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Stray Cat Colonies Lacking Health Surveillance and Management Pose Infection Pressure for *Aelurostrongylus abstrusus* on Sympatric Domestic and Wild Felids

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Simple Summary: This study investigated the prevalence of lungworm infections in cats from different environments in Catalonia, Spain. A total of 93 cats from street colonies, shelters, and owned households were tested for lung nematodes. *Aelurostrongylus abstrusus* was detected in 34.5% of the cats from street colonies, as well as in one shelter cat, but not in any of the owned cats. These findings suggest that uncontrolled stray cat colonies pose a significant health risk to owned and wild felids due to the high prevalence of lungworm infections. The study emphasizes the need for managing cat populations, particularly through deworming and health protocols, to reduce the risk of infection. Including such measures in cat colony management programmes, like capture–sterilization—release campaigns, is crucial to controlling the spread of lungworm.

Abstract: The prevalence of respiratory nematodes in domestic animals has increased in Europe in recent decades. *Aelurostrongylus abstrusus* is the most common parasitic nematode of the respiratory tract in felids, and an increase in its prevalence has been suggested in different European countries including Spain, with values ranging from 0% to 30%. The Baermann technique was used to detect metastrongyloid larvae in 93 faecal samples from cats living in colonies (n = 29), cats living in shelters (n = 30), and owned cats (n = 34). Eleven cats (11.2%) were infected by *A. abstrusus*, the only species detected. The prevalence in colony cats (34.5%, 10/29) was significantly higher than the 3.3% (1/30) prevalence in shelter cats. Conversely, *A. abstrusus* was not found in any of the owned cats. The results can be representative of other areas in the Mediterranean basin, indicating the need to improve feline management and knowledge about the distribution and abundance of this parasite through geographically wider studies in Spain. This study emphasizes the importance of deworming domestic cats, especially those from street and rural environments or with outdoor lifestyles. The results also urge the need for population and health control of street cat colonies. Incorporating a deworming protocol in the current trapping–neutering–release campaigns for cat population control will be essential.

Keywords: *Aelurostrongylus abstrusus*; street colony cats; lung nematodes; shelter cats; Spain

Citation: Gassó, D.; López-Olvera, J.R.; Mentaberre, G. Stray Cat Colonies Lacking Health Surveillance and Management Pose Infection Pressure for *Aelurostrongylus abstrusus* on Sympatric Domestic and Wild Felids. *Animals* **2024**, *14*, 3400. https://doi.org/10.3390/ani14233400

Academic Editors: Ewa M. Skibniewska and Michal Skibniewski

Received: 21 September 2024
Revised: 15 November 2024
Accepted: 20 November 2024
Published: 25 November 2024

1. Introduction

In recent decades, the observed prevalence and distribution of cat respiratory nematodes in Europe have increased [1], with first-time detections of these parasites in countries such as Albania [2] and Sweden [3]. For years, the prevalence of lungworms described in different European countries including Spain ranged between 1% and 2% [4–8], although higher prevalences around 10% had been reported in other European countries such as Portugal [9], Italy [10], and Germany [11]. In Italy, cat lungworm parasites are endemic,

with prevalences reaching up to 38% [12,13]. However, higher prevalences in cat faeces ranging from 6.5% to 55.2% have been more recently reported in different regions within Spain [1,14,15]. These numbers increase to values between 20% and 30% when considering seroprevalence in cats [16–18], because false negative coproscopic results occur during prepatent infections and due to the irregularity of larval shedding [19]. Lungworms have also been reported in Asia, America, and Australia [20]. Globalization and global warming have been pointed to as principal factors favouring the spread of lungworms [21], which require an intermediate host to complete their life cycle. Both the parasites and their intermediate hosts (slug or snail) can adapt to climate change [22], facilitating their dispersion and the increase in their distribution range. However, few studies have been conducted on the intermediate [23] and even less on the paratenic [24] hosts, highlighting the need for further investigation in this area.

These widely distributed parasites infect domestic cats (*Felis catus* Linnaeus 1758) [25–27] but also their wild counterparts, European wildcats (*Felis silvestris* Schreber 1777) and other wild felids [28,29]. The clinical signs caused by lungworms range from asymptomatic to severe bronchopneumonia and death [30–33].

