Review

An Epidemiological Study of Feline and Canine Dermatophytoses in Japan

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ABSTRACT

In a 2012-2014 epidemiological study of feline and canine dermatophytoses in Japan, we investigated the prevalence of fungi among 296 cats and 170 dogs treated at a veterinary clinic and 51 cats and dogs at an animal shelter at Fukui City in Japan. *Microsporum canis* was isolated from only one cat out of the 517 animals. Also, from 2012 to 2017, we analyzed isolates from 76 cats and 15 dogs with dermatophytoses at 14 veterinary clinics across 10 prefectures in Honshu and Shikoku. *M. canis* was the cause for 85 of the cases and *Microsporum gypseum* for the other six. *M. canis* infection routes in cats are thought to include stray cats as well as breeding facilities and pet shops, whereas for dogs, only breeding facilities and pet shops. Tinea was found in 18.7 % (14/75) of the owners of these animals. We showed that microsatellite genotyping is useful for molecular epidemiological investigations such as determination of infection routes of *M. canis*.

Key words: cats, dermatophytoses, dogs, epidemiology, Japan, *Microsporum canis*

Introduction

Most dermatophytes infecting pet cats and dogs are *Microsporum canis*, *Microsporum gypseum* (new classification: *Nannizzia gypsea*), and some zoophilic species of *Trichophyton mentagrophytes* and *Trichophyton benhamiae*⁴⁻⁵, all of which can cause tinea in humans. The prevalence of feline and canine dermatophytoses in Japan has been falling in recent years due to better rearing environments and measures implemented by municipalities against stray cats and dogs⁴⁻⁵. Nevertheless, measures to control dermatophytoses have become important as raising dogs and cats indoors has become popular, making contact between pet animals and humans more common. Herein, we discuss the results of our recent investigation into the prevalence of dermatophytes in cats and dogs and the results of another investigation into outbreaks of dermatophytoses at 14 veterinary clinics in Honshu and Shikoku. We also discuss the application of microsatellite (MS) polymorphism analysis as a molecular biological marker for differentiation of *M. canis* strains.

Prevalence of symptomless feline and canine dermatophytoses

Between November 2012 and December 2014, we examined 296 cats and 170 dogs taken to a veterinary clinic run by one of the authors (SY) in Fukui City (Fukui prefecture, Hokuriku, Fig. 1). None of the animals had symptoms of dermatophytoses. Skin swabs taken with cotton wool sticks from all 466 animals were cultured for fungus⁶. Briefly, using a sterile cotton swab moistened by sterile saline, almost the whole body surface of an animal was rubbed carefully, then the tip of the swab was pressed onto the agar plate and the cotton part of each swab was cut and placed onto the same agar plate. The medium used in the study was Sabouraud’s dextrose agar with cycloheximide and chloramphenicol (Mycosel agar®, Eiken Chemical Co. Ltd., Tochigi, Japan) supplemented with gentamicin sulfate (50 µg/ml). The inoculated plates were aerobically incubated at 25°C for up to 14 days. Growing fungi were identified by morphological characteristics. The animals’ origin, living conditions, and age were also analysed (Table 1). During the same period, swab samples from 46 cats and 5 dogs at a Fukui Health and
Welfare Center in Fukui City were also obtained and cultured using the same methods. The cats were assumed to be at least 6-months old if their permanent teeth had already fully developed.

Table 2 shows our results along with those of recent studies indicating prevalence rates of dermatophytoses among cats and dogs in Japan. Although we investigated 517 symptomless animals, one was positive for *M. canis*, which was isolated from a swab taken from a pedigree cat immediately after purchase from a pet shop. The prevalence of dermatophytes among cats and dogs in and round Fukui City was found to be very low, irrespective of animal living conditions, origin, and age.

Table 1. Background of healthy animals examined in a veterinary clinic

| Species | No. of animals | Animal origin, exposure to environment and age | No. of identified (%) |
|---------|----------------|---------------------------------------------|-----------------------|
| Cat     | 296            | Kept indoors constantly                     | 95 (32.1)             |
|         |                | Stray cat, aged < 6 months old              | 95 (32.1)             |
|         |                | Reside indoors but allowed to wander outside | 45 (15.2)             |
|         |                | Stray cat, aged ≥ 6 months old              | 37 (12.5)             |
|         |                | Purchased from pet shop within 2 weeks      | 24 (8.1)              |
| Dog     | 170            | Purchased from pet shop within 2 weeks      | 95 (55.9)             |
|         |                | Kept indoors and not taken for walks on grass | 43 (25.3)             |
|         |                | Kept indoors but taken for walks on grass   | 24 (14.1)             |
|         |                | Kept outdoors                               | 8 (4.7)               |

