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SHORT COMMUNICATION

Sporothrix brasiliensis as the major causative species of the zoonotic outbreak of human sporotrichosis in the Brazilian Amazon

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Abstract

Background: Sporotrichosis is a neglected tropical disease and the most common subcutaneous mycosis, mainly caused by Sporothrix species, particularly *S. brasiliensis, S. schenckii* and *S. globosa*, which exhibit varying biological behaviours and virulence. The epidemic of sporotrichosis in Brazil, initiated in Rio de Janeiro in the late 1990s, rapidly spread to other states, including Amazonas in 2021. This study aimed to identify the specific Sporothrix species responsible for the human sporotrichosis outbreak in the Brazilian Amazon.

Methods: A cross-sectional study was conducted by enrolling clinically suspected cases of sporotrichosis attended at a reference dermatologic centre, in Manaus (Brazil). Biological material was collected from their skin lesions for culture (Mycosel) and for species identification (qPCR).

Results: Sporothrix cultures were obtained from 150 cases. Sporotrichosis predominantly affected females (67.3%), aged 44.5 years on average, with lymphocutaneous lesions (72.7%). *Sporothrix brasiliensis* was identified in 89.3% of patients. Up to 83.3% of these patients reported contact with cats previously to the skin lesion, and the time-spatial progression of the human cases followed the notification of cases in cats, in the metropolitan region of Manaus.

Conclusion: *Sporothrix brasiliensis* is the dominant species in the zoonotic outbreak of human sporotrichosis in the Brazilian Amazon, with cats identified as the primary vectors. Effective sanitary control measures, education and responsible pet ownership are crucial to mitigating zoonotic sporotrichosis' impact in Brazil and preventing its spread to neighbouring Latin American cities.

KEYWORDS
Brazilian Amazon, polymerase chain reaction, *Sporothrix brasiliensis*, sporotrichosis

INTRODUCTION

Sporotrichosis is a neglected tropical disease caused by fungi of the *Sporothrix* genus, characterised by skin and subcutaneous tissue lesions in humans. These fungi are

Sustainable Development Goal: Good Health and Wellbeing (SDG3)

commonly found in decomposing organic matter, soil and plants. The main risk factors for acquiring sporotrichosis include occupational exposure, residence in endemic areas, contact with infected cats, underlying health conditions (such as diabetes, chronic lung disease and HIV/AIDS) and skin trauma. Sporotrichosis mainly affects the skin, often presenting as ulcers and superficial nodules that may progress to more extensive lymphocutaneous infections. In severe cases, particularly among immunocompromised individuals, the infection can disseminate to the lungs, bones, or other internal organs. The chronic nature of sporotrichosis also imposes economic burdens due to medical expenses, lost workdays and the need for prolonged care [1–3].

Among 53 identified species, *S. brasiliensis, S. schenckii, S. globosa* and *S. luriei* are clinically significant, with distinct global distributions and transmission modes: sapronotic or zoonotic. *S. schenckii* and *S. globosa* are prevalent in the Americas and Asia, whereas *S. brasiliensis* is primarily found in South America, and transmitted mainly through infected cats and dogs [2–4].

A major sporotrichosis epidemic in Brazil spread rapidly from Rio de Janeiro in the late 1990s [3, 5]. In Amazonas, human cases began in 2020, rising 304%, from 2021 to 2022 and 249% from 2022 to 2023 (Figures 1 and 2). The increase in animal cases was 428% and 345%, respectively, in the same period [4]. This exponential growth is alarming due to the high number of affected individuals and limited understanding of circulating species, which vary in pathogenicity [4–6].

Therefore, along with individual precautions like wearing protective clothing when handling plants and avoiding contact with infected animals, collaborative efforts among healthcare providers, veterinarians and public health authorities are crucial for implementing effective control measures to reduce the impact of sporotrichosis.

This study aimed to identify the species responsible for the human sporotrichosis outbreak in the Brazilian Amazon.