The lungworm *Aelurostrongylus abstrusus* Railliet 1898 (Nematode: Rhabditida: Angiostrongylidae) is the most common parasitic nematode of the respiratory tract in felids, which are mainly infected by eating infected small rodents that act as paratenic hosts. *Aelurostrongylus abstrusus* is found throughout the world, with prevalences reported in Europe ranging from 0.4 to 43.1% [5]. Other lungworms, such as *Troglostrongylus* spp. (Crenosomatidae) and *Oslerus rostratus* Gerichter 1945 (Filaroididae), were neglected in the past due to similarities in their first-stage larvae (L1), which are used for diagnosis, with the more abundant *A. abstrusus*. Although they have been more frequently identified in recent years thanks to the better characterization of their morphological differences and the molecular data availability [34,35], they continue to be detected in low numbers in domestic cats [36], in wildlife [28,29], or in cats living in sympatry with wild felids [12,18,37,38]. However, *Troglostrongylus brevior* Gerichter 1948 has specifically been increasingly reported in domestic cats in Europe [1,28,36,39]. In European felids, other lung nematodes are also present, including *Capillaria aerophila* Creplin 1839 (Trichurida: Capillariidae) [36], which is distinguishable by its characteristic lemon-shaped eggs that are excreted in faeces. Additionally, the cardiopulmonary nematodes *Angiostrongylus chabaudi* Biocca 1957 (Angiostrongylidae) [40] and *Metathelazia massinoi* Davtian 1933 (Spirurida: Pneumospiruridae)—also known as *Vogeloides massinoi* and *Osleroides massino* [41,42]—although less commonly observed, have also been described in wild hosts.

While cats' lifestyle, mainly outdoor access, is acknowledged as a hazard factor for lungworm infection [1,14,28,36,43], few studies have compared the prevalence of lungworms between shelter cats and street-colony-dwelling cats in Europe [44]. These prevalences are likely to differ, because street-colony-dwelling cats do not receive any treatment, while shelter cats receive effective treatments to control lungworms [1,20,45,46]. However, no studies in Spain have compared lungworm prevalences based on cats' lifestyle.

There is therefore a lack of knowledge regarding the reasons for the variability and the apparent recent increase in the prevalence of lungworms in domestic cats in Europe overall and specifically in Spain, as well as the effect of cats' lifestyle and outdoor access on such a prevalence. The objective of this study is to assess the prevalence of cat lung metastrongyloids and the effect of cats' lifestyle in a specific geographic area of Catalonia, northeastern Spain.

2. Materials and Methods

2.1. Study Area

The province of Lleida, situated in northeastern Spain within Catalonia, boasts diverse landscapes ranging from the Pyrenees to the Ebro River basin. Characterized by agricultural plains, valleys, and mountainous areas, it presents a unique gradient of anthropization and climate. Our study areas, primarily in the Urgell and Segarra, encompass diverse rural

environments with the potential for domestic–wildlife interactions (Figure 1). Previous studies found that interactions between domestic and wild carnivores may be most likely to occur in rural locations [47,48].

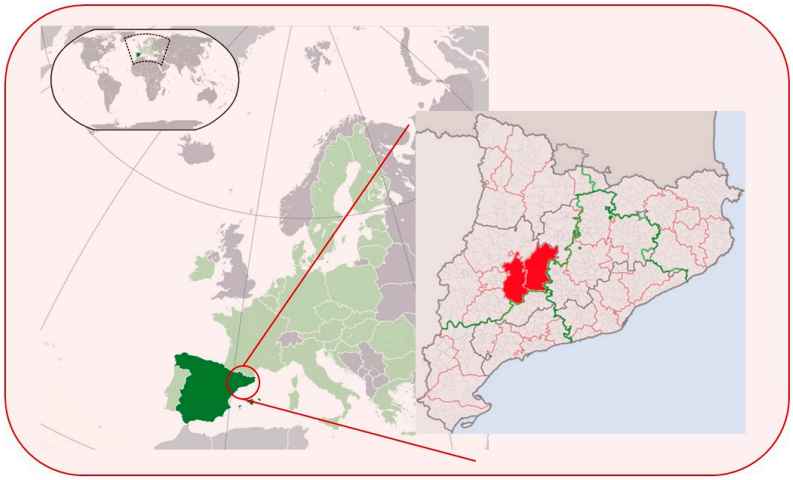

Figure 1. Map of the study area. Spain is marked in dark green. Catalonia region is shown in the inset, with the study areas of Urgell and Segarra indicated in red.

2.2. Faecal Samples and Data Collection

From April 2023 to Jun 2024, 93 faecal samples were collected from cat colonies (n = 29), cat shelters (n = 30), and owned cats (n = 34, including eight with outdoor access and 26 always kept indoors, Table 1). Fresh faecal samples were directly collected from outdoor sand, trap boxes, or commercial cat litter, respectively. All the faecal samples were subjected to a modified Baermann technique [49]. The Baermann test was performed using 5 to 10 g of faeces wrapped in a double layer of gauze and placed in a sedimentation cup filled with water at environmental temperature. After 12–24 h, the supernatant was discarded, and the sediment (10 mL) was analysed with a stereoscopic magnifying glass. When a total larvae count was impossible due to their abundance, a McMaster chamber was used for quantification. Metastrongyloid larvae L1 of *A. abstrusus* were identified by key morphological and morphometric features, particularly their total length and tail and head shape [25,35,45,46]. The differential features of metastrongyloid larvae found in feline faecal samples have been previously described [25].

