

Epidemiology and Spatial Distribution of Parasitic Infections in Cats in Malang, East Java, Indonesia: Risk Factors and Public Health Implications

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Abstract

Cats are common companion animals that are susceptible to various parasitic infections, particularly under unsanitary environmental conditions. Apart from transmitting zoonotic infections, infected cats may also suffer from metabolic disorders, malnutrition, anemia, and even death. Fecal, hair, and ectoparasite samples from 170 cats (stray and domestic) were collected from 12 districts in Malang. Statistical tests (Chi-square, OR, and RR) and QGIS-based spatial mapping were employed for data analysis. The findings revealed that 46.4% (79/170) of gastrointestinal endoparasite cases involved *Ancylostoma* spp. (20.6%), *Toxocara cati* (19.4%), *Toxascaris leonina* (7.6%), *Strongyloides* spp. (2.9%), *Dipylidium caninum* (4.1%), *Cystoisospora felis* (5.8%), *Cystoisospora rivolta* (3.5%), and *Toxoplasma gondii*-like oocysts (1.1%). Ectoparasite infestations accounted for 52.9% (90/170), with *Ctenocephalides felis* (50.5%), *Sarcoptes scabiei* (3.5%), *Felicola subrostratus* (1.1%), and *Rhipicephalus sanguineus* (0.5%) being recorded. Risk factor analysis revealed a significant correlation ($p < 0.05$) between lifestyle and the prevalence rates of cat gastrointestinal endoparasite infections and ectoparasite infestations, while sex and altitude showed no significant correlation ($p > 0.05$) with either. The findings of the study bear significance for both human and animal health, highlighting the importance of interdisciplinary collaboration among preventive medicine, veterinary science, and public health, and providing a valuable evidence base to support policy development and targeted intervention programs aimed at controlling zoonotic parasites in companion animals, particularly in urban and peri-urban areas.

Keywords: cat, parasitic disease, risk factor, zoonotic

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INTRODUCTION

Cats, which have become increasingly integral to veterinary medicine, are highly susceptible to various parasitic diseases due to inadequate maintenance and environmental exposure (Adhikari *et al.*, 2023). Gastrointestinal helminths such as *Toxocara cati* and *Ancylostoma* spp. can lead to malnutrition, anemia, and, in severe cases, death, while ectoparasites such as fleas and ticks can cause dermatitis, trigger allergic reactions, and facilitate the transmission of vector-borne pathogens (Fard and Sadeghi, 2024). The zoonotic potential of these parasites, including protozoa like *Toxoplasma gondii* and coccidia like *Cystoisospora rivolta*, raises significant concern, particularly in immunocompromised populations and children

(Chan *et al.*, 2023). Subclinical infections in cats often go unnoticed, making them silent reservoirs of zoonotic agents. Given that over 75% of emerging infectious diseases in humans originate from animals, with felines contributing prominently, feline parasitism remains a critical public and veterinary health issue (Ridwan *et al.*, 2023).

Studies have reported varying prevalence rates of gastrointestinal parasites in cats globally: 41.39% in China, 100% in India, 20.8% in Japan, and 39.8% in Korea (Adhikari *et al.*, 2023; Lee *et al.*, 2019). In Indonesia, prevalence rates also varied: 16% in Banjarnegara, 23.9% in Banyuwangi, 83.3% in Surabaya (Dukuh Kupang), 35% in Bogor (Lia and Soraya, 2022), and 37% in Denpasar (Misa *et al.*, 2022). Wardhani *et al.* (2021) reported a 30% prevalence

rate in Surabaya city at large, and Widhowati *et al.* (2020) discovered prevalence rates of 41.3% and 23.9% for *T. cati* and *Ancylostoma* sp. in traditional markets, respectively. Higher infection rates are more frequently reported in stray cats than in owned ones, particularly in urban settings (Rabbani *et al.*, 2020). These data underscore the widespread and heterogeneous nature of feline parasitism and its relevance to public and animal health management. Complementing these findings, Sawitri *et al.* (2024) reported a prevalence of 37.9% for *Toxocara* sp., 22.4% for *Ancylostoma* sp., and 25.6% for *Uncinaria* sp. in cats in the Jakarta area. Meanwhile, Siswandi *et al.* (2023) found that 35% of hospitalized cats in Surabaya harbored intestinal parasites, including *T. cati*, *Ancylostoma* sp., *Cryptosporidium* sp., and *Isospora* spp. These results confirmed that feline parasitism remains an ongoing concern both in community and in clinical settings.

Despite Malang's dense cat population and favorable climate for parasitic survival, no integrated study has yet addressed both the epidemiology and spatial dynamics of feline parasitism in this area. Located in East Java, Indonesia, Malang is characterized by a tropical climate, high humidity, dense informal settlements, and extensive human–cat interactions, ideal conditions for the persistence and transmission of zoonotic parasites. The city's lack of detailed epidemiological and spatially mapped data hampers targeted veterinary interventions and public health policies. Therefore, this study aimed to determine the prevalence, diversity, associated risk factors, and geographic distribution of gastrointestinal infections and ectoparasitic infestations in domestic and stray cats in Malang. By integrating statistical risk factor analysis with GIS-based spatial mapping, this study provides novel insights into the localized patterns of feline parasitism in tropical urban areas. The findings not only fill a critical data gap for the region but also offer practical guidance for local authorities, veterinarians, and public health officials in developing targeted parasite control programs, optimizing deworming schedules, and designing community-based awareness initiatives.

