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A STUDY ON ECTOPARASITES INFESTING DOMESTIC CATS IN GIZA GOVERNORATE, EGYPT

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Received: 3 March 2024; **Accepted:** 18 May 2024

ABSTRACT

Cats, as widely embraced companions in diverse environments, face significant health threats due to infection by ectoparasites. The present study investigates the prevalence of ectoparasite infestations in domestic cats (*Felis catus*) in Giza Governorate, Egypt. Spanning from December 2022 to November 2023, the study included 400 samples of diverse feline populations. Fleas and ear mites were detected in 20.75% and 11.25% of the examined cats, respectively. While ticks and myiasis were observed in 0.5% for each. Clinical manifestations and morphological structures of the detected parasites were documented. Moreover, the research integrates molecular characterization, utilizing the COI gene for *Sarcophaga* species identification. The study also analyzed risk factors, adjusting for age, sex, and season, revealing variations in infestation rates. Cats under one year old exhibited the highest infestation rate (48.35%). Seasonal variation showed the highest prevalence in autumn, followed by summer and winter, with a decline in spring. This survey study provides valuable insights into ectoparasite infestations in domestic cats to serve as a pivotal step toward promoting cat welfare and safeguarding public health.

Keywords: Cats, Ectoparasites, Fleas, Mites, Ticks, Myiasis, COI gene, Egypt.

INTRODUCTION

Cats are widely popular pets that live in various habitats, including domestic, urban, suburban, and rural environments (Fardell *et al.,* 2021). However, these feline companions are susceptible to several parasitic infestations, which can significantly affect their well-being and cause various health issues and discomfort (Bezabh *et al.,* 2022). The presence of ectoparasites in cats not only compromises their welfare, but also poses potential risks to human health (Liguori *et al.,* 2023). Ectoparasites like fleas, mites, and ticks not only cause itching, skin irritation, hair loss, anemia and allergic reactions in cats but also transmit pathogens (Azarm *et al.,* 2023). Moreover, Myiasis is another parasitic disorder of significant

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importance in cats. This serious phenomenon is reported in developing countries and rural areas (Scholl *et al.,* 2019). Myiasis can affect cats of any age or breed, with a higher incidence in warm regions with unhygienic environments, leading to varying degrees of damage and discomfort (Pezzi *et al.,* 2021 and Ribeiro Campos *et al.,* 2021).

The larvae of dipteran families, such as Sarcophagidae and Muscidae can transmit different pathogens and cause myasis, involving the active feeding of these larvae on the host tissues (Ayalon *et al.,* 2020). Detection of the cause of myiasis is crucial for effectively managing this condition and minimizing the harm inflicted by larvae (Ribeiro Campos *et al.,* 2021). In this respect, the mitochondria-encoded cytochrome C oxidase subunit I (coxI) gene has emerged as a pivotal candidate gene for the molecular identification of flies (Kim *et al.,* 2020 and Talebzadeh *et al.,* 2020). The universal presence of this gene in mitochondria, coupled with the ease of amplification and sequencing, has facilitated the development of comprehensive DNA databases that aid in the accurate identification of flies (Ghosh *et al.,* 2022). Currently, coxI is the most widely used genetic marker for differentiating Diptera species (Fuentes-Lopez *et al.,* 2020).

In recent years, research on the prevalence and distribution of endo- and ectoparasite infections in cats has gained significant attention (Genchi *et al.,* 2021). Cats living in different environments, such as indoor-only cats or those with access to outdoor environments, may be exposed to varying levels of parasitic infestations. Additionally, the geographical area of residence has been found to affect the prevalence and diversity of parasites (Chalkowski *et al.,* 2019).

The objective of the present study is to provide a comprehensive understanding of the national situation regarding feline ectoparasites in Giza Governorate, Egypt, by evaluating the overall prevalence and distribution of these parasites. These findings will contribute to establishment of effective control strategies and preventive measures against feline parasitic infestations in Egypt. Ultimately, this study will play a pivotal role in ensuring the well-being and overall health of cats in the studied locality.

MATERIALS AND METHODS

1. Study area and sampling design

This study was conducted in Giza Governorate, Egypt. The samples were collected from all available cats in Gornmental and some private Veterinary clinic representing the target area of the study. A total of 400 various types of housed cats (*Felis catus*) were examined; 196 were males, while the remaining 204 were females. The age range of the examined cats was quite diverse, spanning from 14 days to 17 years. While their weight was varying between 350 grams and 4 kilograms. The body condition score of the cats showed a spectrum from emaciated to overweight, providing a comprehensive representation of the feline population under investigation.

2. Parasites collection, preparation and identification

Sampling for the study was carried out at the clinic of the Faculty of Veterinary Medicine, Cairo University from December 2022 to November 2023. Detailed inspection of the entire body surface face, ears, and nails performed for detection of external parasites or skin lesions. Moreover, a clean stainless steel fine-toothed comb was used for the fleas' collection. Furthermore, careful attention had been paid to identifying the potential symptoms associated with parasitic diseases (Sparkes and Noli, 2020).

