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# Preliminary survey of feline intestinal parasites in Ghana

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## ABSTRACT

Cats can host an array of parasite species. This is particularly evident in sub-Saharan Africa, where climatic conditions favour parasites and their vectors, and pets are given little medical attention. The presence of parasites in cats results in significant morbidity in these companion animals. Proximity of infected cats to humans also favours zoonotic transmissions. This study aimed at ascertaining the prevalence and diversity of parasites in cats. A total of 90 feline faecal samples were examined using floatation techniques. Overall, 75 cats (83.3%) were infected with at least one of six parasite species. *Toxocara* ova were found in 35 (38.9%), hookworm ova in 20 (22.2%), *Isospora* in 19 (21.1%), *Capillaria* in 17 (18.9%), pinworm eggs in 5 (5.6%) and flukes in 4 (4.4%) cats respectively. Sex of cats was a significant determinant of infections. This study demonstrates environmental contamination with feline parasites of zoonotic importance, thus necessitating a One-Health surveillance to minimize zoonotic risks from these companion animals. Cats play active roles in the transmission of multiple parasites of zoonotic importance in Ghana.

**Contribution/Originality:** This paper provides data for the first time on parasites of zoonotic importance in cats in Ghana, a developing country with a high population of stray cats.

## 1. INTRODUCTION

Cats are companion animals that are well adapted to human settlements worldwide. In addition to providing social and emotional benefits, cats serve as biological control agents of rodent pests in homes and important sources of animal proteins [1]. Despite these benefits, cats remain public health threats, as they can host infective stages of several parasite species that are naturally transmissible to humans and other domestic animals [2].

Endoparasites have been recovered from both feral and pet cats including *Toxoplasma gondii*, *Dipylidium caninum*, *Ancylostoma* spp., *Toxocara cati*, *Giardia* cysts, *Cryptosporidium* spp., and *Strongyloides stercoralis*, all of which are of zoonotic importance [3]. Endoparasitism in cats may cause mild or life-threatening disorders, depending on the species of the parasite and the parasite loads [4]. Zoonotic transmissions from cats to humans may occur through contact with animal fur/hair, excrement, or exposure to contaminated environmental matrices (including soil, water, and food) infested with feline parasite eggs, larvae or oocysts [5]. Some feline parasites have been reported to cause diseases of public health importance, including cutaneous and visceral larva migrans, dipylidiasis, and toxoplasmosis [6]. Cat ownership has been documented as a risk factor for *Toxoplasma* infections in pregnant women [7]. Studies on endoparasites of cats have reported a prevalence ranging from 20 to 40% in Europe [8].

Infection rates in the United States are estimated at 0.03 to 33% [9]. In Africa, the prevalence of parasites in cats can be as high as 91%. Significantly higher prevalence of parasitic infections has been reported in stray cats as compared to indoor cats [10]. Only a small population of cat owners provide their cats with litter boxes. However, the disposal of the litter in the open contributes to environmental contamination with parasite eggs and/or oocysts of zoonotic importance [4]. In Ghana, there exists a high population of stray animals, including cats and dogs. Pet keeping is a common practice in Ghana, yet these animals are rarely given medical treatment. So far, there is no study on feline parasites nor the role they play in zoonotic transmissions in Ghana. Knowledge of the diversity of parasite in cats is needed to inform public health interventions and limit zoonotic transmissions. This study aimed at providing data on the parasites of cats in Ghana.

## 2. MATERIALS AND METHOD

### *2.1. Study Area*

The study was conducted in Mampong, the capital of the Mampong Municipal Assembly in the Ashanti region of Ghana. Geographically, it is located on latitude 705"42" N and longitude1 24"49" W, approximately 60km northeast of the regional capital, Kumasi. It has an estimated population of 88, 650 people, accounting for approximately half of the population of the entire municipality [11]. The town lies within a wet semi-equatorial forest zone and has rippling and picturesque landforms that range from escarpments and hills to tropical lowlands. Agricultural activities are predominantly the occupation of townships owing to their fertile soil [12].

### *2.2. Study Design*

This study was a multi-site, cross-sectional field survey to provide current baseline on endoparasites of cats in Ashanti- Mampong, Ghana. The study area was divided into seven groups according to the names in the study area (Tunsuom, Site, Awaiso, Locust, Tataforoso, Adiembra, Zongo). Figure 1 shows the study area on the map of Ghana.