MATERIALS AND METHODS

Ethical Approval

The Animal Care Committee at Universitas Brawijaya approved the animal ethics protocol with reference number 065-KEP-UB-2023. Despite the use of stray cats, the study ensured adherence to animal welfare standards by providing spacious, clean, and comfortable cages, with constant access to food and water, and making efforts to minimize pain, injury, and diseases.

Study Period and Location

This study employed a qualitative and quantitative cross-sectional design. This research design was selected to provide a snapshot of the prevalence, diversity, and associated risk factors for parasitic infections in cats at a specific point in time, allowing for conducting spatial and statistical analyses without the need for a follow-up. The study was conducted from March to September 2023.

Study Area

This study was conducted in Malang, East Java, Indonesia, including Malang City, Malang Regency, and Batu City, which encompasses 12 districts. Situated at altitudes ranging from 440 to 1,700 meters above sea level, Malang has an average temperature within the range from 22.25°C to 26.00°C and relative humidity within the range from 78.25% to 87.00%. The collected samples were examined at the Parasitology Laboratory, Faculty of Veterinary Medicine, Universitas Brawijaya, Malang, Indonesia.

Study Subjects and Sample Characteristics

The study involved a total of 170 cats, comprising 85 stray cats and 85 domestic cats. Cats of all ages (kittens and adults), sexes (male and female), and various breeds were included. Hair, ectoparasite, and feces samples were collected for examination. The risk factor variables in relation to parasitic infections analyzed were altitude, sex, and lifestyle (stray or owned).

Sample Size and Sampling Procedure

The required sample size (n) was estimated using the infinite population formula, assuming an expected prevalence (Pexp) of 30%, a margin of error of 7%, and a confidence level of 95%. The final sample size was 170. The infinite population formula is used when the population from which samples are extracted is unknown. The study used a non-probability sampling technique, a sampling technique that does not provide equal opportunities for each member of the population to be selected as a sample. It was conducted by the convenience sampling technique, which is based on ease of access, accidental encounter, or available opportunity. However, it is important to note that convenience sampling may introduce selection bias, as the sample may not accurately represent the entire population (Thrusfield *et al.*, 2018).

Data Collection Instruments

Data were collected using a short interview questionnaire, an application, and software. Short interviews regarding domestic cats included questions on the lifestyles of the cats, asking whether they were kept fully indoors, kept semi-outdoors, or living fully outdoors while still provided with water and feed. Google Maps was the application used in collecting data, particularly on coordinate points and altitudes. QGIS version 3.34.3 was the software used to generate maps. Coordinates of the sampling points were integrated into administrative and geo-spatial shapefile layers to generate the maps. The digitized shapefiles of district boundaries, natural feature layers, and administrative borders were sourced from the Indonesian Geospatial Information Agency 2019 version.

Sample Collection and Parasitological Examination

The coordinate point of each cat's location was recorded for mapping purposes. Domestic cats were sampled directly at their owners' residences. In contrast, stray cats were temporarily housed at the researcher's facility for 1–2 days, or until defecation occurred. After sample collection, each stray cat was returned to

the original capture site to ensure ethical handling and minimize environmental disruption. All specimen collection procedures followed ethical guidelines approved by the institutional ethics committee. Fresh fecal samples from each cat were collected and analyzed within a maximum of 24 hours at the Parasitology Laboratory, Faculty of Veterinary Medicine, Universitas Brawijaya. Simultaneously, the entire skin surface of each cat was examined for ectoparasites and dermatological lesions. A modified deep skin scraping technique was performed at the border between lesioned and normal skin areas to prevent capillary bleeding. Skin scrapings were transferred to glass slides, treated with a few drops of 10% potassium hydroxide (KOH), and incubated for 40 minutes at 25°C, following the protocol by Moskvina and Zheleznova (2015). Ectoparasites were identified microscopically using a calibrated Olympus CX-23 microscope (Japan), based on morphological identification keys (Montoya *et al.*, 2018), and subsequently preserved in 70% ethanol.

To detect intestinal parasites, fecal samples were first examined using the direct wet mount method by mixing a small amount of feces with distilled water. This method is useful for detecting motile trophozoites or high-burden infections but has limited sensitivity in low-intensity infections (Abossie *et al.*, 2017). To improve diagnostic sensitivity, a flotation technique was subsequently used. A saturated sodium chloride (NaCl) solution with a specific gravity (SG) of 1.20 was employed, allowing parasite eggs and protozoan oocysts to float for easier identification. The flotation material was transferred onto a glass slide and examined microscopically using a calibrated Olympus CX-23 microscope (Japan). All identified parasites, including both ectoparasites and endoparasites, were validated by expert parasitologists at the Parasitology Laboratory to ensure diagnostic accuracy and reliability. Morphological identification was performed based on standard diagnostic keys and descriptions provided in Taylor *et al.* (2016).

Data Analysis

Descriptive statistics were used to summarize the data, including the morphological characterization of gastrointestinal endoparasites and ectoparasites. IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA) was employed to compute the prevalence of parasitic infections. Bivariate analysis was performed using Chi-square (χ^2) tests to evaluate associations between infection prevalence and categorical variables, such as sex, lifestyle, and altitude of each sampling site. Statistical significance was considered at $p < 0.05$ (Montoya *et al.*, 2018). To estimate the strength of association between potential risk factors and parasitic infections, both Odds Ratios (ORs) and Relative Risks (RRs) were calculated. The OR represents the odds of infections occurring in an exposed group relative to a non-exposed group, while the RR indicates the probability of infections occurring in the exposed group compared to the unexposed group.

