



Case Report: Molecular and Pathological Investigations of Zoonotic *Anatrichosoma* Spp.-Induced Ulcerative Pododermatitis in a Domestic Cat in Thailand

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Anatrichosoma spp. is a group of trichuroid nematodes that mainly infect non-human primates and domestic cats. The lifecycle of these nematodes remains unclear. In non-human primates, *Anatrichosoma* spp. were found in the nasal cavity. However, ulcerative dermatitis has been reported in infected cats. An adult, intact, female domestic short-haired cat was presented with ulcerative pododermatitis of all limbs. Punch biopsy was performed at the edge of the ulcerative wound for histopathological investigation and showed necrosis and infiltration of inflammatory cells around the nematode-like lesion. Eggs with *Capillaria*-like characteristics were present. Tissue sections were subjected to DNA extraction and PCR targeting *18S rRNA*, using primers designed from *Anatrichosoma 18S rRNA*. The phylogenetic tree revealed that DNA obtained from the lesion of the domestic cat was grouped with *Anatrichosoma* spp. from the olive glass mouse (*Abothrix olivacea*), *Capillaria plica* and *Eucoleus aerophilus*, both from the red fox (*Vulpes Vulpes*). The study is the first report of feline anatrinosomiasis in Thailand, and we present both pathological findings and molecular evidence. The cat was successfully treated with emodepsine/praziquantel. The skin lesion recovered within 3 days after anthelmintic treatment. Because *Anatrichosoma* spp. have been reported in humans, the zoonotic potential of this parasite should be considered.

Keywords: *Anatrichosoma* spp., pododermatitis, cat, Thailand, molecular investigation

INTRODUCTION

Anatrichosoma spp. is a genus of trichuroid nematodes and infects a wide range of hosts. Several species are known, including *Anatrichosoma buccalis* (1, 2), *A. rhina*, *A. nacepo* (3), *A. haycocki* (4), *A. ocularis* (5), and *A. cynamolgi* (6, 7). *Anatrichosoma* spp. has also been reported in humans and is considered a zoonotic nematode (8, 9). However, the lifecycle of this parasite is poorly understood.



FIGURE 1 | Ulcerative pododermatitis caused by *Anatrichosoma* spp. was presented in four feet (A); 2 weeks post-treatment with emodepsine/praziquantel led to complete recovery (B).

Anatrichosomiasis has been reported in mucosal and submucosal nasal cavities in non-human primates, particularly the rhesus monkey (*Macaca mulatta*) and cynomolgus macaques (*Macaca fascicularis*) in Southeast Asia (3, 10). In white-handed gibbons (*Hylobates lar*), this parasite was found in the ears, lips, nares and eyelids (11). *Anatrichosoma* spp. has also been observed in the paracloacal gland of the dusky antechinus (*Antechinus swainsonii*) and brown antechinus (*A. stuartii*) (4). Human *anatrichosomiasis* causes multiple oral ulcers and can also be found in the subcutaneous nodule of the breast (8, 9). Opossums (*Didelphis marsupialis* and *D. virginiana*) can be infected with *A. buccalis*, causing pododermatitis; it can also be found in the mucosal palate (1, 2). In the common tree shrew (*Tupaia glis*), *Anatrichosoma ocularis* has been detected in the eyes (5). *Anatrichosomiasis* in domestic cats has been reported in Namibia, South Africa and the United States, causing ulcerative pododermatitis (12–14). In dogs, *Anatrichosoma* spp. has been found in the nodule on the dorsal midline in the lumbar region (15).

Anatrichosoma spp. infection is typically diagnosed based on pathological lesions. To our knowledge, only one nucleotide sequence of *Anatrichosoma* spp. has been submitted in GenBank (Accession number KU215886). However, a molecular identification protocol has not been published. This study describes, for the first time, *Anatrichosoma* spp.-induced ulcerative pododermatitis in a domestic cat in Thailand, using pathological and molecular data.