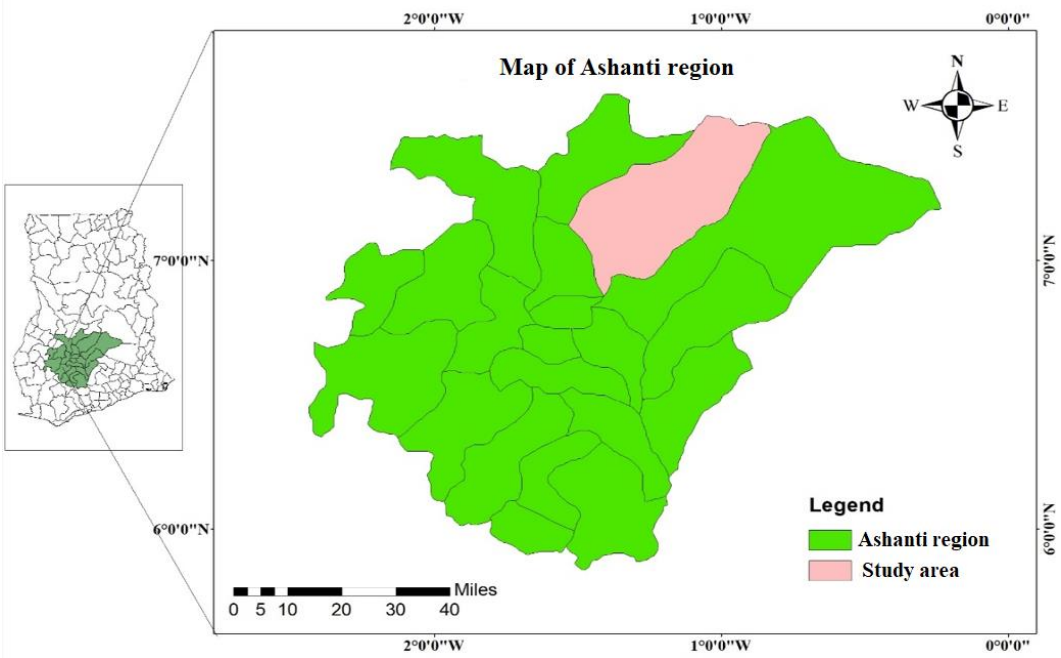



**Figure 1.** Map of Ashanti region showing the study area.

### *2.3. Study Animals*

Cats of varying age and sex were sampled from the study community. Random house to house sampling was done for cats who owners were available and consented to have their animal sampled. A total of 90 cat stool samples

were collected from 72 households. Cats were classified according to age as kittens (0–6 months), young cats (>6 months to 12 months), or adults (>12 months).

### *2.4. Sample Collection and Faecal Examination*

Samples were randomly collected from households in containers containing formalin to protect eggs from destruction. Briefly, 3 grams of stool samples were emulsified in 50ml sodium chloride floatation fluid. The mixture was filtered using fabric gauge into the test tube, then a floating liquid is added to achieve meniscus. After 15 minutes, the test tube was covered with a cover slip and gently placed on the microscope slide for parasite identification [13]. Each sample was examined under 10x and 40x magnifications of the microscope. Following microscopy, parasite ova or oocysts were identified according to existing keys and descriptions [14].

### *2.5. Data Analysis*

Data was analyzed to determine frequencies and percentages using RStudio (2022.02.3 Build 492) statistical tool. Test for associations was conducted with the Chi-square ($\chi 2$) test at 5% significance level.

### *2.6. Ethical Approval and Consent to Owners*

Individual consent from cat owners was obtained prior to collection of faecal samples.

## 3. RESULTS

### *3.1. Characteristics of Sampled Cats*

A total of 90 cats, including 47 males (52.2%), were drawn from the study community. Of these, 23 (25.6%) were kittens, 37 (41.1%) were aged between 6 – 12 months and 30 (33.3%) above 12 months of age. Most of the cats (71.1%) were allowed to roam about freely in the communities. A total of 47 males and 43 female cats were examined, 43 (91.5%) and 32 (74.4%) were infected respectively.

### *3.2. Prevalence of Parasites in Cats*

Out of the 90 samples examined, 75 (83.3%) were found to be positive with at least one of six parasite eggs/oocysts. *Toxocara* ova were found in 35 (38.9%), hookworm ova in 20 (22.2%), *Isospora* in 19 (21.1%), *Capillaria* in 17 (18.9%), pinworm ova in 5 (5.6%) and flukes in 4 (4.4%) cats respectively. Figure 2 shows the prevalence of the parasites recovered from the cats.