RESULTS AND DISCUSSION

Prevalence of Gastrointestinal Endoparasites

The overall prevalence of gastrointestinal endoparasites in cats was 46.4% (79 out of 170), reflecting a considerable parasitic burden in the study population. The most commonly identified

species were *Ancylostoma* spp. (20.6%) and *Toxocara cati* (19.4%), both of which are helminths of major zoonotic concern, particularly due to their roles in cutaneous larva migrans and visceral/ocular larva migrans syndromes in humans. Other detected nematodes included *Toxascaris leonina* (7.6%), which is less commonly associated with zoonoses but still relevant in polyparasitic cases, and *Strongyloides* spp. (2.9%), which has potential zoonotic implications in immunocompromised hosts. The cestode *Dipylidium caninum* was found in 4.1% of cats, often associated with fleas as intermediate vectors. Among protozoa, *Cystoisospora felis* (5.8%) and *Cystoisospora rivolta* (3.5%) were the most frequently encountered, followed by *Toxoplasma gondii*-like oocysts (1.1%), highlighting possible risks to pregnant women and immunocompromised individuals. Double infections were detected in 19 samples, with the most common combinations involving *T. cati* and *Ancylostoma* spp., or *T. cati* and *C. felis*. Triple infections, found in four samples, typically included representatives from each major group: a nematode, a protozoan, and a cestode. These patterns suggest that co-infection is not uncommon and may complicate clinical outcomes. The morphology of each GI parasite is depicted in Figure 1 (A–I).

Table 1. Chi-square, OR and RR tests to determine association and risk factor between endoparasite infection and observed variable in Malang (n = 170)

Variable	Endoparasite infection		p-value	OR	RR
	Positive	Negative			
Gender			0.166	1.533 (0.836–2.811)	1.257 (0.907–1.743)
Male	44	41			
Female	35	50			
Altitude			0.081	2.188 (0.895–5.354)	1.602 (0.880–2.919)
≤700 masl	71	73			
>700 masl	8	18			
Lifestyle			0.009*	-	-
Stray	48	37			
Owned	31	54			

*indicates significant association (p -value < 0.05).

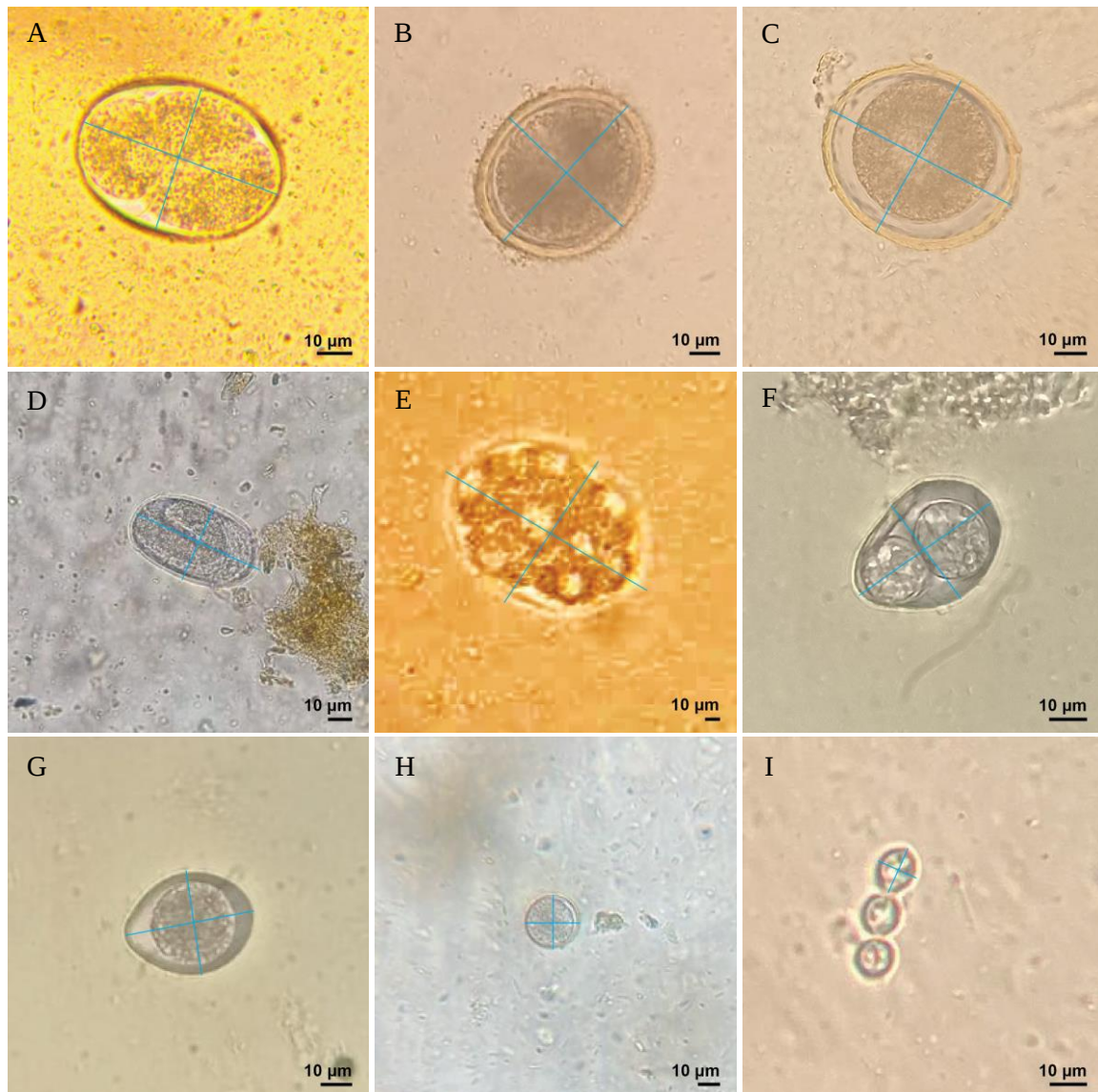
Table 2. The frequency and prevalence of each parasite, whether endo- or ectoparasite, categorized by gender, altitude of location, and lifestyle