These results agree with reports of 0% prevalence among 32 house cats in Kanto (Tokyo and Kanagawa prefectures), 0% among 177 dogs in an animal shelter in Kanto (Saitama prefecture), and 1.1% among 180 domestic cats (geographical areas not given). Therefore, in recent years, the prevalence of dermatophytes among pet cats and dogs and stray cats in Japan has been extremely low. However, an analysis of the source of infection of 25 people diagnosed with *M. canis* at a dermatology clinic in Kyushu (Kumamoto prefecture) showed...
that 12 probably contracted it from stray cats they had adopted, and three probably contracted it from cats bought at pet shops. And an analysis of 21 cases of dermatophytosis diagnosed at a dermatology clinic in Hokuriku (Ishikawa prefecture) showed that two contracted it from dogs and 15 from cats, among which 14 cats had probably contracted it through contact with other animals outdoors. There may be large differences in the incidence rates of infections by isolates per year. In a seven-year survey at a veterinary clinic in the same area, the majority of cases occurred in just two of the seven years. Therefore, it is speculated that infection reservoirs exist outdoors locally and for limited periods.

### Survey of cases of dermatophytoses in animals

We conducted a survey of animals diagnosed with dermatophytoses at 15 veterinary clinics in Honshu, which is the largest island in Japan, and Shikoku (2 in Kanto, 7 in Hokuriku, 2 in Kinki, 2 in Chugoku, and 1 in Shikoku) between September 2012 and April 2017. We investigated causative fungi, age, origin and living condition of infected animals, and whether transmission occurred indoors. A total of 91 animals were infected, 77 cats and 14 dogs, of which 35 were in Kanto, 31 in Hokuriku, 3 in Kinki, 7 in Chugoku, and 15 in Shikoku (Fig. 1).

We asked the owners about the source of infection, their living conditions, and whether there was an infected human in their household. Owners who had tinea lesions took samples of themselves by pressing sticky tape over the lesion after giving their informed consent to participate in this study. The harvested scales were cultivated, and the fungus was identified. The results are shown in Table 3.

The only dermatophytes isolated were M. canis and M. gypseum. The former was much more common, accounting for 96.1% of the incidences associated with cats and 78.6% with dogs. These findings were similar to those of previous reports in Japan. Most cats under 6 months old infected with M. canis were either stray cats, from animal shelters, or had just been bought from a pet shop. Older cats over 6 months old infected with M. canis were house pets in almost half the cases, the others being, in decreasing numbers, stray cats, pet cats that often went outdoors, and cats from pet shops. Of the 14 dogs infected with M. canis, nine probably contracted it in pet shops or at grooming service providers. All the animals infected with M. gypseum were thought to have contracted it outdoors: the cats with M. gypseum were strays or housed in animal shelters, and the dogs with M. gypseum habitually came into contact with soil. Tinea infected 14 (18.7%) of 75 households that own animals, and M. canis was isolated from skin samples of owners in all 14 cases. The transmission rate from pet to owner was similar to that reported previously.

Itoh et al. reported 3% prevalence of dermatophytes among 99 young cats aged 1 to 6 months old housed in 8 pet shops (geographical areas not given). In contrast, Chiba et al. reported dermatophyte prevalence at 16 facilities among animal-handling businesses in Tokyo, and categorized it as a high rate (21.5%). Therefore, in Japan, there may be concentrations of animals infected with M. canis in some insanitary pet shops and facilities where pets are reared in large numbers such as at pet-breeding establishments, which may be one of the routes of transmission to humans and other animals. Outdoor transmission is another major infection route, but the prevalence of dermatophytes might not be high even among stray cats and pet cats that go outdoors. However, because outdoor reservoirs of infection may emerge regionally, we should continuously investigate the status quo of parasitic fungi. In contrast, the most likely route of infection for dogs is the pet shop, because most dogs in Japan, unlike cats, are confined indoors. Indeed, municipalities have publicized animal-rearing methods, and the risk of dogs...
contracting *M. canis* outdoors has probably dramatically fallen due to decreasing numbers of stray dogs. As *M. gypseum* is geophilic, it will probably be isolated as a causative fungus of canine and feline dermatophytoses at a low rate in the future. Extra caution is especially needed for dogs on long-term immuno-suppressants when they come into contact with soil. In addition, although the genus *Trichophyton* was not isolated in this study, *T. mentagrophytes* was isolated from a kitten housed in an animal shelter in Fukui prefecture in 2018 (unpublished data). It is inferred that this fungus also infects at a low rate.