Table 1. Features of the cats sampled in this study.

		Cat Colonies	Cat Shelter	Owned Cats	Total
Sample size		29	30	34	93
Known age (years)		5	1	28	35
	Mean	0.85	4.5	3.58	3.4
	SD	0.34	NA	2.31	2.56
	Minimum	0.25	NA	0.1	0.1
	Maximum	10	NA	6	10
Known sex		10	3	34	47
	Female	4	3	17	24 (51%)
	Male	6	0	17	23 (49%)
Endoparasitic treatment *					
Yes		0	30	21	51 (61.4%)
	<6 months ago		30	11	41 (49.4%)
	>6 months ago		0	9	9 (10.8%)
	Unknown			1	1 (1.1%)
No		29	0	3	32 (38.4%)

SD = Standard deviation; * milbemycin oxime/praziquantel at manufacturer-recommended dosages.

The characteristics of the cats included in this study are presented in Table 1.

2.3. Data Analysis

The descriptive analysis of the data and a two-proportion z-test were performed using R software version 4.4.0 (R Core Team, 2024 [50]).

3. Results

Of the 93 cats, 11 (11.8%, CI95 5.3–19.4) were infected by *A. abstrusus* (Figure 2). Ten of the infested cats were from colonies (10/29, 34.5%, CI95 17.2–51.8) and one was from a shelter (1/30, 3.3%, CI95 0.0–9.8), resulting in a statistically significant higher prevalence in street cats than in shelter cats (X-squared = 7.4909; df = 1; *p*-value = 0.006201). The parasite was not detected in any of the owned cats (0/34).

Figure 2. First-stage larva of *Aelurostrongylus abstrusus*, with the anterior end showing a rounded extremity and a terminal oral opening and a kinked tail with distinct knob-like or small finger-like projections at the tip of the cuticular spines.

The mean intensity was 1365 larvae (min–max: 2–12,000; sd: 13,988.2), and the only shelter cat who was infected had an intensity of 36 larvae, all found in ten grammes of faeces.

4. Discussion

The prevalence of the lungworm *A. abstrusus* observed in this study was overall similar to those found in previous and recent studies conducted in Spain [1,14,15]. However, the specific prevalence in the street-colony-dwelling cats was higher, similar to previous reports in Bulgaria (35.8%) [1], and even higher than the 25% seroprevalence described in endemic areas of Italy [17]. Since coprological techniques are less sensitive than serology [19], the real exposure to *A. abstrusus* of the cats sampled in this study could be even higher. This tendency of a higher prevalence in stray cats compared to shelter cats and, finally, owned ones, has been previously reported for intestinal parasites and lungworms, including *A. abstrusus* [10,44]. The higher prevalence of *A. abstrusus* in street colony cats found in this study matches with the high metastrongyloid infection rates reported in outdoor cats in

the Canary Islands [14] and agrees with previous studies from Italy and Switzerland in identifying an outdoor lifestyle as a risk factor, supported by prevalence data for lungworms, including *A. abstrusus* [10,51]. However, to our knowledge, this is one of the first studies to examine the relationship between *A. abstrusus* prevalence and cats' lifestyle specifically in the Mediterranean basin, which is particularly relevant. Given the current climate change conditions in the region, future increases in the range of helminth infections toward northern latitudes in Europe can be anticipated [21,52].

Outdoor access has already been identified as a risk factor for lungworm and specifically *A. abstrusus* infection in domestic cats [5,10,44,51,53]. This higher outdoor hazard could be related to the infection pressure posed by wild carnivores, who have a higher lungworm prevalence than domestic ones [28,29,54–56] and could serve as a reservoir for *T. brevior* and *Eucoleus aerophilus* (syn. *Capillaria aerophila*), leading to high prevalence and co-infections where domestic and wild cats coexist [37,57]. In our study area, *A. abstrusus* infections may similarly be maintained through reservoir hosts. Here, street colony domestic cats, who generally lack the deworming practises applied to home-kept cats, may play a similar role to wild reservoirs by posing an infection risk to domestic cats. The presence of European wildcat in the region [58] further supports the potential for cross-species infection pressure. Further studies including this wild reservoir of lung nematodes in general and *A. abstrusus* specifically are required to investigate the role of this species in the shared epidemiology of these parasites from a One Health approach [55,59].

The lack of finding of lungworm species other than *A. abstrusus* agrees with recent reports of this species as the most important respiratory nematode in cats [57], although *T. brevior* and *E. aerophilus* are becoming increasingly relevant in feline clinical parasitology [45]. Similar results, with a single infecting species, have been observed in northeastern Spain [15] and other countries like Ireland [6]. Although previous issues with misdiagnosis in lungworm species have been resolved [57,60], the use of molecular techniques such as PCR would be preferable [18,34], not only for species identification but also to explore the epidemiological cycles among host species and populations.