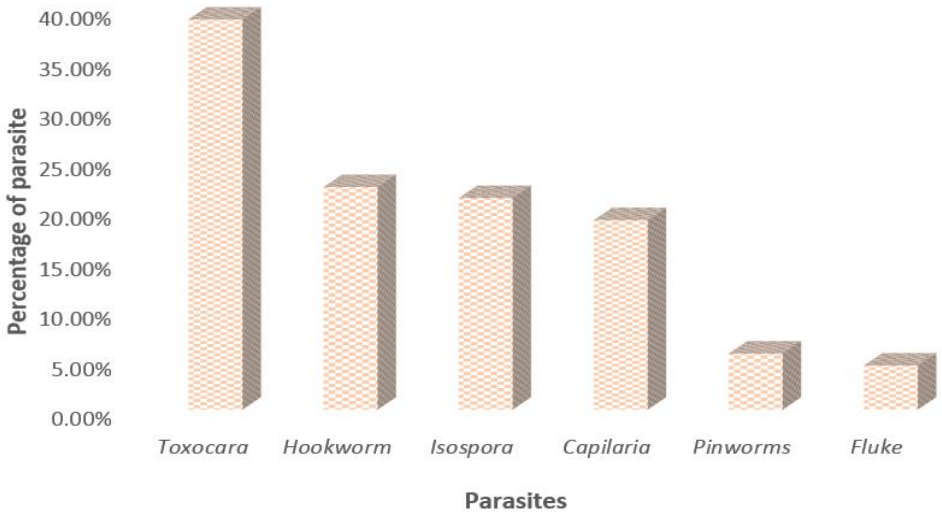



**Figure 2.** Parasitic prevalence in cats sampled.

**Table 1.** Prevalence and distribution of parasites species in relation to age.

| Age | No. examined | Parasite species | | | | | | Overall prevalence | P-value |
|---|---|---|---|---|---|---|---|---|---|
| | | *Toxocara* | Hookworm | *Isospora* | *Capillaria* | Pinworms | Flukes | | |
| 0-6m | 23 | 9(39.1%) | 8(34.8%) | 5(21.7%) | 4(17.4%) | 1(4.3%) | 0(0%) | 17(73.9%) | 0.003 |
| 7-12m | 37 | 12(32.4%) | 7(18.9%) | 9(24.3%) | 12(32.4%) | 1(2.7%) | 2(5.4%) | 32(86.5%) | 0.001 |
| >12m | 30 | 14(46.7%) | 5(16.7%) | 5(16.7%) | 1(3.3%) | 3(10%) | 2(6.7%) | 26(86.6%) | <0.001 |
| Total | 90 | 35 (38.9%) | 20(22.2%) | 19(21.1%) | 17(18.9%) | 5(5.6%) | 4(4.4%) | 75(83.3%) | <0.001 |

**Table 2.** Prevalence and distribution of parasites species in relation to sex single and multiple infections in cats.

| Sex | No. examined | Parasite species | | | | | | Overall prevalence | P-value |
|---|---|---|---|---|---|---|---|---|---|
| | | *Toxocara* | Hookworm | *Isospora* | *Capillaria* | Pinworms | Flukes | | |
| Male | 47 | 19(40.4%) | 12(25.5%) | 9(19.1%) | 12(25.5%) | 3(6.4%) | 3(6.4%) | 43(91.5%) | <0.001 |
| Female | 43 | 16(37.2%) | 8(18.6%) | 10(23.3%) | 5(11.6%) | 2(4.7%) | 1(2.3%) | 32(74.4%) | <0.001 |
| Total | 90 | 35 (38.9%) | 20(22.2%) | 19(21.1%) | 17(18.9%) | 5(5.6%) | 4(4.4%) | 75(83.3%) | <0.001 |