### Application of microsatellite analysis to molecular epidemiology

Molecular markers for detecting intraspecific variation and for strain discrimination have been studied to elucidate the status quo of *M. canis* infection. Sharma et al.\(^\text{17}\) and Pasquetti et al.\(^\text{18}\) reported that the most sensitive biomolecular marker is microsatellite DNA polymorphism. It is even useful for molecular epidemiological studies of *M. canis*, which shows little intraspecific variation\(^\text{19}\). Hereafter, we introduce results of MS analysis of the isolated Japanese strains and discuss its future use.

Using the MS marker method of Pasquetti et al.\(^\text{18}\), Watanabe et al.\(^\text{20}\) analyzed 70 *M. canis* strains in Japan, of which 59 were isolated from humans and 11 from cats, and divided them into 20 genotypes (A to T). They found the same genotype of *M. canis* isolated from pet cats and confirmed cat-to-human transmission in five families (Table 4). Using Watanabe’s method to show that *M. canis* isolated from tinea on the face of a 2-month-old baby had the same genotype as an isolate from a symptomless cat that lived with the baby’s grandparents, we were able to confirm that the baby must have contracted the infection while staying at her grandparents\(^\text{21}\) (Table 4).

MS analysis is therefore a useful method for investigating routes and sources of infections. In the future, analyzing isolates from animals could be used to monitor the spread of infections from pet shops and for investigating reservoirs of infection outdoors. By looking at genotype variance, we can

| Species | No. of animals | Age (months) | No. (%) of *M. canis* isolated | No. (%) of *M. gypseum* isolated | Lifestyle and route of infection | No. (%) of animals |
|---------|---------------|--------------|-------------------------------|---------------------------------|-------------------------------|-------------------|
| Cat     | 77            | Total 74 (96.1) | 3 (3.9)                       | Stray cat or shelter cat        | 28 (71.8)                   |
|         |               | < 6 39        |                               | Immediately after purchase from pet shop | 10 (25.6)               |
|         |               | ≥6 35         |                               | Infected at house where other cat is infected | 1 (2.6)                |
|         |               | 3             | Stray cat or shelter cat       | 17 (48.6)                      |
|         |               | immediately after purchase from pet shop | 8 (22.9)                   |
|         |               | Household cat going out | 3 (8.6)                  |
|         |               | Immediately after purchase from pet shop | 2 (5.7)                   |
|         |               | After shampoo treatment at pet shop | 2 (5.7)                   |
|         |               | Long-term steroid treatment in progress | 1 (2.9)                   |
|         |               | Owner touched infected cat at other residence | 1 (2.9)                   |
|         |               | Unidentified (Full indoor rearing, suffering from diabetes mellitus) | 1 (2.9)                   |
| Dog     | 14            | Total 11 (78.6) | 3 (21.4)                      | Stray cat or shelter cat        | 3 (100.0)                   |
|         |               | < 6 7         |                               | Immediately after purchase from pet shop | 6 (85.7)                |
|         |               | ≥6 4          |                               | Cohabiting infection            | 1 (14.3)                  |
|         |               | 3             | After shampoo treatment at pet shop | 3 (75.0)                   |
|         |               |              | Cohabiting infection            | 1 (25.0)                  |
|         |               |              | Outdoor rearing                | 1 (33.3)                  |
|         |               |              | Displays digging behavior       | 1 (33.3)                  |
|         |               |              | Walking around the lawn for long-term steroid treatment | 1 (33.3)                  |
see the number of infection sources within stray cats and thereby get a picture of the habitat conditions of *M. canis* outdoors.

**Conclusion**

There continues to be many incidences of feline and canine dermatophytoses in Japan. Determining the prevalence and routes of infection of *M. canis* could inform a prevention policy. There appears to be two main routes in cats, namely, pet shops and outdoors due to strays, whereas for dogs, the main route is thought to be through pet shops. Regarding the outdoor route for cats, *M. canis* reservoirs may form locally in certain regions and then spread sporadically. Therefore, when cases of outdoor-related infections, such as infected stray cats or pet cats with dermatophytoses known to be among a stray cat community, are diagnosed by dermatologists or veterinarians, attention should be paid to the probable existence of reservoirs of infection and the risk of subsequent outbreaks. MS analysis is a useful method for elucidating the status quo of infections.

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**Conflicts of interest**

None to declare.

**References**

1) Miller WH, Griffin CE, Campbell KL: Fungal and algal skin diseases. Muller & Kirk's Small Animal Dermatology 7th ed., pp. 223-283, Elsevier Inc., St. Louis, 2013.