Parasite	Gender		Altitude		Lifestyle		Prevalence
	Female (n = 85)	Male (n = 85)	>700 masl*	<700 masl*	Pet (n = 85)	Stray (n = 85)	
Endoparasite							
<i>Ancylostoma spp.</i>	13	22	30	5	8	27	35(20.6%)
<i>Toxocara cati</i>	13	20	23	10	10	23	33 (19.4%)
<i>Toxascaris leonina</i>	5	8	10	3	4	9	13 (7.6%)
<i>Strongyloides spp.</i>	4	1	3	2	2	3	5 (2.9%)
<i>Dipylidium caninum</i>	4	3	7	0	5	2	7 (4.1%)
<i>Cystoisopora felis</i>	3	7	9	1	3	7	10 (5.8%)
<i>Cystoisospora rivolta</i>	3	3	4	2	2	4	6 (3.5%)
<i>Toxoplasma gondii</i> -like oocyst	0	2	2	0	2	0	2 (1.1%)
Ectoparasite							
<i>Ctenocephalides felis</i>	42	43	56	29	24	61	85 (50.5%)
<i>Sarcoptes scabiei</i>	3	3	6	0	2	4	6 (3.5%)
<i>Rhipicephalus sanguineus</i>	0	1	0	1	1	0	1 (0.5%)
<i>Felicola subrostratus</i>	1	1	1	1	0	2	2 (1.1%)

*masl: meters above sea level.

Table 3. Chi-square, OR and RR tests to determine association and risk factor between ectoparasite infection and observed variable in Malang (n = 170)

Variable	Ectoparasites Infection		p-value	OR	RR
	Positive	Negative			
Gender			0.431	1.76	2.2
Male	48				
Female	46				
Altitude			0.463	0.688	0.850
≤700 masl	79	73			
>700 masl	11	7			
Lifestyle			0.000	-	-
Stray	67	18			
Owned	26	59			



Figures 1. Eggs and oocysts of gastrointestinal parasites in fecal samples from cats in Malang, East Jawa, Indonesia. (A) Egg of *Ancylostoma* spp. (B) Egg of *Toxocara cati*. (C) Egg of *Toxascaris leonina*. (D) Egg of *Strongyloides* sp. (E) Egg of *Dipylidium caninum*. (F) Sporulated oocysts of *Cystoisospora felis*. (G). Unsporulated oocyst of *Cystoisospora felis*. (H). Unsporulated oocyst of *Cystoisospora rivolta*. (I) Oocyst-like *Toxoplasma gondii* (Floating and direct smear of feces examination).

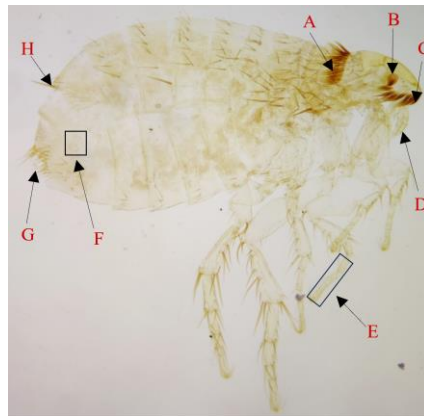


Figure 2. The morphology of *Ctenocephalides felis* (female); (A) prenatal comb, (B) eye, (C) Genal comb, (D) Maxillary comb, (E) Planar bristles, (F) Spermatheca, (G) Pygidium, and (H) Antepygidial bristles (observed with a light microscope with magnification 40×).



Figure 3. The morphology of *Ctenocephalides felis* (male); (A) aedeagus (observed with a light microscope with magnification 40×).



Figure 4. The morphology of *Sarcoptes scabiei* (observed with a light microscope with a magnification 100×).

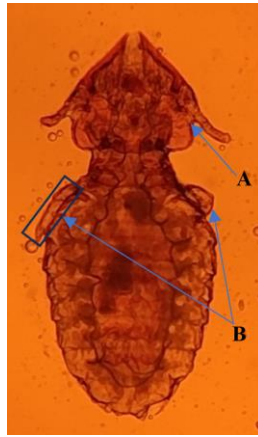


Figure 5. The morphology of *Felicola subrostratus*. (A) The characteristic triangular head is oriented forward, and (B) the short legs terminate in a solitary claw. (observed with a light microscope with a magnification 100×).