While this study contributes new data on the *A. abstrusus* prevalence in domestic cats according to their management condition in the Mediterranean basin, prevalences can vary widely locally [61]. More comprehensive studies involving larger sample sizes from diverse geographic areas are necessary to achieve a more accurate and complete understanding of the epidemiology of *A. abstrusus* in Mediterranean environments. Moreover, our results may be conservative, as the prevalence could be higher due to the limitations and low sensitivity of coprological tests [13,19]. Although serological studies generally yield higher prevalence estimates [11,16,17,51] by detecting prepatent individuals, they can also produce higher prevalence rates due to false positives from cross-reactions with other metastrongyloid parasites or false negatives in immunosuppressed cats [19]. Therefore, coprological and serological methods should be combined to obtain more reliable results.

The impact of domestic cats with outdoor access and stray and feral cats on biodiversity has been repeatedly reported and demonstrated [59,62,63]. Besides predation, domestic cats have also been responsible for causing a feline leukaemia virus epidemic with mortality in the endangered Iberian lynx (*Lynx pardinus* Temminck 1982) population in Doñana, southwestern Spain [64]. While the prevalences of *A. abstrusus* and other lungworms in wild felids are among the highest values reported [55,56], their contributions to environmental burdens and infection pressures depend not only on the individual burden but mainly on the shedding rate and abundance of each population and species [65]. Untreated and uncontrolled street colony cats could act epidemiologically as highly prevalent and highly infected overabundant hosts, individually equalling wild felids but demographically overcoming their role due to their anthropically subsidized populations [62,63,66–68]. Therefore, monitoring not only the prevalence and parasitic load, but also the shedding rate and population density and/or abundance of both domestic and wild hosts [62] is essential to understanding the complexity of the epidemiological scenario of *A. abstrusus* and other lungworms in the interface between domestic and wild felids.

To understand domestic cat population dynamics, the collective population of owned cats, unowned (including feral) cats, and cats in the shelter system must be considered simultaneously, since each subpopulation contributes differently to the overall cat population within a community [66]. Such population monitoring and knowledge should also include the sympatric wild felid populations, which is currently European wildcat in our study area. The "One Health One Welfare" approach, which encompasses human, domestic, and wild animals, as well as ecosystem health, also requires an understanding of the population dynamics and disease epidemiology in each one of these host groups [59].

Our study adds a new population health hazard to the already known biodiversity conservation threats posed by street cat colonies [64,68], highlighting the need and urgency of their population and health monitoring. However, the current management of feral cats and stray cat colonies relies mostly on the trap–neutering–release (TNR) system [69], which has repeatedly been demonstrated to be ineffective [70]. Nevertheless, if continued despite their lack of success, our results support the recommendation that such TNR campaigns incorporate a deworming protocol to treat cats, and potentially a vaccination protocol for contagious viral diseases, such as feline leukaemia virus, to reduce the risk of sympatric threatened wildlife felids [64]. These additional measures will not only protect the welfare of unowned cats but also reduce health risks to owned cats, wildlife, and, ultimately, human health. In particular, deworming can help reduce the prevalence of *Toxocara* spp. and other intestinal parasites, decreasing the risk of zoonotic infections such as larva *migrans* [71].

Veterinary practitioners from Catalonia should consider lung nematodes in the differential diagnosis of cats with respiratory signs, particularly those from street colonies, shelters, or with outdoor access and not properly dewormed. Conducting a Baermann test (an easy and economical method) is essential to avoid misdiagnosing lungworms as asthma or other pulmonary conditions [72].

5. Conclusions

The prevalence of *A. abstrusus* was consistent with both previous and recent studies conducted in Spain; however, the prevalence among colony-dwelling street cats was significantly higher, acting as an uncontrolled potential source of infection. This study adds lungworms, specifically *A. abstrusus*, to the known biodiversity and health risks posed by stray domestic cat colonies.

Author Contributions: Conceptualization, D.G. and G.M.; methodology, D.G.; software, D.G.; validation, D.G., J.R.L.-O. and G.M.; formal analysis, D.G.; investigation, D.G., J.R.L.-O. and G.M.; resources, D.G.; data curation, D.G.; writing—original draft preparation, D.G.; writing—review and editing, D.G., G.M. and J.R.L.-O.; visualization, D.G., G.M. and J.R.L.-O.; supervision, G.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets supporting the conclusions of this article are included within the article.

Acknowledgments: We thank Judit Alvarez for assistance in the laboratory and the associations *Gats de la Segarra* and *Tarregats* for their collaboration.

Conflicts of Interest: The authors declare no conflicts of interest.

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