CASE PRESENTATION

The cat described here was an adult, intact, female domestic short-haired cat. Although it was kept outdoors with other cats, it was the only clinically affected one. The cat was presented to the Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Khon Kean University, because of feet problems. Physical examination revealed ulceration and swelling of all feet, mainly on the hindlimbs (Figure 1A). The lesions were 1

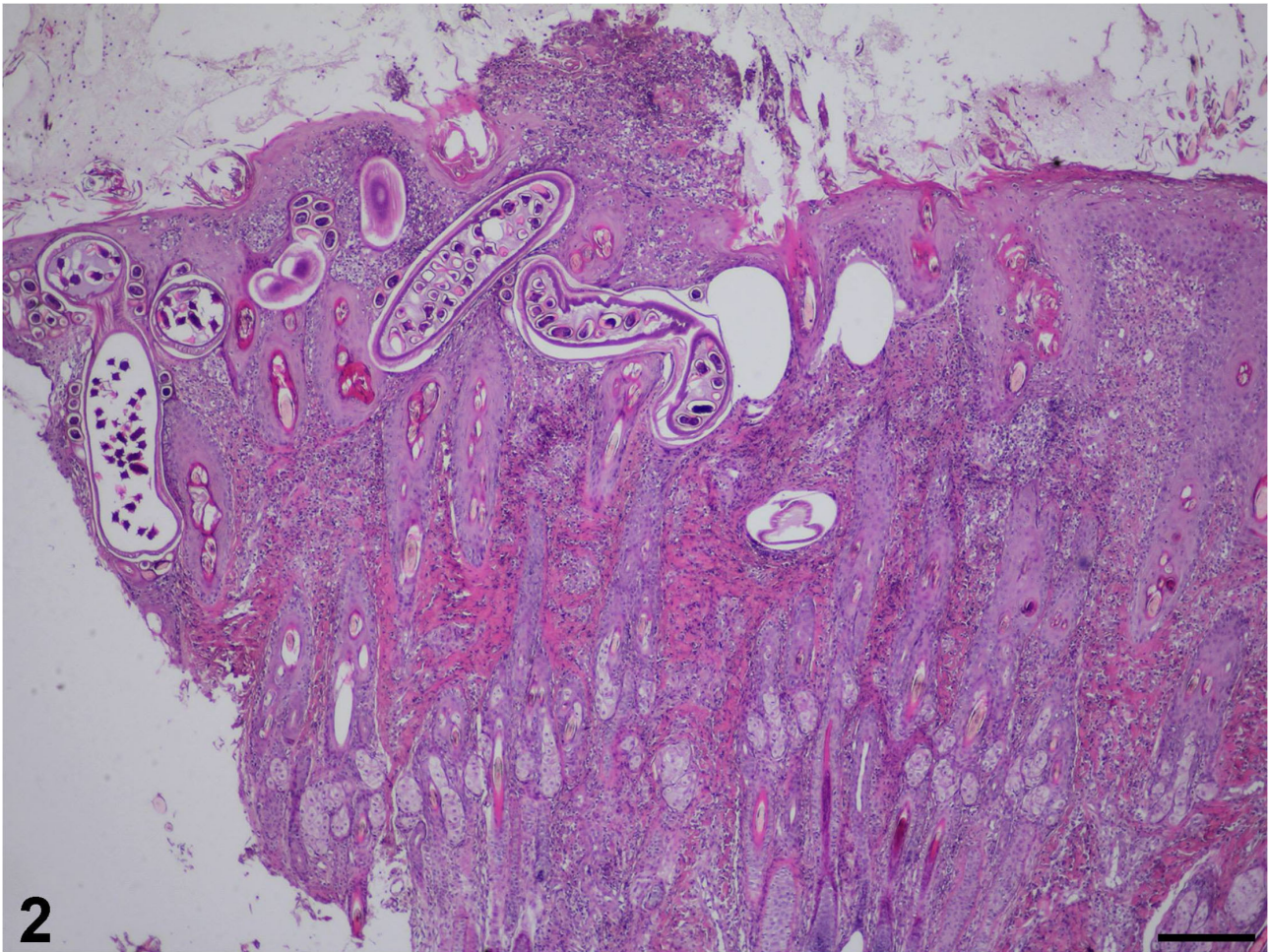


FIGURE 2 | Histopathological section stained with haematoxylin and eosin revealing necrosis in the epidermis and nematode-like lesions in the dermis (200 μm scale bar).

