PAPER

Prevalence of dermatophytes and other superficial fungal organisms in asymptomatic guinea pigs in Southern Italy

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Objectives: Guinea pigs have been indicated as a potential source of zoophilic dermatophytes that cause human dermatomycosis. The purpose of this study was to evaluate the prevalence of dermatophytes as well as saprophytic fungi in asymptomatic pet guinea pigs in Southern Italy.

Methods: Two-hundred pet guinea pigs were enrolled from both private veterinary clinics and pet shops in the Campania region, Italy, from August 2012 to September 2013. Samples were collected using the MacKenzie's toothbrush technique. The plates were incubated for four weeks at 25°C and identification of the fungal colonies was based on both macroscopic and microscopic characteristics.

Results: Two pathogenic dermatophytes were isolated in 9 (4·5%) of 200 guinea pigs; *Epidermophyton* species in 2 (1%) and *Scopulariopsis* species in 7 (3·5%). Saprophytic dermatophytes were isolated from 151 (75·5%) animals enrolled. No fungal growth was observed in 40 (20%) guinea pigs.

Clinical Significance: The results of this study indicate a low prevalence of pathogenic dermatophytes in pet guinea pigs in Southern Italy but the presence of *Epidermophyton* and *Scopulariopsis* species in asymptomatic pet guinea pigs.

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INTRODUCTION

Guinea pigs have been identified as a potential zoonotic source of dermatophytes affecting humans, especially children and immunosuppressed individuals (Vangeel *et al.* 2000, Drouot *et al.* 2009, Khettar & Contet-Audonneau 2012, Kraemer *et al.* 2012, 2013). Predisposing factors for dermatophytoses in pet guinea pigs include stress, overcrowding, immunodeficiency, poor husbandry, malnutrition, concurrent underlying diseases and pregnancy (Marshall 2003, Kraemer *et al.* 2013). Infected animals may show dermatological signs such as pruritic areas of circular, irregular or diffuse alopecia, scaling, crusting and coalescing lesions with raised erythematous borders on the head, ears, back and limbs. However, subclinical infections have also been reported (Vangeel *et al.* 2000, Marshall 2003, Hoppmann & Barron 2007, Kraemer *et al.* 2012, 2013). *Trichophyton mentagrophytes var. mentagrophytes* is the most commonly isolated dermatophyte in both healthy and affected guinea pigs (Vangeel *et al.* 2000, Kraemer *et al.* 2012). However, *Trichophyton terrestre*, *Trichophyton rubrum*, *Trichophyton verrucosum*, *Microsporum canis*, *Microsporum audouinii* and *Microsporum gypseum* have also been isolated from infected guinea pigs (Donnelly *et al.* 2000, Gauguere 2001, Marshall 2003). A new variety of *T. mentagrophytes*, *T. mentagrophytes var. porcellae*, has been recently identified in humans in close contact with pet guinea pigs in France (Khettar & Contet-Audonneau 2012). Recently, potential zoonotic fungi, such as *Scopulariopsis* species, have been isolated in healthy guinea pigs in Belgium (Vangeel *et al.* 2000).

Table 1. Frequency of genera of fungi isolated from hair coat of 200 pet guinea pigs in Southern Italy and their respective details

Fungi genera	No. of cases	Percentage	Average age (years)*	M	F
Mucor species	80	40	1·1	39	41
Aspergillus species	34	17	1·7	12	22
Penicillium species	26	13	1·7	12	14
Alternaria species	17	8·5	0·7	12	5
Cladosporium species	16	8	1·5	9	7
Rhizopus species	12	6	2·4	6	6
Scopulariopsis species	7	3·5	1·2	2	5
Chrysosporium species	2	1	2·1	1	1
Epidermophyton species	2	1	0·3	1	1
Scolecobasidium species	1	0·5	2		1
Sporotricum species	1	0·5	0·4	1	

F Female, M Male
*Age of guinea pigs at the time the fungi were isolated

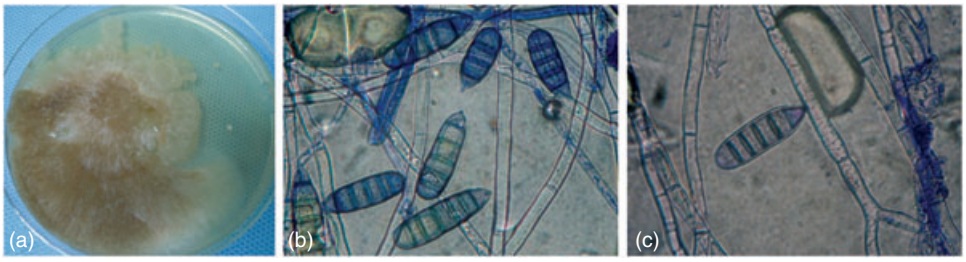

FIG 1. Photomicrograph of *Epidermophyton* species colony in Sabouraud agar (a) and macroconidia (b, c) (×400 magnification)