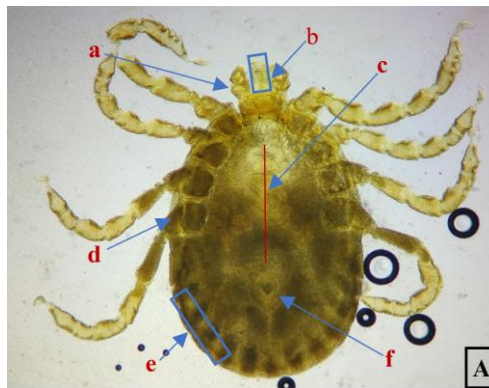


Figure 6. The morphology of *Rhipicephalus sanguineus* (a) calyces, (b) hypostome, (c) scutum, (d) spiracles, (e) feston, (f) anus. Image B, (g) capitulum (observed with a light microscope with magnification 40×).

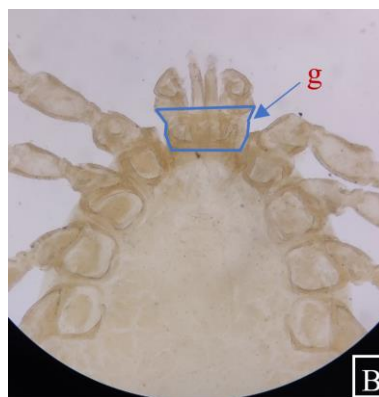
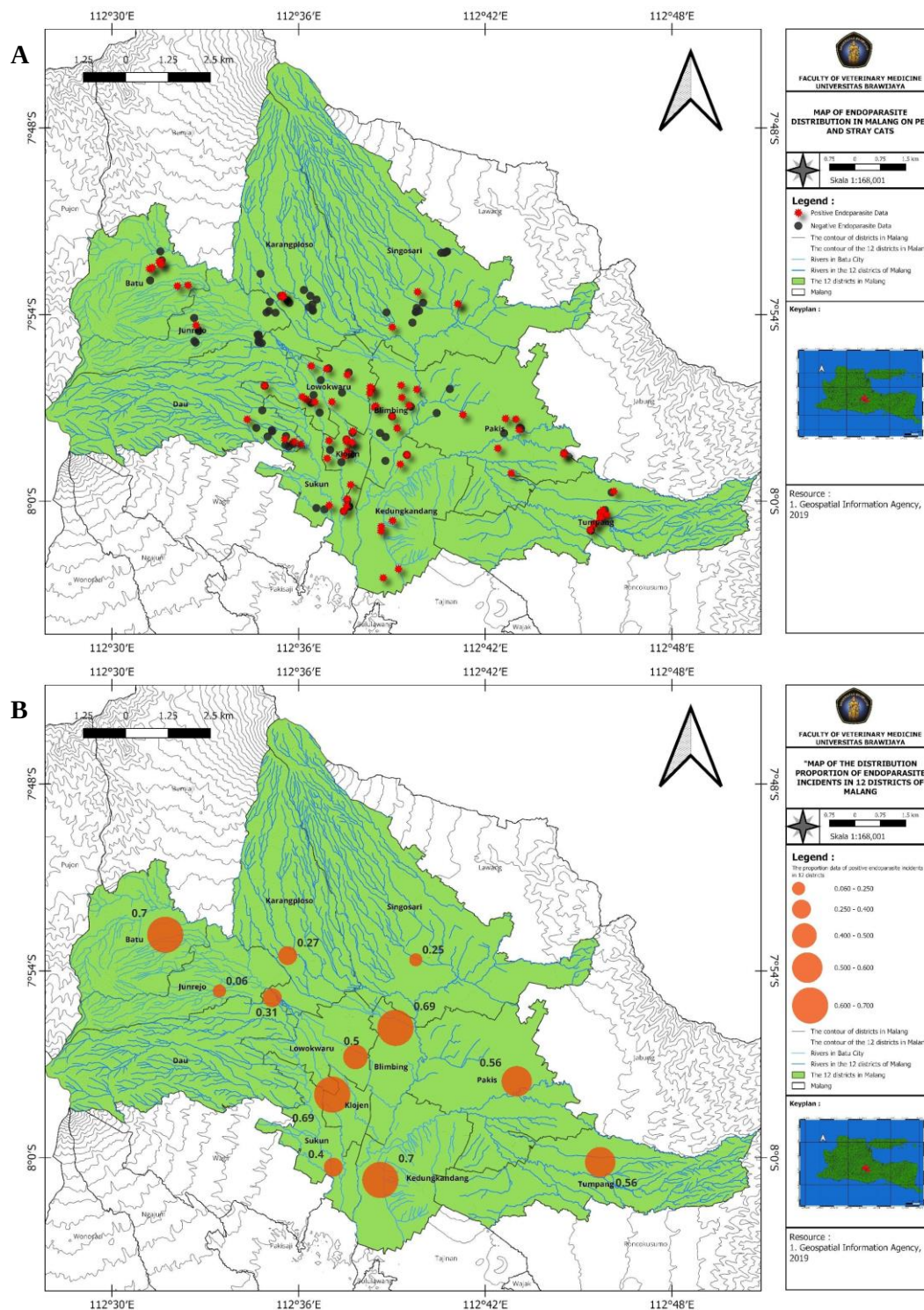


Figure 7. The morphology of Anterior part *Rhipicephalus sanguineus*. (g) capitulum (observed with a light microscope with magnification 40×).