week old. The other vital signs, including appetite, heart rate, respiratory rate, mucous membrane color and hydration status, were within the normal ranges. Wound dressing accompanied with amoxicillin–clavulanic acid administration was performed, which partly improved the lesions. Subsequently, a punch biopsy was performed at the edge of the ulcerative wound 3 days after the first visit. Ulcerative, pyogranulomatous and eosinophilic pododermatitis with nematodes was diagnosed histopathologically. The cat was treated with wound dressing and additional treatment with emodepsine/praziquantel (Profender[®] spot-on, Bayer); the skin lesions recovered within 3 days post-anthelmintic treatment and completely recovered after 2 weeks (**Figure 1B**).

The skin for the biopsy was fixed with 10% buffered formalin and embedded in paraffin wax. The paraffin-embedded specimen was cut into 4- μm thick slices and stained with haematoxylin and eosin (HE) for histopathological examination.

Microscopically, the ulceration and some hyperplasia of the epidermis could be observed. The cross-section of the

nematode was noticed in the epidermis and dermis (**Figure 2**). **Figure 3** shows inflammatory cell infiltration. The nematode was 135–150 μm in diameter and characterized by a striated cuticle, hypodermal musculature, pseudocoelom, and a uterus containing eggs; eggs were also accumulated next to the adult. The egg was oval, 30 \times 55 μm in size, with a bi-operculate thick wall (**Figure 3**). Infiltration of mixed inflammatory cells including neutrophils, macrophages and eosinophils was noted at the dermis, accompanied by necrosis (**Figure 3**).

Formalin-fixed paraffin-embedded samples were pooled and used for DNA extraction applying the QIAamp DNA FFPE Tissue Kit. The parasite species were identified *via* PCR targeting of the 18S rRNA gene, using a customized primer, ANT-F (5'ATGGCCGTTCTTAGTTGGTG'3) and ANT-R (5'CGCTGACGCTTTCAGTG TAG'3). Primers were designed based on the *Anatrichosoma* spp. 18S rRNA sequence (KU215886) using Primer3 (version 0.4.0). The expected product was 213 base pairs. The PCR reaction mix contained 10 μl of 2 \times ViRed Taq Master Mix (Vivantis, Malaysia), 0.5 μM of each primer