2) Moriello KA, Coyner K, Paterson S, Mignon B: Diagnosis and treatment of dermatophytosis in dogs and cats: clinical consensus guidelines of the world association for veterinary dermatology. Vet Dermatol 28: 266-e68, 2017.

3) Kano R, Iyori K, Harada K, Murayama N, Yamasaki M, Makimura K, Tsuboi R, Yamagishi K, Murai T, Nishifuji K, Hasegawa A, Nagata M: Canine and feline dermatophytosis: a guideline for the antifungal therapy. Jpn J Vet Dermatol 24: 9-12, 2017. [Article in Japanese]
4) Kobayashi H, Yoshioka M, Anzawa K, Mochizuki T: Cases of Microsporum canis infection between 2005 and 2011 in a dermatology clinic in the southern part of Kanazawa City. Skin Research 12: 219-223, 2013. [Article in Japanese]
5) Kano R: Animal cutaneous mycoses in Japan. Med Mycol J 53: 19-23, 2012. [Article in Japanese]
6) Yamada S, Anzawa K, Mochizuki T: Survey of dermatophyte infection in cats and dogs in the Fukui region of Japan. Skin Research 14: 166-170, 2015. [Article in Japanese]
7) Sakaki Y, Arai H, Kobayashi C, Narusawa T, Usui A, Saeki E: Prevalence of dermatophytes of dogs in an animal shelter. Abstract book for 20th Annual Meeting of Japanese Society of Veterinary Dermatology, p108, 2017. [Article in Japanese]
8) Itoh N, Kato H, Ito Y, Oozasa N, Kimura Y, Kanai K: Prevalence of dermatophytes in private household cats. Jpn J Vet Dermatol 23: 9-12, 2017. [Article in Japanese]
9) Sakae H, Noguchi H, Ichinokawa Y, Hiruma M: Analysis of 25 cases of Microsporum canis infection encountered at a dermatology clinic in Kumamoto during a recent 3-year period. Med Mycol J 52: 139-144, 2011. [Article in Japanese]
10) Ikeshoji T, Takahashi M, Igami, N, Kubo S, Matsuda M, Takata M, Ishikawa M: Distribution of dermatophytes carriers in cats. J Jpn Vet Med Ass 45: 430-431, 1992. [Article in Japanese]
11) Nagata M, Nankou H: Microsporum canis infection in animals. MB Derma 45: 29-34, 2001. [Article in Japanese]
12) Nagata M: Human and animal common infections seen from dogs and cats. Rinsho Derma 54: 329-335, 2012. [Article in Japanese]
13) Itoh N, Suda M, Iijima Y, Ito Y, Totsapon P, Kimura Y: Prevalence of dermatophytes in pet shop young cats. Jpn J Vet Dermatol 23: 69-72, 2017. [Article in Japanese]
14) Chiba T, Takahashi Y, Uehara S: Examination and analysis of zoontic fungi in Tokyo. Ann Rep Tokyo Metr Inst Pub Health 67: 39-48, 2016. [Article in Japanese]
15) Dobrowolska A, Debska J, Kozlowska M, Staczek P: Strains differentiation of Microsporum canis by RAPD analysis using (GACA) 4 and (ACA) 5 primers. Pol J Microbiol 60: 145-148, 2011.
16) Cano J, Rezusta A, Solé M, Gil J, Rubio MC, Revillo MJ, Guarro J: Inter-single-sequence-repeat-PCR typing as a new tool for identification of Microsporum canis strains. J Dermatol Sci 39: 17-21, 2005.
17) Sharma R, de Hoog S, Presber W, Gräser Y: A virulent genotype of Microsporum canis is responsible for the majority of human infections. J Med Microbiol 56: 1377-1385, 2007.
18) Pasquetti M, Peano A, Soglia D, Min AR, Pankewitz F, Ohst T, Gräser Y: Development and validation of a microsatellite marker-based method for tracing infections by Microsporum canis. J Dermatol Sci 70: 123-129, 2013.
19) Mochizuki T, Takeda K, Anzawa K: Molecular markers useful for intraspecies subtyping and strain differentiation of dermatophytes. Mycopathologia 182: 57-65, 2017.
20) Watanabe J, Anzawa K, Mochizuki T: Molecular epidemiology of Japanese isolates of Microsporum canis based on multilocus microsatellite typing fragment analysis. Jpn J Infect Dis 70: 544-548, 2017.
21) Takeda K, Anzawa K, Mochizuki T, Yamada S, Kobayashi H, Kimura S: Infant case of tinea faciei caused by Microsporum canis. J Dermatol 45: e187-e188, 2018.