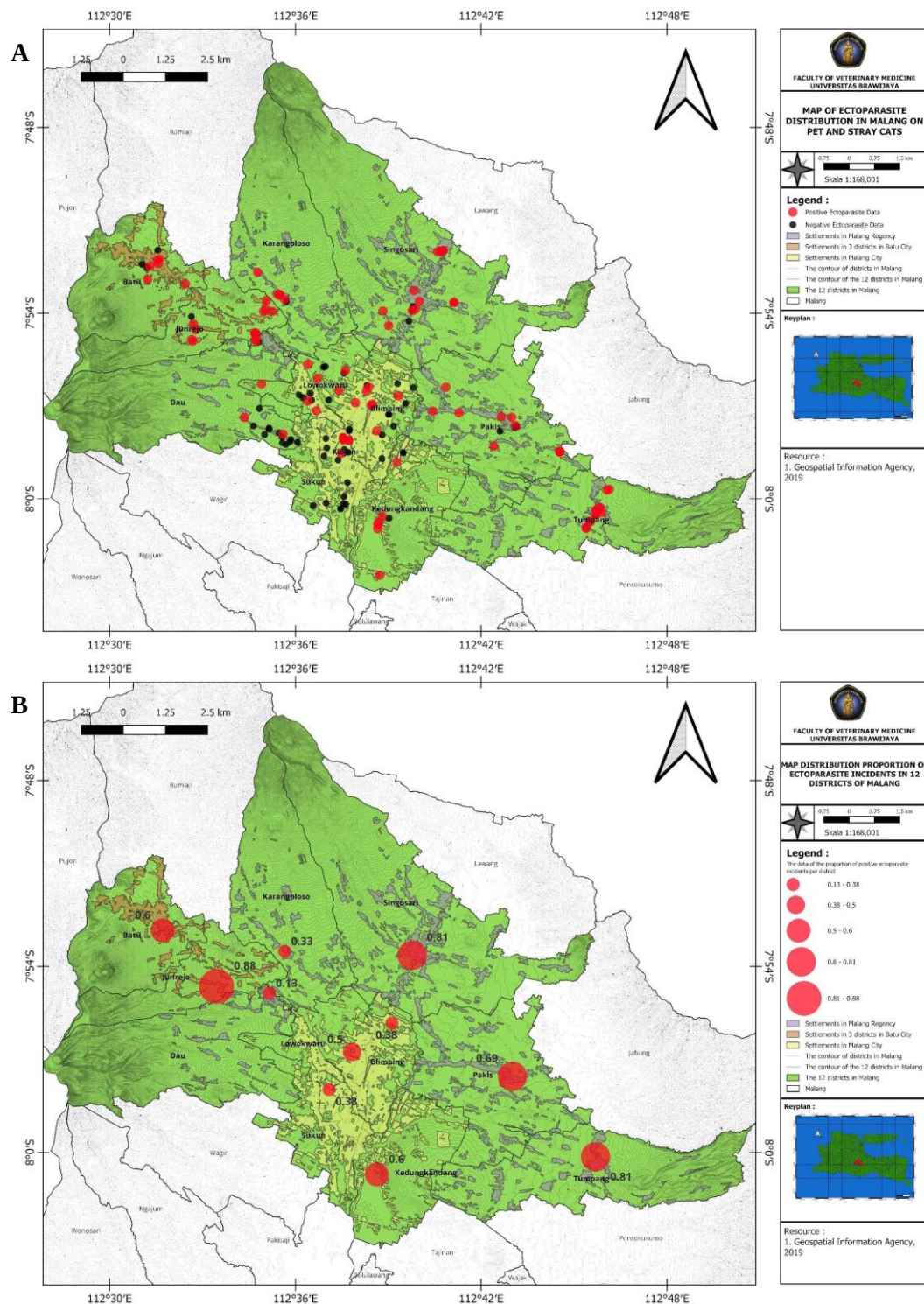


Figure 9. (A) Map showing the distribution of ectoparasite infestation of cat in Malang based on 12 subdistricts. (B) Map of proportion values for ectoparasite diseases based on 12 sub-districts in Malang, East Java, Indonesia.

Risk Factors for Endoparasites

Among the infected cats, 25.8% (44/170) were male and 20.5% (35/170) were female. Although the Chi-square test results showed no statistically significant association ($p = 0.166$), the odds ratio (1.533) and relative risk (1.257)

suggest a possible trend toward a higher infection risk in males. This may be biologically explained by male cats' wider territorial ranges and increased roaming behavior, which elevate their chances of encountering contaminated environments or intermediate hosts.

No statistically significant relationship was found between altitude and endoparasite infection ($p = 0.081$). However, cats living at elevations ≤ 700 meters above sea level (masl) exhibited higher infection likelihood (OR = 2.188, RR = 1.602). These areas tend to have higher humidity and temperature stability, conditions favorable for parasite egg or larval development.

Cat lifestyle was strongly associated with endoparasite infection ($p = 0.009$). Stray and outdoor cats exhibited a 28.2% infection rate compared to 18.2% in domestic cats. This trend aligned with increased exposure to contaminated environments and lack of regular deworming in non-owned cats. More detailed categorization in future studies, such as fully indoor, semi-outdoor, and free-roaming cats, could yield more nuanced risk profiles. The p -values, ORs, and RRs obtained in this study can be seen in Table 1.