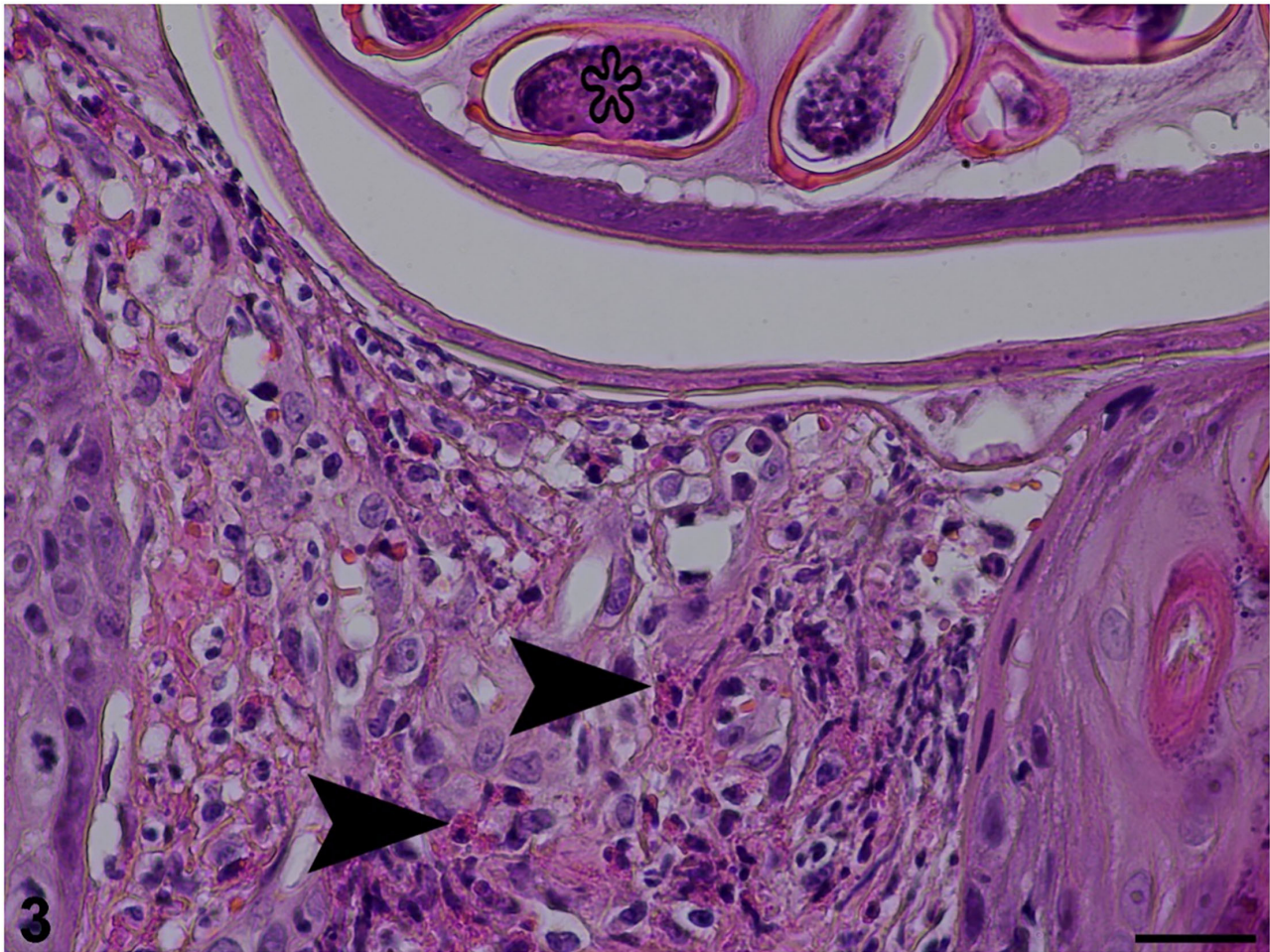


FIGURE 3 | Histopathological section stained with haematoxylin and eosin revealing inflammatory cell infiltration (arrowheads) in dermis and egg (star) in the uterus of an adult female (25 μ m scale bar).