To date, only a few surveys have been published on the prevalence of dermatophytoses in laboratory (Papini *et al.* 2007) and pet guinea pigs (Vangeel *et al.* 2000, Kraemer *et al.* 2012). To the authors' knowledge, epidemiological data regarding dermatophyte infestations in pet guinea pigs in Southern Italy are lacking. The aim of this study was to evaluate the prevalence of pathogenic dermatophytes as well as saprophytic fungi in asymptomatic pet guinea pigs in Southern Italy.

MATERIALS AND METHODS

The study was a prospective cross-sectional study of 200 asymptomatic pet guinea pigs examined between August 2012 and July 2013 in several private veterinary clinics and pet shops in the Campania region, Italy that were screened for dermatophytes. Samples were collected using the MacKenzie's toothbrush technique. All animals were brushed with a sterile toothbrush for 5 minutes all over the body (head, trunk, back, abdomen and limbs). Samples were immediately incubated on dermatophyte test medium (DTM) and Sabouraud Dextrose Agar (Teknofarma S.p.A.). The plates were incubated for 4 weeks at 25°C (Vangeel *et al.* 2000). All plates showing no fungal culture within 4 weeks were considered negative. Identification of dermatophyte colonies was based on both macroscopic and microscopic characteristics (Vangeel *et al.* 2000). For microscopic examination lactophenol-cotton blue stain was used to examine hyphae macroconidia, and microconidia. For each case the following information was retrieved: sex, weight, age at the time of sampling and origin (client-owned *versus* pet shops).

RESULTS

None of the guinea pigs had clinical signs at the time of enrollment. Ninety-five guinea pigs were males and 105 were females, the average age at the time samples were collected 1·1 ±1·1 years (range: 0·1 to 4 years) and the average weight was 540 ±299 gm (range: 66 to 1200 gm). Ninety-five were from pet shops and 105 were privately owned. The average age, sex and frequency of genera of fungi isolated in the animals enrolled are summarised in Table 1.

Pathogenic dermatophytes were detected in 9 (4·5%) of 200 pet guinea pigs; *Epidermophyton* species (Fig 1) in 2 (1%) and *Scopulariopsis* species (Fig 2) in 7 (3·5%). Saprophytic dermatophytes were isolated from 151 (75·5%) of 200 animals enrolled; *Mucor* species was isolated in 80 (40%), *Aspergillus* species in 34 (17%), *Penicillium* species in 26 (13%), *Alternaria* species in 17 (8·5%), *Cladosporium* species in 16 (8%), *Rhizopus* species in 12 (6%), *Chrysosporium* species in 2 (1%). *Scolecobasiduim* species and *Sporotricum* species were isolated in one (0·5%) animal each. No fungal growth was observed in 40 (20%) guinea pigs.

Isolation of multiple saprophytic fungi occurred in 36 (18%) cases. In one case a concurrent isolation of a pathogenic dermatophyte (*Epidermophyton* species) and a saprophytic fungus (*Cladosporium* species) occurred.

DISCUSSION

The results of this survey indicate that the prevalence of pathogenic dermatophytes in asymptomatic pet guinea pigs in Southern

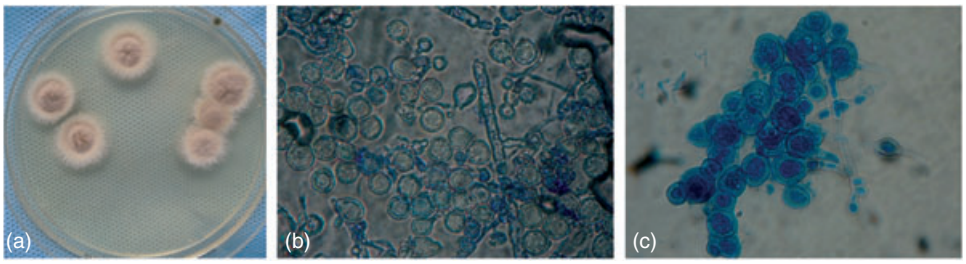

FIG 2. Photomicrograph of *Scopulariopsis* species colony in Sabouraud agar (a) and macroconidia (b, c) (×400 magnification)

Italy is approximately 5%. These results are in agreement with previous reports indicating that asymptomatic pet guinea pigs may serve as carrier for pathogenic dermatophytes such as *T. mentagrophytes* and *M. canis* (Vangeel *et al.* 2000, Kraemer *et al.* 2012). Although those dermatophytes were not isolated from any of the animals screened in this study, the presence of two other human pathogenic dermatophytes, *Epidermophyton* species and *Scopulariopsis* species was detected, of which only the latter has been previously isolated from pet guinea pigs (Vangeel *et al.* 2000). The different results found in this survey could be explained by the different prevalence of various dermatophytes in different geographic locations, differences in sampling methodology and contact with various sources of infection (Kraemer *et al.* 2012).