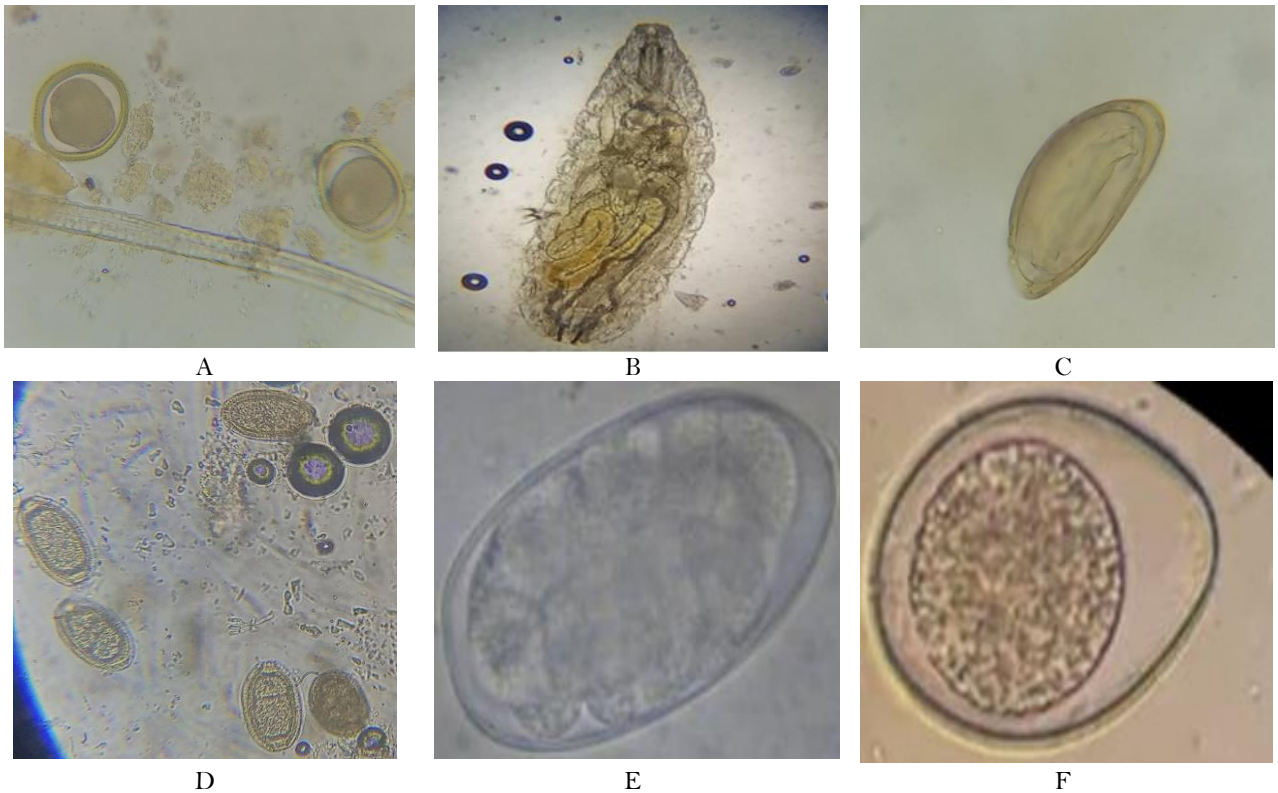
### *3.3. Parasitic Infections in Relation to Age and Sex of Cats.*

Significantly higher prevalence was seen in male cats (91.5%) as compared to female cats (74.4%) ($\chi 2$ = 4.7115, p= 0.02996). The overall age-specific prevalence was 73.9% for kittens, 86.5% for young cats and 86.6% for older cats ($p < 0.05$). Overall, sex, but not age, was a determinant of parasitic infections in cats. Tables 1 and 2 describe the distribution of parasites in relation to age and sex respectively.

Single infections were found in 52 cats (57.8%), with 18 (20.0%) double infections, 3(3.3%) triple infections and 2 (2.2%) quadruple infections. Out of the 23 cats with multiple infections, 10 (43.5%) had combined *Toxocara* and hookworm infections. Table 3 shows types of multiple infections in cats.