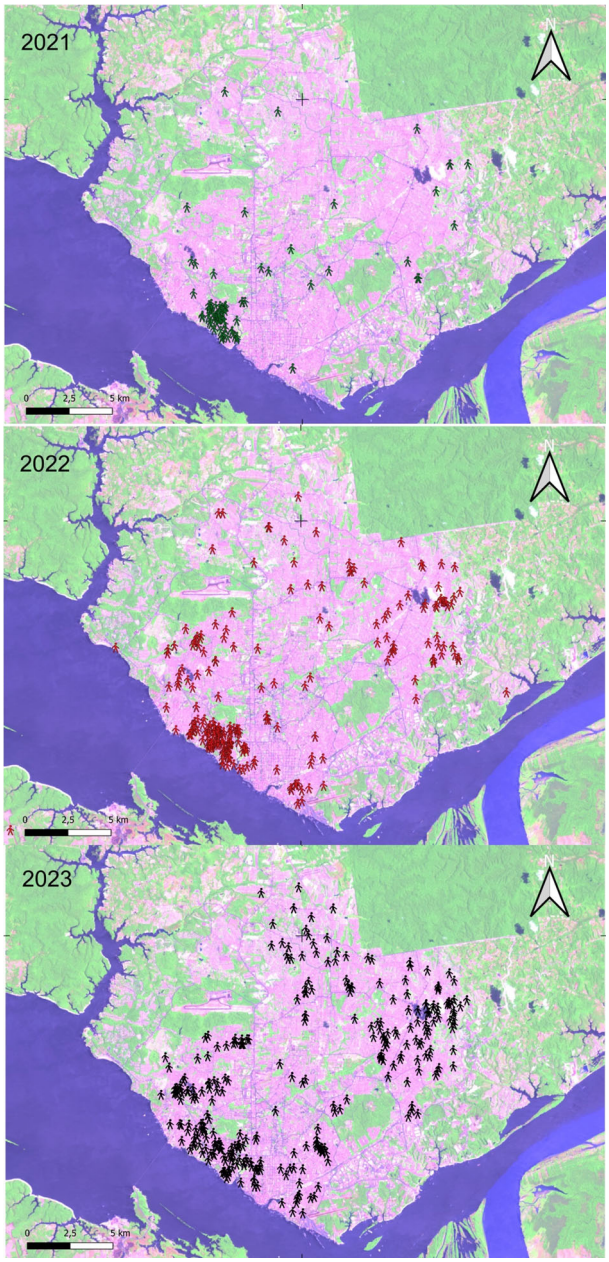

FIGURE 1 Spatial progression of reported human sporotrichosis cases in the metropolitan region of Manaus from 2021 to 2023 (*Source*: SINAN-NET).

MATERIALS AND METHODS

A cross-sectional study was conducted by enrolling clinically suspected cases of sporotrichosis attended at Alfredo da Matta Foundation (AMF) between September 2022 and December 2023, Manaus (Brazil).

The exudate of cutaneous lesions was collected for both culture and molecular testing. Sabouraud agar and mycosel agar were used for culture, while TaqMan Real-Time PCR (qPCR) was used for the identification of *S. brasiliensis* and *S. schenkii* [7].

Patients with fungal growth observed in the culture (the gold standard) [3, 4] were consecutively included in the study, and molecular testing was subsequently performed. For species identification via qPCR, exudate from cutaneous lesions was initially employed as the clinical sample. A colony aliquot from the culture medium was utilised when amplification from exudate from cutaneous lesions failed.

This study was approved by the Research Ethics Committee of AMF (no 705066823.9.0000.0002).

RESULTS

Sporothrix cultures were obtained from 150 patients, confirming the diagnosis of all patients. Sporotrichosis was more prevalent among females (67.3%), with a mean age of