Epidermophyton species is an anthropophilic dermatophyte commonly isolated in humans affected by both dermatophytosis and onychomycosis (Walsh & Dixon 1996). *Epidermophyton* species infection has been experimentally induced in guinea pigs (Cabanes *et al.* 1987, Donnelly *et al.* 2000), although only in a few cases clinical signs were evident even after multiple inoculations, possibly due to the anthropophilic character of *Epidermophyton* species (Cabanes *et al.* 1987) explaining the lack of dermatological lesions in the guinea pigs enrolled in this study. The almost complete lack of cutaneous lesions associated with the presence of such a dermatophyte on healthy guinea pigs (asymptomatic carriers) may increase the risk of zoonotic transmission of such pathogens to humans and in particular immunocompromised adults or children (Andrews & Burns 2008, Seebacher *et al.* 2008). Interestingly, both guinea pigs harbouring *Epidermyophyton* species in this study were privately owned pets, suggesting a possible transmission of such fungus from and to humans.

A few studies analysing the pathogenic potential for moulds in humans have shown that non-dermatophytic moulds such as *Aspergillus*, *Alternaria*, *Cladosporium*, *Penicillium* and *Scopulariopsis* species, may be involved and be responsible for onychomycosis in people (Hilmioğlu-Polat *et al.* 2005, Hajoui *et al.* 2012). In particular, *Scopulariopsis brevicaulis,* a geophilic fungus, has been associated with dermatophytosis in both animals (dogs and horses) and humans inducing onychomycosis and hyalohyphomycosis. In addition, such a fungus has been identified as a causative agent of onychomycosis, panophthalmia, granulomas and generalised infection in humans (Vangeel *et al.* 2000, Wu *et al.* 2009, Petanovic *et al.* 2010). In guinea pigs, *Scopulariopsis* species has been isolated in 13% of the population screened by Vangeel *et al.* (2000). Contrary to *Epidermophyton* species cases, all guinea pigs from which *Scopulariopsis* species were isolated in this study were from pet shops and not from privately owned pets suggesting a different source for these fungi.

Scolecobasidium species was isolated in one animal enrolled in this survey. *Scolecobasidium* (aka *Ochroconis*, *Dactylaria*) species is a fungal biota considered a contaminant. *Scolecobasidium* species has been rarely isolated in companion animals, and potential pathogenicity (phaeohyphomycosis) has been described (VanSteenhouse *et al.* 1988). To the authors' knowledge *Scolecobasidium* species have never been previously isolated from guinea pigs.

Contrary to other published studies, isolation of the more common pathogenic fungi such as *T. mentagrophytes* and *M. canis* was not demonstrated in the guinea pigs screened in this study. *T. mentagrophytes* has been reported in asymptomatic guinea pigs in a percentage ranging between 3·5 and 8·5% (Vangeel *et al.* 2000, Kraemer *et al.* 2012).

All the other genera of fungi isolated in this survey have a widespread distribution and they are highly represented in the environment surrounding pet guinea pigs such as ground (*Mucor* and *Rhizopus*, and *Cladosporium* species) and decomposed material (*Penicillium* and *Rhizopus* species), or they are ubiquitous such as *Aspergillus* species (Fedullo *et al.* 2013). The majority of the genera of fungi isolated in this survey are listed among the different species of opportunistic fungi capable of causing disease in humans, especially in immunosuppressed individuals (Fedullo *et al.* 2013).

In conclusion, this is the first survey on the prevalence of dermatophytes (pathogenic and non-pathogenic) in pet guinea pigs in Southern Italy. The results of this study indicate that guinea pigs can harbour a wide number of saprophytic fungi associated with dermatophytosis in immunocompromised humans and children. This raises the possibility of potential zoonotic transmission of dermatophytes from guinea pigs to humans. Therefore it is recommended that routine fungal diagnostic testing in pet guinea pigs be carried out, in order to detect potential zoonotic fungi.

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Conflict of Interest

None of the authors of this article has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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