**Table 3.** Poly-parasitism in cats.

| Mixed parasitism | Frequency | Percent (%) |
|---|---|---|
| Double infections | | |
| *Toxocara* + Hookworm | 5 | 5.6 |
| *Toxocara* + *Capillaria* | 4 | 4.4 |
| *Toxocara* + *Isospora* | 3 | 3.3 |
| *Capillaria* + Hookworm | 2 | 2.2 |
| *Isospora* + Hookworm | 2 | 2.2 |
| *Toxocara* + *Pinworm* | 1 | 1.1 |
| *Toxocara* + *Fluke* | 1 | 1.1 |
| Triple infections | | |
| *Toxocara* + *Capillaria* + Hookworm | 2 | 2.2 |
| *Toxocara*+ *Isospora* + Hookworm | 1 | 1.1 |
| Quadruple infections | | |
| *Toxocara* + *Isospora* + *Capillaria* + Hookworm | 2 | 2.2 |



A B C D E F

**Note:** A- Toxocara spp. B-Fluke C- Pinworm ova D- Capillaria spp. E- Hookworm ova F- Isospora spp.

## 4. DISCUSSION

This study provides an overview of gastrointestinal parasites in cats in Mampong. In total, cat parasitic infections accounted for 83.3% (75/90). This is comparable to reports in India (85%; 77.2%) [15, 16], Nigeria

(95.5%) [17] and United Arab Emirates (87%) [18], but lower than the prevalence reported in Iran (90%) [19], Egypt (91%) [20] and Iran (94%) [21]. Lower prevalence were, however, reported in Canada (32%) [22], Romania (34%) [23], Malaysia [24], USA (63.9%) [25], and Kenya (73,7%) [26]. Regional variations, environmental, climate conditions and animal care practices may be responsible for similarity or differences in the incidence of cat parasitic infections.

Parasites of both veterinary and public health importance were recovered from the cats sampled. In the current study, *Toxocara* spp. was the most prevalent parasite (38.9%), which is in line with reports from other parts of the world (20.3%) [23], (44.4%) [27] and (44.6%) [25] that *Toxocara spp.* is the most commonly encountered endoparasite of cats. *Toxocara cati*, a well-known zoonotic parasite, can infect people and cause visceral and ocular larva migrans, especially in children [22, 25]. The danger of human infection is raised since *Toxocara cati* eggs are known to stay and remain viable in the environment for a long time. The widespread distribution of this ascarid is mostly attributable to the eggs' strong tolerance to harsh environmental conditions [8]. Additionally, infestation among young cats is increased by transmammary transmission [25]. In our study both age groups of cats had a prevalence of this parasite over 30%. Information about the high prevalence of these zoonotic parasites is important for public health concerns. The high prevalence of T. *cati* in cats may be due to the high consumption of paratenic hosts, such as rodents and birds [27]. For *Toxocara* spp., pre- and perinatal transmission, age immunity, and exposure to paratenic hosts and highly resistant eggs contaminating the environment are all well-established [28]. The warmer climatic conditions in the study area likely increase the presence and persistence of infective stages of the parasite [29].

Hookworms were the second most prevalent parasites in this study (22.2%), which is similar to published data [30, 31]. Infection of cats with hookworms may occur via ingestion of free larvae from the soil or paratenic hosts, maternal milk and transcutaneous penetration by infective larvae. Species of hookworms identified in cats include *Ancylostoma* spp. and *Uncinaria stenocephala*. Human exposure to these parasites may result in cutaneous larval migrans, anaemia and eosinophilic gastroenteritis [32]. Considering hookworm larvae can persist in the soil for several months, the habit of burying faeces by cats is of public health concern.

*Isospora* are the commonest coccidian parasites found in cats. They inhabit the gastrointestinal tract of cats and can cause diarrhoea. Species of *Isospora* recovered from cats include *Isospora felis* and *Isospora rivolta*. Unlike, *Cryptosporidium parvum* and *Toxoplasma gondii*, *Isospora* is not contagious to humans, but is transmissible from cat to cat. The prevalence of 21.1% reported in this study is higher than previous reports in Iraq (13.3%) [33], (6.61%) [34], Switzerland (8.1%) [35]. Given that *Isospora* oocysts are highly resistant to environmental conditions and disinfectants, improved hygiene and proper disposal of cat feces are important in cat-to-cat infections.

Another nematode recovered from 18.9% of the cats was *Capillaria* spp. *Capillaria aerophila*, (syn. *Eucoleus aerophilus)* is a zoonotic trichuroid nematode parasite that inhabits the upper respiratory tract cats and other carnivores [36]. Infections in cats with lung nematodes result from ingestion of paratenic hosts, including rodents, soricomorphs, and birds. Lung nematodes are considered the most important causes of parasite-induced respiratory infection in felids [37]. Due to their high pathogenicity, pulmonary nematodes have received increased attention in recent years, particularly in Europe, where there is apparent emergence [36, 37]. There are sporadic cases of human infections, with zoonotic transmission often reported in areas with high prevalence [38].

