya

Pradesh. Dermatophytosis of the inguinal region (*tinea cruris*) is more frequent between adult men and presents as annular lesions with erythematous-scaly border on the groin. The main fungal agents involved are the same agents of *tinea corporis*.

Some special clinical presentations of dermatophytosis must be highlighted due to their specific characteristics. Majocchi granuloma is a deeper dermatophyte infection with dermic and follicular involvement and greater inflammatory reaction. [3] *Tinea incognita* corresponds to a dermatophytosis lesion modified after topical or oral corticosteroids use, reducing inflammatory signs, making diagnosis difficult. *Tinea imbricata* is caused by *Trichophyton concentricum* (named after the concentric aspect of the skin lesions), occurring from transfer of soils of Ujjain (James *et al.*, 2006). *Tinea corporis gladiatorum* can present in athletes (classically wrestlers) with extensive direct skin-to-skin contact (Yee and Al Aboud, 2019). In immunocompromised and susceptible patients, dermatophytosis may be a deep, extensive, severe and invasive disease (Nazarian *et al.*, 2019).

A dermatophytid is a secondary, distant, hypersensitivity reaction that can occur as immunological response to a dermatophyte infection. The essential criteria for diagnosis are: (1) a proven focus of dermatophyte infection confirmed by fungal isolation in culture; (2) absence of dermatophyte isolation from the dermatophytid lesion, and (3) clearing of dermatophytid lesion after dermatophyte has been eradicated (Al Aboud *et al.*, 2003).

Diagnosis of dermatophytoses involves the direct microscopic analyses of the skin and nail scales, where any dermatophyte presents as septate, branched hyaline hyphae that can disarticulate, resulting in arthroconidia. In hair, dermatophytes also appear as hyphae or arthroconidia chains being classified in three types of parasitism: (1) *ectothrix*, when hyphae and arthroconidia are distributed around and inside the tonsured hair shaft (Fig. 11); (2) *endothrix*, when hyphae and arthroconidia are distributed inside the tonsured hair shaft; and (3) *favic*, when hyphae and arthroconidia are distributed inside the hair shaft, without tonsure. Dermatophytes grow well in Sabouraud and Mycosel Agar after incubation at 25°C for 10 days on average. All dermatophytes are resistant to cycloheximide present in Mycosel Agar, which helps in their isolation in this media. The species are routinely identified by macroscopic (texture and pigment of the colonies) and microscopic (morphology and abundance of macroconidia and microconidia) analyses of fungi isolated from the soils of Ujjain.



III. RESULTS

Table 1 . Macroscopic and microscopic characteristics of most clinically important dermatophytes from

soils of Ujjain

Dermatophyte	Macromorphology	Micromorphology
<i>T. rubrum</i>	White colony with downy to velvety texture, and red reverse pigment	Delicate pyriform to claviform microconidia and cigar-shaped macroconidia (Fig. 12(A))
<i>T. mentagrophytes</i>	White to beige colony with powdery surface, brown reverse pigment	Clustered round microconidia, spiral hyphae, and claviform macroconidia (Fig. 12(B))
<i>T. tonsurans</i>	Beige colony with velvety to powdery texture, radial grooves, and reddish-brown reverse pigment	Long claviform to broad pyriform microconidia, cigar-shaped macroconidia, and clamidoconidia (Fig. 12(C))
<i>E. floccosum</i>	Beige velvety colony raised and folded in the center, yellowish-brown reverse pigment	Thin-walled macroconidia growing directly from the hyphae and numerous clamidoconidia (Fig. 12(D))
<i>M. canis</i>	White colony with fuzzy texture, bright golden yellow reverse pigment	Spindle-shaped, thick-walled macroconidia with more than 6 cells, and few pyriform to claviform microconidia (Fig. 12(E))
<i>Nannizzia gypsea</i>	Beige colony with granular texture, brown reverse pigment	Ellipsoidal, thin-walled, four to six-celled macroconidia, and numerous claviform microconidia (Fig. 12(F))