Prevalence of Ectoparasites

The ectoparasite prevalence in this study was 52.9% (90 out of 170), indicating a slightly higher overall burden than the burden caused by gastrointestinal endoparasites. *Ctenocephalides felis* (50.5%) was the predominant species, consistent with its global distribution as a common flea of cats and its role in transmitting *Dipylidium caninum*. Other identified species included *Sarcoptes scabiei* (3.5%), which causes mange; *Felicola subrostratus* (1.1%), a louse species typically found in neglected or long-haired cats; and *Rhipicephalus sanguineus* (0.5%), a tick with potential to transmit vector-borne pathogens. Double infestations, primarily involving *C. felis* and *S. scabiei*, were recorded in five cats. Details of these findings are presented in Table 2. The morphology of each ectoparasite is depicted in Figure 2–7.

Risk Factors for Ectoparasites

Of the cats with ectoparasite infestations, 28.2% were male and 27.1% were female. No significant sex-based association was found ($p = 0.431$). Nevertheless, the odds ratio (1.76) and relative risk (2.20) again suggest a behavioral predisposition among males toward greater exposure due to roaming.

Unlike endoparasites, ectoparasite prevalence was not significantly influenced by altitude ($p = 0.463$). Interestingly, the direction of the association was reversed: cats found below 700 meters above sea level had a slightly lower infestation risk (OR = 0.688, RR = 0.85), suggesting that microclimatic factors or anthropogenic influences (e.g., housing density and pet ownership rates) may override altitude-based effects.

Lifestyle was a significant determinant of ectoparasite burden ($p = 0.000$). Stray and outdoor cats made up 39.4% of ectoparasite-positive cases, while only 15.3% were from indoor cats. Stray cats had almost four times the risk of infestation (OR = 3.952, RR = 1.91), reflecting both increased exposure and lack of regular grooming or preventive treatment. The p -values, ORs, and RRs obtained in this study can be seen in Table 3.

Geographical Distribution and Environmental Correlations

Kedungkandang and Batu districts had the highest incidence rates of gastrointestinal endoparasite infections (11 cases each), followed by Blimbing and Klojen (seven each). Junrejo district had the lowest incidence, with only one case. These patterns correspond to the distribution of densely populated, lower-income urban zones, where sanitation and veterinary access are often limited (Figure 8).

Junrejo had the highest number of ectoparasite infestation cases, followed by Tumpang and Singosari. Sukun district had no detected infestations. This inverse relationship compared to endoparasite distribution may reflect environmental differences in aspects such as vegetation cover, stray animal density, and local climate. For example, Junrejo's semi-rural character and outdoor animal housing may support ectoparasite reproduction (Figure 9).

Spatial and Environmental Considerations

Spatial mapping revealed clustering of parasite-positive cases in specific urban and peri-urban zones. Although this study did not integrate environmental layers, future analyses could

benefit from overlaying parasite data with temperature, rainfall, population density, and land use data. Such analyses would enable deeper understanding of ecological niches for each parasite type. Additionally, multivariate analysis is recommended to control for confounding variables and to determine the relative contribution of lifestyle, altitude, and sex to overall infection risk.

This study revealed a high burden of parasitic infections in both stray and domestic cats in Malang, Indonesia. Gastrointestinal endoparasites were detected in 46.4% (79/170) of cats, while ectoparasites were found in 52.9% (90/170). Among endoparasites, *Ancylostoma* spp. (20.6%, 35/170) and *Toxocara cati* (18.9%, 32/170) were the most prevalent, indicating a substantial zoonotic risk. For ectoparasites, *Ctenocephalides felis* was the dominant species, infesting 50.5% (86/170) of cats. These findings align with existing data from other regions, such as Bali (Subrata *et al.*, 2017) and China (Yang and Liang, 2015), underscoring the local significance of parasitic infections and the need for targeted control strategies. The warm, humid tropical climate of Malang provides favorable conditions for the survival and transmission of parasites in the environment (Bonilla-Aldana *et al.*, 2024). *Dipylidium caninum* was found in 4.1% (7/170) of fecal samples, although no segments were macroscopically observed, likely due to the intermittent shedding of proglottids (Rousseau *et al.*, 2022). Additionally, protozoan infections were recorded, including infections with *Cystoisospora felis* (5.8%, 10/170), *Cystoisospora rivolta* (3.5%, 6/170), and *Toxoplasma*-like oocysts (1.1%, 2/170). While these oocysts resemble *Toxoplasma gondii*, their morphology is also consistent with *Hammondia hammondi*. Given the zoonotic implications of *T. gondii*, especially in pregnant women, children, and immunocompromised individuals, further molecular confirmation using PCR or qPCR is strongly recommended to distinguish between the two species (Schaes *et al.*, 2021).

When interpreting environmental risk factors, no significant association was found between altitude and endoparasite prevalence,

even though the study area covered elevations from 440 to 1,700 meters above sea level. This suggests that, within the diverse microclimatic range in Malang, elevation alone does not drive infection rates, likely due to relatively consistent temperature and humidity. However, future studies using microclimate data (e.g., soil moisture, local temperatures) could offer more nuanced insights (Zhu *et al.*, 2023; Blasco *et al.*, 2021; Lia and Soraya, 2022). Similarly, no significant difference was observed between male and female cats in terms of parasitic infection, consistent with previous studies in Russia (Moskvina and Zheleznova, 2015) and Switzerland (Zottler *et al.*, 2019). This suggests that sex might not be a key determinant in parasite transmission in this population. However, the potential behavioral patterns of male cats, with an increased roaming range, still warrant further investigation.