Pinworm ova were also recovered from 5.6% of the fecal samples examined. Pinworms are considered atypical cat parasites given that these nematodes are host-specific. Pinworm ova in cats may stem from consumption of rodents, such as mice and rats which are known to harbour pinworms. Two species of pinworms commonly reported in rodents include *Syphacia obvelata* and *Aspiculuris tetraptera* [21]. The role of cats in the transmission of pinworm infections needs to be elucidated. In addition to pinworms, unknown flukes were recovered from 4.4% of the cats. Several species of flukes have been recovered from cats, including species of zoonotic importance.

Sex of cat was identified as risk factors of infection in this study. Significantly higher prevalence in male cats compared to females could be attributed to the greater propensity by the former to roam about.

## 5. CONCLUSION

The prevalence of parasites in the cats was 83.3%. Presence of the zoonotic helminths, hookworms, *Toxocara*, and *Capillaria* suggest cats are potential zoonotic agents in the area. Sex of cat was a significant determinant of infections. Presence of zoonotic parasites in cats with poor deworming history is of public health concern. A One-Health surveillance is recommended to limit zoonotic transmissions from cats.

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**Competing Interests:** The authors declare that they have no competing interests.
**Authors' Contributions:** Both authors contributed equally to the conception and design of the study.

## REFERENCES

[1] G. Miró, R. Gálvez, A. Montoya, B. Delgado, and J. Drake, "Survey of Spanish pet owners about endoparasite infection risk and deworming frequencies," *Parasites & Vectors*, vol. 13, no. 1, pp. 1-10, 2020. https://doi.org/10.1186/s13071-020-3976-8

[2] M. Genchi *et al.*, "Prevalence and risk factors associated with cat parasites in Italy: A multicenter study," *Parasites & Vectors*, vol. 14, no. 1, pp. 1-11, 2021. https://doi.org/10.1186/s13071-021-04981-2

[3] I. Rabbani *et al.*, "Zoonotic and other gastrointestinal parasites in cats in Lumajang, East Java, Indonesia," *Infectious Disease Reports*, vol. 12, no. Suppl 1, pp. 8747-8747, 2020. https://doi.org/10.4081/idr.2020.8747

[4] S. Morelli, "Cat respiratory nematodes: Current knowledge novel data and warranted studies on clinical features treatment and control," *Pathogens*, vol. 10, no. 4, pp. 1-32, 2021. https://doi.org/10.3390/pathogens10040454

[5] P. K. Amissah-Reynolds, "Zoonotic risks from domestic animals in Ghana," *International Journal of Pathogen Research*, pp. 17-31, 2020. https://doi.org/10.9734/ijpr/2020/v4i330113

[6] R. J. Traub, P. A. Zendejas-Heredia, L. Massetti, and V. Colella, "Zoonotic hookworms of dogs and cats–lessons from the past to inform current knowledge and future directions of research," *International Journal for Parasitology*, vol. 51, no. 13-14, pp. 1233-1241, 2021. https://doi.org/10.1016/j.ijpara.2021.10.005

[7] P. O. Odeniran, K. F. Omolabi, and I. O. Ademola, "Risk factors associated with seropositivity for toxoplasma gondii in population-based studies among immunocompromised patients (pregnant women, HIV patients and children) in West African countries cameroon and gabon: A meta-analysis," *Acta Tropica*, vol. 209, p. 105544, 2020. https://doi.org/10.1016/j.actatropica.2020.105544

[8] A. Giannelli *et al.*, "Lungworms and gastrointestinal parasites of domestic cats: A European perspective," *International Journal for Parasitology*, vol. 47, no. 9, pp. 517-528, 2017. https://doi.org/10.1016/j.ijpara.2017.02.003

[9] S. Sweet, D. Szlosek, D. McCrann, M. Coyne, D. Kincaid, and E. Hegarty, "Retrospective analysis of feline intestinal parasites: Trends in testing positivity by age, USA geographical region and reason for veterinary visit," *Parasites & Vectors*, vol. 13, no. 1, pp. 1-10, 2020. https://doi.org/10.1186/s13071-020-04319-4

[10] U. F. Korkmaz, S. Gökpınar, and K. Yıldız, "Prevalence of intestinal parasites in cats and their importance in terms of public health," *Turkish Journal of Parasitology*, vol. 40, no. 4, pp. 194 -198, 2016. https://doi.org/10.5152/tpd.2016.4841

[11] Ghana Statistical Service, "Ghana 2021 population and housing census, Ghana Statistical Service. Retrieved: https://statsghana.gov.gh/gssmain," 2021.