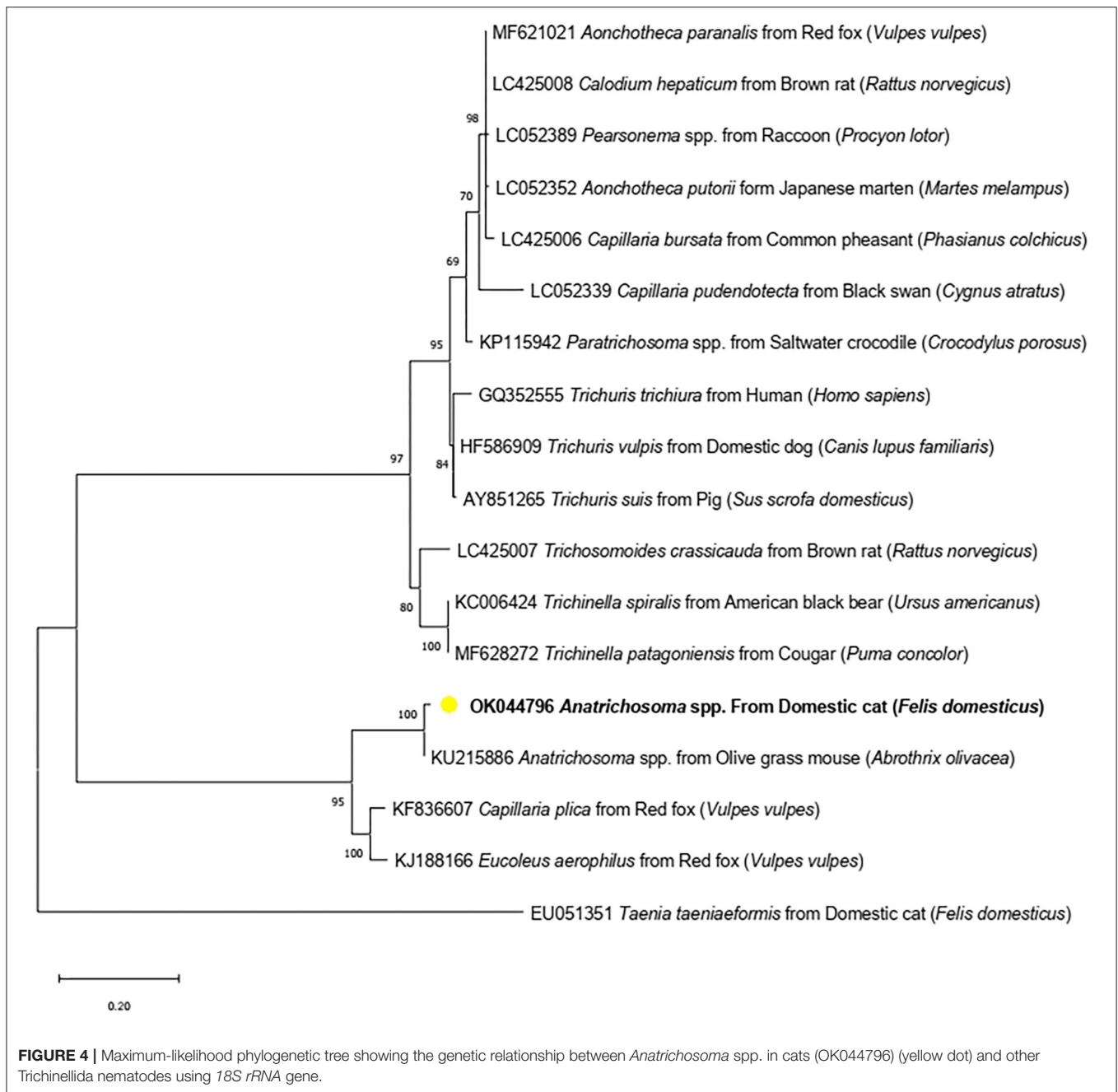
and 4 μ l of DNA. The conditions were initially 94°C for 5 min for pre-denaturation and followed by 35 cycles at 94°C for 30 s, 55°C for 30 s, 72°C for 30 s and final extension steps at 72°C for 10 min. The PCR products were run with gel electrophoresis and submitted to sanger sequencing. *Anatrichosoma* spp. DNA (positive control) was not used on PCR amplification while distilled water was used as the negative control. However, PCR was conducted twice separately and both expected products were submitted to sequencing. The results were identity. The sequence was aligned using BioEdit software (version 7.0.5.3) with several species of the order Trichinellida submitted in GenBank (<https://www.ncbi.nlm.nih.gov/>). A phylogenetic tree from the sequence of partial 18S rRNA was constructed employing Maximum likelihood methods using the Kimura 2-parameter for the substitution model. The phylograms were statistically tested using a Bootstrap method with 1,000 replications. *Taenia taeniaeformis* (EU051351) was set as an out group. The phylogenetic tree was produced using MEGA X software and constructed using fragment 18S rRNA

sequences of several species of the order Trichinellida. The sequences were grouped into three clusters: *Trichuris/Capillaria* spp., *Trichinella* spp. and *Anatrichosoma* spp. (**Figure 4**).

The *Anatrichosoma* spp. obtained from this study (Accession number OK044796) has 99.00% identity with *Anatrichosoma* spp. from the olive glass mouse (*Abrothrix olivacea*) (KU215886). *Anatrichosoma* spp. found in this study (OK044796) was placed in the *Anatrichosoma* spp. cluster, which included *Anatrichosoma* spp. from the olive glass mouse (*Abrothrix olivacea*) (KU215886) and both *Capillaria plica* and *Eucoleus aerophilus* from the red fox (*Vulpes vulpes*).