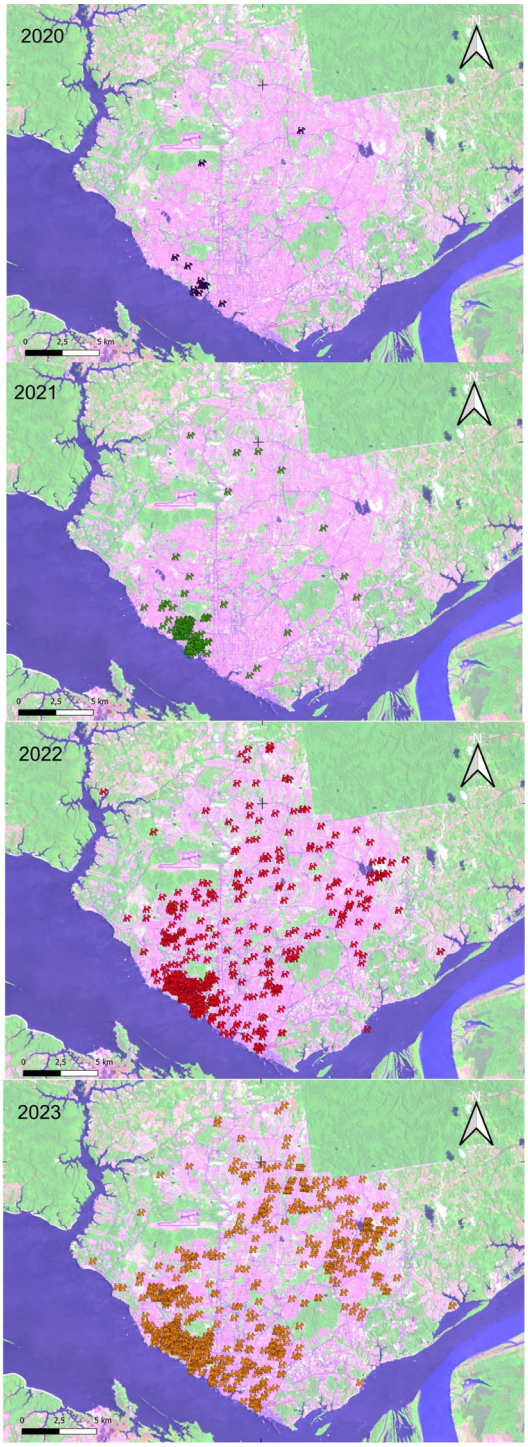

FIGURE 2 Spatial progression of reported sporotrichosis in cats from the metropolitan region of Manaus from 2020 to 2023 (*Source*: SINAN-NET).

44.5 years, predominantly presenting lymphocutaneous lesions (72.7%), and affecting the upper limbs (55.3%) (Table 1 and Figure 3).

S. brasiliensis was identified in 89.3% (134/150) of the samples (Figure 4), 61.2% (82/134) directly from the exudate of cutaneous lesions and 38.8% (52/134) from the cultures.

TABLE 1 Main clinical and demographic data from the 150 cases of human sporotrichosis from the Amazon outbreak.

Variables	Results
Sex, *n* (%)	
Female	101
Male	49
Age (in years)	
mean (SD)	44,5
Min–max	18–79
Clinical presentation, *n* (%)	
Lymphocutaneous	109 (72,7)
Fixed cutaneous	24 (16%)
Mixed	1 (0.7%)
Multiple inoculation	14 (9.3%)
Non-registered	2 (1.3%)
Body site, *n* (%)[a]	
Upper limb	83 (55.3%)
Lower limb	50 (33.3%)
Trunk	13 (8.6%)
Face	7 (4.7%)
Ocular mucosa	1 (0.7%)
Non-registered	14 (9.3%)
Contact with cats, *n* (%)	125 (83.3%)
Contact with domestic sick cats	64 (51.2%)
Contact with peri-hold sick cats	23 (15.4%)
Reported cat scratch and/or bite	38 (30.4%)
Molecular testing	
Sporotrix brasiliensis	134 (89.3%)
Sporotrix schenkii	0 (−)
NA	16 (10.7%)

Abbreviation: NA, no amplification for the primers.
[a]Patients may exhibit involvement at multiple body sites.

FIGURE 3 Lymphocutaneous human sporotrichosis. Ulcer with infiltrated borders on the finger (local of inoculation—cat bite). This initial ulcer was followed by the development of a secondary ulcer and ascending lymphangitis.

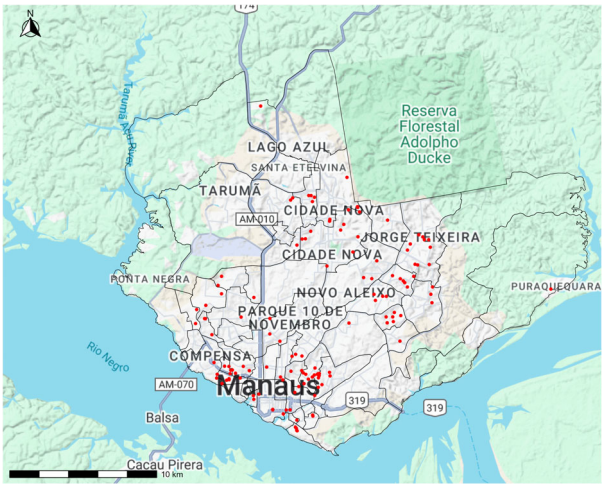

FIGURE 4 Geographical map of the metropolitan region of Manaus, showing the locations where the 134 patients who tested positive for *S. brasiliensis* reside. Each case is represented by a red dot on the map (*Source*: FUHAM).