The strongest association was identified between the cat's lifestyle and endoparasitic infection. Stray cats exhibited markedly higher infection rates than domestic cats. This pattern supports the hypothesis that free-roaming behavior and exposure to unsanitary environments elevate the risk of ingesting infective oocysts or helminth eggs. Soil contact, feces burying, and rodent hunting contribute significantly to this risk, especially for parasites like *T. cati* and *Ancylostoma* spp. (Taetzsch *et al.*, 2018; Firdausy *et al.*, 2025). Public education on responsible pet ownership and stray cat management could help reduce transmission to humans and other animals.

Regarding ectoparasites, flea infestation was the most common, with *C. felis* detected in over half the sampled cats (50.5%, 86/170). Environmental factors such as humidity and temperature were key contributors to flea proliferation (Seidi *et al.*, 2025). In contrast, *Rhipicephalus sanguineus* and *Felicola subrostratus* were rare (0.5% and 1.1%, respectively), consistent with global trends where flea infestations are generally more frequent than lice or tick infestations in cats (Sánchez-Montes *et al.*, 2023). *Sarcoptes scabiei*, the causative agent of sarcoptic mange, was detected in 3.5%

(6/170) of the study population. Although this prevalence rate appears lower than the figures reported in other Indonesian veterinary clinics, it remains a relevant public health concern due to the parasite's high transmissibility and zoonotic potential. A previous study conducted at the East Java Animal Hospital reported a higher prevalence of 5.62% among cats (Ramadhanty *et al.*, 2024), while an even higher rate of 33.19% was recorded in clinical cases at the Pemalang Animal Health Center (Qudsiyati *et al.*, 2022). The variation in prevalence may reflect differences in geographic distribution, clinical surveillance intensity, and animal population characteristics. Despite the relatively low prevalence observed in this study, the identification of *S. scabiei* in domestic cats underscores the importance of regular dermatological screening and early intervention, particularly in environments with high animal density. Mites survival in moist environments and transmission via close contact reinforce the importance of hygiene and veterinary access, particularly in shelters and multi-cat households (Arlian *et al.*, 2017).

Spatial mapping revealed parasite-positive cats in all the 12 districts surveyed, particularly in urban areas and slum-like environments. Mapping outcomes illustrate that infection hotspots are associated with higher human and stray cat densities, as observed in Kedungkandang, Batu, and Blimbing. These areas may require prioritized intervention due to their role in maintaining parasitic transmission cycles. Importantly, the identification of zoonotic parasites such as *T. cati*, *Ancylostoma* spp., and *T. gondii*-like oocysts raises significant public health concerns. These parasites are known to cause visceral larva migrans, ocular larva migrans, cutaneous larva migrans, and toxoplasmosis in humans. Vulnerable populations, including children, pregnant women, and immunocompromised individuals, are particularly at risk (Bayou *et al.*, 2024; Wierzbowska *et al.*, 2020). Additionally, ectoparasites like *C. felis* can transmit zoonotic agents such as *Bartonella henselae* (cat scratch disease) and *Rickettsia felis* (murine typhus),

while *R. sanguineus* may carry *Ehrlichia* spp. and other tick-borne pathogens (Geeraedts *et al.*, 2022). These risks reinforce the urgent need for routine veterinary screening, effective parasite control, and public awareness campaigns to mitigate zoonotic transmission and safeguard community health.

CONCLUSION

This study provides a comprehensive overview of the prevalence, diversity, and spatial distribution of gastrointestinal infections and ectoparasitic infestations in both stray and domestic cats in Malang, East Java. Ectoparasitic infestations were more dominant, with a prevalence of 52.9%, compared to 46.4% for gastrointestinal endoparasite infections. *Ctenocephalides felis* (50.5%) was the most frequently detected ectoparasite, while *Ancylostoma* spp. (20.6%) and *Toxocara cati* (19.4%) were the most common gastrointestinal parasites. A significant association was observed between the cat husbandry system and endoparasitic infection rates, highlighting the influence of lifestyle, with a particularly prominent difference between stray and owned cats, on parasitic transmission. In contrast, sex and altitude did not show significant associations with either ectoparasitic infestations or endoparasitic infections. Given these findings, improvement of parasite control measures should focus on targeted deworming programs, stray cat population management, and enhancing hygiene in cats' living environments. Most importantly, raising public awareness must be emphasized as a core component of preventive strategies. By integrating spatial analysis with epidemiological data, this study contributes novel and practical insights for developing evidence-based veterinary health policies and One Health approaches to reducing zoonotic risks in urban ecosystems.

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AUTHORS' CONTRIBUTIONS

RY contributed to conceptualization, methodology, investigation, manuscript preparation, revision, and secured funding. HBP was involved in data analysis, sampling, manuscript preparation, and revision. ADR contributed to data analysis, sampling, manuscript preparation, and revision. DRPP participated in data analysis, sampling, and revision. SKR contributed to methodology and data analysis. All authors have read and approve the final manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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