DISCUSSION

This study reports the first case of *Anatrichosoma* spp. infection in a cat in Thailand, confirmed by both pathological findings and molecular identification. Histological investigation showed numerous inflammatory cells infiltrated around the migratory



tract, in accordance with previous reports, particularly adult and egg morphologies of the nematode (12). Nematode eggs were also found, with characteristics of *Capillaria*-like eggs operculated on both ends. *Anatrichosoma* spp. should be listed as one of the causative agents of pododermatitis in cats (12, 13). Pathological changes during infection included eosinophil infiltration, as previously described (12, 13). Adult *Anatrichosoma* spp. were typically found in the superficial layer of various mucosal epithelial tissues, including nasal, stomach, eye, skin and buccal cavities (5, 13, 16, 17). Female adults were commonly found in the superficial layer and males in the submucosal layer (13, 17).

In this study, emodepsine/praziquantel (Profender[®] spot-on, Bayer) was used for the treatment of the feline anatrachosomiasis. In previous reports, feline anatrachosomiasis was treated with ivermectin at 0.3 mg/kg (12, 13).

Because the lifecycle of *Anatrichosoma* spp. is unclear, the transmission and reservoir host are poorly known. However, *Anatrichosoma* spp. commonly affects non-human primates (6, 7, 11, 18–22), suggesting that such primates are reservoir hosts for *Anatrichosoma* spp. Interestingly, this cat was raised in a suburban area and had no contact with any wild non-human primates. *Anatrichosoma* eggs were presented in ulcerative

wounds. The eggs might contaminate the soil, and transmission *via* contact with contaminated soil should, therefore, be considered. Because *Trichuris trichiura* eggs have been reported in oral mucosal lesions in a child in Brazil (23), it has been suggested that *Anatrichosoma* spp. should be in the differential diagnosis list when *Capillaria*-like eggs were found in superficial cutaneous and subcutaneous sites from these animals (24). None of these capillarids can cause cutaneous lesions, whereas *Anatrichosoma* spp. can lead to cutaneous infections in pets and wild species (11–15).

This study revealed the sequence of an 18S *rRNA* fragment of *Anatrichosoma* spp. in cats, suggesting that *Anatrichosoma* spp. in cats are genetically closely related to the nematodes of carnivores, *Capillaria plica* and *Eucoleus aerophilus*. Two related nematodes might share a genetic relationship within carnivore hosts. However, this cluster is separated from other *Trichuris* and *Capillaria* spp. of carnivores, such as *Trichuris vulpis*. Further molecular identification is, therefore, necessary. Unfortunately, the DNA sample from this study was obtained from formalin-fixed paraffin-embedded tissue, making it difficult to amplify a large fragment of targeted genes. Formalin lowers DNA yields because it can cause DNA–protein cross-links (25). Further studies are required to establish its prevalence in animals and humans.

CONCLUSION

Anatrichosomiasis is a neglected parasitic disease caused by *Anatrichosoma* spp. Clinical presentation depends on the parasite species and host. In non-human primates, parasites were found in mucosal and submucosal tissues of the nasal cavity. In contrast to cats, parasites were found in the epidermis and dermis of carpal and tarsal pads, causing ulcerative pododermatitis. The life cycle of *Anatrichosoma* spp. is poorly understood, and the

transmission route is still unclear. We expect this first report of feline anatrichosomiasis in Thailand by pathological findings and molecular confirmation to generate further studies in this interesting research field.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary files, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

Ethical review and approval was not required for the animal study because this is a clinical case. Written informed consent was obtained from the owners for the participation of their animals in this study.

AUTHOR CONTRIBUTIONS

WJ, SK, and PT conceptualized and reviewed the manuscript. WJ, SK, TS, and PT collected data. All authors contributed to the article and approved the submitted version.

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