[12] N. Tamerat Beyene, Y. T. Mekonnen, and F. Lemma, "Cat and dog gastrointestinal helminth and assessment of community perception on helminthic zoonosis in haramaya town, eastern ethiopia tuberculosis view project liver cancer cells in different tissue environments view project," *American Journal of Scientific Research and Essays*, vol. 10, no. 5, pp. 299–306, 2015.

[13] P. K. Amissah-Reynolds, I. Monney, L. M. Adowah, and S. O. Agyemang, "Prevalence of helminths in dogs and owners' awareness of zoonotic diseases in mampong Ashanti Ghana," *Journal of Parasitology Research*, vol. 2016, pp. 1-6, 2016. https://doi.org/10.1155/2016/1715924

[14] E. J. L. Soulsby, *Helminths arthropods and protozoa of domesticated animals*, 7th ed. London: Balliere, Tindall and Cassel, 1982.

[15] S. Borthakur and S. Mukharjee, "Gastrointestinal helminthes in stray cats (Felis catus) from Aizawl, Mizoram, India," *The Southeast Asian Journal of Tropical Medicine and Public Health*, vol. 42, no. 2, pp. 255-258, 2011.

[16] M. G. Lavanya, K. Malkar, S., and R. Pednekar, "Prevalence of gastrointestinal parasites with special reference to zoonotic parasites in domestic cats (Felis catus) in Mumbai Maharashtra," *Journal of Veterinary Healthcare*, vol. 1, pp. 47-49, 2016.

[17] A. O. Omonijo and O. A. Sowemimo, "Prevalence of ectoparasites of dogs and cats in Ijero and Moba LGAs, Ekiti State, Nigeria," *Nigerian Journal of Parasitology*, vol. 38, no. 2, pp. 278-283, 2017. https://doi.org/10.4314/njpar.v38i2.27

[18] R. K. Schuster, K. Thomas, S. Sivakumar, and D. O'Donovan, "The parasite fauna of stray domestic cats (Felis catus) in Dubai, United Arab Emirates," *Parasitology Research*, vol. 105, no. 1, pp. 125-134, 2009. https://doi.org/10.1007/s00436-009-1372-6

[19] M. Sharif, A. Daryani, M. Nasrolahei, and S. P. Ziapour, "A survey of gastrointestinal helminthes in stray cats in Northern Iran," *Comparative Clinical Pathology*, vol. 19, no. 3, pp. 257-261, 2010. https://doi.org/10.1007/s00580-009-0866-z

[20] R. E. Khalafalla, "A survey study on gastrointestinal parasites of stray cats in northern region of nile delta egypt," *PLoS One*, vol. 6, no. 7, p. e20283, 2011.

[21] N. Hajipour *et al.*, "A survey study on gastrointestinal parasites of stray cats in Azarshahr East Azerbaijan province, Iran," *Journal of Parasitic Diseases*, vol. 40, no. 4, pp. 1255-1260, 2016. https://doi.org/10.1007/s12639-015-0663-3

[22] A. Villeneuve *et al.*, "Parasite prevalence in fecal samples from shelter dogs and cats across the Canadian provinces," *Parasites & Vectors*, vol. 8, no. 1, pp. 1-10, 2015. https://doi.org/10.1186/s13071-015-0870-x

[23] V. Mircean, A. Titilincu, and C. Vasile, "Prevalence of endoparasites in household cat (Felis catus) populations from Transylvania (Romania) and association with risk factors," *Veterinary Parasitology*, vol. 171, no. 1-2, pp. 163-166, 2010. https://doi.org/10.1016/j.vetpar.2010.03.005

[24] S. Tun, I. Ithoi, R. Mahmud, N. I. Samsudin, C. K. Heng, and L. Y. Ling, "Detection of helminth eggs and identification of hookworm species in stray cats dogs and soil from klang valley Malaysia," *PLoS One*, vol. 10, no. 12, p. e0142231, 2015. https://doi.org/10.1371/journal.pone.0142231

[25] Y. Nagamori, M. E. Payton, R. Duncan-Decocq, and E. M. Johnson, "Fecal survey of parasites in free-roaming cats in northcentral Oklahoma United States," *Veterinary Parasitology: Regional Studies and Reports*, vol. 14, pp. 50-53, 2018. https://doi.org/10.1016/j.vprsr.2018.08.008