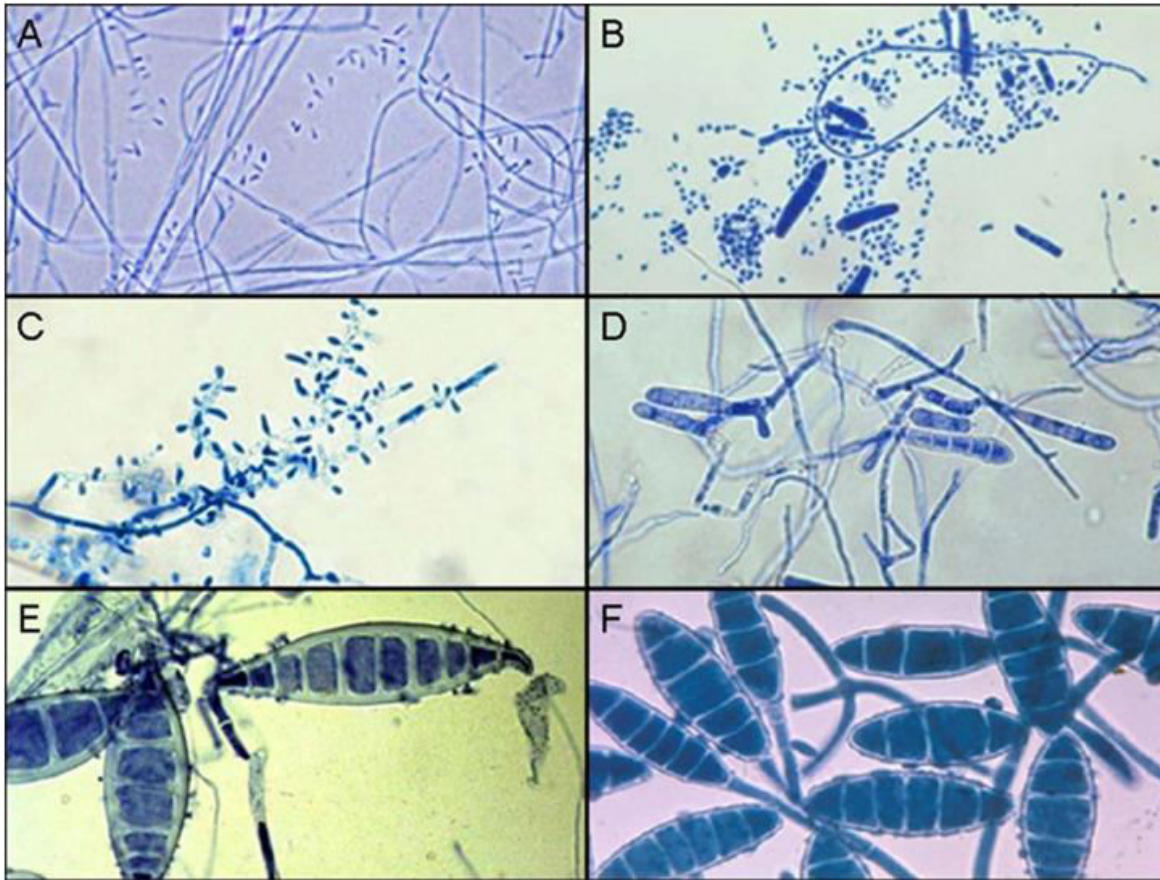


Fig. 12 . Microscopic characteristics of most clinically important dermatophytes (A) *Trichophyton rubrum*. (B) *Trichophyton mentagrophytes*. (C) *Trichophyton tonsurans*. (D) *Epidermophyton floccosum* . (E) *Microsporum canis*. (F) *Nannizzia gypsea* .

Dermatophytosis (ringworm or tinea) is a superficial cutaneous infection with one or more of the keratinophilic fungi that belong to the genera *Microsporum*, *Trichophyton*, or *Epidermophyton*. Transmission of dermatophytes occurs by close contact with other infected animals or through contact with contaminated fomites (which includes the haircoats of animals and arthropods such as fleas or houseflies). Dermatophyte spores survive more than a year in the environment under optimal conditions of temperature and humidity, and they resist most routinely used hospital disinfectants, which facilitates transmission. Dermatophytes are somewhat host species specific and are classified as *geophilic*, *zoophilic*, or *anthropophilic*. [4]Geophilic dermatophytes are soil saprophytes. The most common geophilic dermatophyte that infects dogs or cats is *Microsporum gypseum*, which is most prevalent in warm, humid tropical and subtropical environments. Zoophilic dermatophytes are adapted to animal hosts and are rarely found in soil. The most common zoophilic dermatophyte that infects dogs and especially cats is *Microsporum canis*; this organism accounts for more than 90% of dermatophyte isolates from cats worldwide and more than 60% of isolates from dogs. Sylvatic dermatophytes are zoophilic dermatophytes that are adapted to rodents or hedgehogs. The most common sylvatic dermatophyte that infects dogs and cats is *Trichophyton mentagrophytes*. Anthropophilic dermatophytes are adapted to human hosts and do not survive in the soil; they include *Microsporum audouinii*, *Trichophyton tonsurans*, *Trichophyton rubrum*, and *Epidermophyton floccosum*. Rarely, these species infect or contaminate dogs or cats that have a history of close contact with infected humans. Mixed infections with multiple dermatophyte species occur rarely in dogs.[7]



Risk factors for dermatophytosis in dogs and cats include young age and concurrent immunosuppressive disorders, especially endogenous or iatrogenic hyperadrenocorticism. Dermatophytosis is more common in cats than in dogs, but the prevalence varies with geographic location. Positive dermatophyte cultures occurred in 6% of submissions from dogs or cats in the southern United States (3.8% for dogs and 14.9% for cats), and in the United Kingdom, 16% were positive (10% for dogs and 16% for cats). Higher prevalences of detection (19% to 43%) have been reported in some studies of cats and dogs, with and without skin lesions, from Ujjain, Madhya Pradesh.[5] Dermatophytosis (especially geophilic dermatophytosis) is more prevalent in regions with high warmth and humidity. Shelter cats, the vast majority of which lack skin lesions, are more likely to carry dermatophytes on their haircoats than healthy pet cats. Dermatophytes were cultured from 5.5% and 19% of all shelter cats depending on geographical region,^{18,19} whereas the prevalence of *M. canis* isolation from healthy pet cats is generally less than 2.5%. [6]

IV. CONCLUSION

Animals admitted to breeding or boarding facilities that have a history of dermatophytosis are also at risk of infection, whereas dermatophytes are generally not detectable on the haircoats of animals in facilities without a history of infection.²⁰ Retrovirus-infected cats are no more likely to carry dermatophytes than retrovirus-negative cats,²¹ but retrovirus-infected cats carry a greater range of species and may be more likely to develop skin lesions (dermatophytosis). Genetic factors may also be important. Dogs that hunt and burrow in soil may be at increased risk for infection by geophilic or sylvatic dermatophytes, which may explain the common distribution of lesions on the face and distal thoracic limbs for these dermatophyte species which spread from soils of Ujjain, Madhya Pradesh.[7]

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