Sixteen (11.2%) exudate samples did not amplify for *S. brasiliensis*. Among these, 11 samples were subsequently tested for *S. schenkii*, with negative results. For the remaining five patients who had positive cultures but negative amplification results for *S. brasiliensis*, no additional remaining biological samples were available, thus precluding further qPCR analysis.

Notably, 125 individuals (83.3%) reported having had contact with cats in their medical history, either within the household (83 individuals, 66.4%) or in the surrounding environment (42 individuals, 33.6%). In addition, 87 individuals (66.6%) were aware of sick cats, and 38 (30.4%) reported experiencing cat scratches or bites at the site of their skin lesions.

DISCUSSION

This study indicated *Sporothrix brasiliensis* as the primary species responsible for the sporotrichosis outbreak in the Amazon state. This species is also predominant in the Brazilian Southeast epidemic, indicating its spread across metropolitan regions of the country, including the Northeast and Manaus [2, 6]. In contrast, *S. globosa* is the main species causing sporotrichosis in neighbouring Venezuela [8].

The sequential detection of cases in humans, often preceded by reports of ill cats, suggests that the transmission of sporotrichosis in Amazonas is predominantly zoonotic, with felines playing a pivotal role in its spread, much like in other Brazilian regions [2, 4]. Currently, the epidemiological landscape in Manaus appears to be shifting rapidly, likely driven by exposure to infected cats migrating from other states in Brazil [4–6]. During this early outbreak phase, the pathogen's genetic diversity remains limited, a phenomenon consistent with the founder effect. However, as transmission continues, genetic variability is expected to increase to align with the diversity of the source population [10], although this expansion has not yet been observed in the Amazon state.

Manaus, with over two million inhabitants, is the largest urban centre in the Amazon and serves as a critical connection point linking Brazil's North Region with neighbouring countries, including Peru, Colombia, Venezuela and several Caribbean nations. The rise in zoonotic sporotrichosis cases in Manaus poses a potential risk for other densely populated cities across these neighbouring countries.

S. brasiliensis displays unique characteristics compared to others, including slower growth at 20°C (soil temperature) but accelerated growth above 36°C (mammalian tissue temperature). These traits facilitate zoonotic transmission, especially in regions affected by urbanisation, deforestation and climate-driven habitat changes [9–11].

Notably, *S. brasiliensis* is associated with increased virulence, leading to more severe clinical presentations than other species. Differences in antifungal susceptibility profiles across species underscore the importance of species-specific identification for tailored treatments [6]. Additionally, molecular diagnostics aid in differentiating sporotrichosis from other endemic dermatoses in the Amazon, such as mycobacteriosis and American tegumentary leishmaniasis, which share clinical features with lymphocutaneous sporotrichosis [3].

The rising incidence of sporotrichosis reflects a significant public health challenge in Amazonas and across various Brazilian states, highlighting the need for integrated approaches to safeguard human and animal health, especially in the face of insufficient sanitary control measures and climate impacts [6]. Environmental degradation, particularly the deforestation of crucial Brazilian biomes like the cerrado, the Atlantic Forest and the Amazon rainforest, has exacerbated global temperature increases, severe flooding and storms, which are linked to the emergence of zoonotic diseases [10, 11].

This study faces some limitations, including a potential selection bias from focusing solely on patients suspected of sporotrichosis, possibly excluding severe cases or hospitalised patients. Furthermore, the 16 (10.6%) samples that failed to amplify for *S. brasiliensis* and *S. schenckii* may represent other *Sporothrix* species.

CONCLUSION

Sporothrix brasiliensis is the dominant species in the zoonotic outbreak of human sporotrichosis in the Brazilian Amazon, with cats identified as the primary vector. Effective sanitary control measures, education and responsible pet ownership are crucial to mitigating zoonotic sporotrichosis' impact in Brazil and preventing its spread to neighbouring Latin American cities.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Raw data of this study is available under contact with the corresponding author.

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