[26] A. Nyambura Njuguna, J. M. Kagira, S. Muturi Karanja, M. Ngotho, L. Mutharia, and N. Wangari Maina, "Prevalence of toxoplasma gondii and other gastrointestinal parasites in domestic cats from households in Thika Region Kenya," *BioMed Research International*, pp. 1-6, 2017. https://doi.org/10.1155/2017/7615810

[27] A. Bakhshani, M. Maleki, A. Haghparast, S. Parande Shirvan, and H. Borji, "A survey on Toxocara cati eggs on the hair of stray cats: a potential risk factor for human toxocariasis in Northeastern Iran," *Comparative Immunology, Microbiology and Infectious Diseases*, vol. 64, pp. 10–13, 2019. https://doi.org/10.1016/j.cimid.2019.02.008

[28] D. Azam, O. M. Ukpai, A. Said, G. A. Abd-Allah, and E. R. Morgan, "Temperature and the development and survival of infective toxocara canis larvae," *Parasitology Research*, vol. 110, no. 2, pp. 649–656, 2012. https://doi.org/10.1007/s00436-011-2536-8

[29] E. R. Morgan, D. Azam, and K. Pegler, "Quantifying sources of environmental contamination with toxocara spp eggs," *Veterinary Parasitology*, vol. 193, no. 4, pp. 390-397, 2013. https://doi.org/10.1016/j.vetpar.2012.12.034

[30] P. F. Pereira, "Gastrointestinal parasites in stray and shelter cats in the municipality of Rio de Janeiro Brazil," *Brazilian Journal of Veterinary Parasitology*, vol. 26, no. 3, pp. 383–388, 2017. https://doi.org/10.1590/s1984-29612017024

[31] N. d. V. Ramos, M. L. E. Silva, M. S. Barreto, L. A. Barros, and F. Mendes-De-almeida, "Endoparasites of household and shelter cats in the city of Rio de Janeiro, Brazil," *Brazilian Journal of Veterinary Parasitology*, vol. 29, no. 1, 2020. https://doi.org/10.1590/s1984-29612019110

[32] O. Farrant et, "Prevalence risk factors and health consequences of soil-transmitted helminth infection on the Bijagos Islands Guinea Bissau: A community-wide cross-sectional study," *PLOS Neglected Tropical Diseases*, vol. 14, no. 12, p. e0008938, 2020. https://doi.org/10.1371/journal.pntd.0008938

[33] Z. K. Alani, H. J. Jasim, H. Barakat, and J. T. O. Al-, "Prevalence and molecular studies of isospora," *In House and Stray Cats at Baghdad Province*, vol. 23, no. 3, pp. 335–343, 2022.

[34] D. A. Kalef and F. A. A.-M. Al-Khayat, "A comparative study of some intestinal parasites in fecal samples of domestic and stray cats in Baghdad Iraq," *Comparative Parasitology*, vol. 89, no. 1, pp. 31-35, 2022. https://doi.org/10.1654/21-00015

[35] E.-M. Zottler, M. Bieri, W. Basso, and M. Schnyder, "Intestinal parasites and lungworms in stray shelter and privately owned cats of Switzerland," *Parasitology International*, vol. 69, pp. 75-81, 2019. https://doi.org/10.1016/j.parint.2018.12.005

[36] D. Traversa and A. D. Cesare, "Cardio-pulmonary parasitic nematodes affecting cats in Europe: Unraveling the past, depicting the present and predicting the future," *Frontiers in Veterinary Science*, vol. 1, no. 10, pp. 1–9, 2014. https://doi.org/10.3389/fvets.2014.00011

[37] P. E. Crisi *et al.*, "Single and mixed feline lungworm infections: Clinical radiographic and therapeutic features of 26 cases (2013–2015)," *Journal of Feline Medicine and Surgery*, vol. 19, no. 10, pp. 1017-1029, 2017. https://doi.org/10.1177/1098612x16670563

[38] V. Lalošević, D. Lalošević, I. Čapo, V. Simin, A. Galfi, and D. Traversa, "High infection rate of zoonotic eucoleus aerophilus infection in foxes from Serbia," *Parasites*, vol. 20, no. 1, pp. 1-5, 2013. https://doi.org/10.1051/parasite/2012003