The collected ectoparasites were preserved in 70% ethanol in labeled glass containers, and then transmitted to the laboratories of the Department of Parasitology, Faculty of Veterinary Medicine, Cairo University. The detected parasites were mounted on slides and examined using an Olympus BX43F

Microscope, Tokyo163-0914, Japan. to be identified and morphologically characterized according to Soulsby (1982), Giangaspero *et al.* (2017) and Colella *et al.* (2020).

3. Handling of dipteran larvae

Macroscopic examination of the body of some examined cats revealed the presence of skin lesions with larvae. The detected larvae were collected and preserved as previously for identification and further investigations. Some living larvae were brought to the laboratories of the Department of Parasitology, Faculty of Veterinary Medicine, Assiut University to be reared into adults, according to Singh *et al.* (2012). They were placed in polyethylene boxes, fed with 90 g of ground beef, and kept at 25 ± 2°C, 50% relative humidity, and 16/8 (L/D) photoperiod. The emerged adult flies were collected and identified, according to Soulsby (1982).

4. Molecular Characterization of the Emerged *Sarcophaga* Using COI Gene

For extraction of the genomic DNA from the ethanol-preserved flies, the QIAamp DNA Mini Kit (Catalogue no. 51304) was utilized according to the manufacturer's instructions. Anumber of XXXXX flie samples were used for identification. COI gene was amplified with the primer pairs (5′-GGTCAACAAATCATAAAGATATTGG-3′) as the forward primer and (5′-TAAACTTCAGGGTGACCAAAAAATCA-3′) as the reverse primer (Talebzadeh *et al.*, 2020). PCR was performed with a total reaction volume of 25 µl. For amplifying the target gene, the initial primary denaturation was at 94°C for 5 minutes, followed by secondary denaturation at 94°C for 30 seconds, annealing at 48°C for 40 seconds, and extension at 72°C for 45 seconds. This cycling process was repeated 35 cycles, with a final extension step at 72°C for 10 minutes. The obtained PCR product underwent separation on a 1.5% agarose gel using electrophoresis, and then was visualized and captured using a UV radiation detector to confirm successful amplification (Sambrook, *et al.*, 1989).

The PCR products were purified using the QIAquick PCR Product Extraction Kit from Qiagen Inc., Valencia CA. Positive clones were identified by PCR and selected for sequencing using (ABI, 3130, USA) sequencer. The obtained sequences were analyzed and compared to existing sequences available in GenBank using the NCBI BLAST program, and then recorded in GenBank (Giordani *et al.,* 2023).

5. Phylogenetic analysis

Phylogenetic analysis was performed by the neighbor-joining method (Thompson *et al.,* 1994). The CLUSTAL W multiple sequence alignment program (version 12.1 of the MegAlign module), and the Lasergene DNAStar software Pairwise (Madison, Wisconsin, USA) were employed for sequence comparison. Evolutionary analyses were conducted using MEGA 11 (Tamura *et al.,* 2013).

6. Statistical analysis

For the statistical analysis of the data in the present study, several methods were employed, according to (Chan, 2003). The chi-square test was used to examine the association between the risk factors (age, gender, and season) and the occurrence of ectoparasite infestations in cats. The prevalence of the detected ectoparasites was calculated by dividing the number of infested cats by the total number of examined cats, and expressed as a percentage. The prevalence of mixed infections (dual and triple) was also calculated. To determine the significance of the associations and prevalence rates, p-values were calculated. A p-value of ≤ 0.05 was considered statistically significant, indicating a strong association between the risk factors and the occurrence of ectoparasite infestations in cats.

7. Approval for Ethical Conduct

The present study was performed following the guidelines demonstrated by the Ethical Committee of the Faculty of Veterinary Medicine, Assiut University, Egypt, with (06/2023/0117) ethical approval number.

RESULTS

1. Prevalence of ectoparasite infestations in domestic cats in Giza Governorate

As shown in Table (1); inspection of 400 domestic cats revealed that the overall infestation rate was ٤٦,٠% (184 out of 400 cats). Only 54.0% (216 out of 400 cats) were found to be free from ectoparasites. Single infestations were identified in 32.0% of the cases (128/400). Additionally, mixed infestations were observed in 14.0% (56/400) of the cases examined. Among these, 13.0% (52/400) presented with a combination of fleas and ear mites. Furthermore, triple infestations were detected in 1.0% (4/400) of the examined cases. Statistical analysis revealed that the comparison between infested and non-infested populations exhibited a significant difference in infestation prevalence ($P \leq 0.05$).

Table 1: Prevalence of ectoparasite infestations in the examined Cases.

Infection Type	Number of Cases	Prevalence	p.value
Single	128/400	32.0%	
Mixed (Dual)	52/400	13.0%	
Mixed (Triple)	4/400	1.0%	
Total infestation	184/400	46.0%	≤ 0.05
Total non- infested	216	54.0%	

Statistically Significant $P \leq 0.05$

2. Risk factors of the detected ectoparasites in the examined cats with consideration to age, sex, and season

The data in Table (2) demonstrated the prevalence of the detected ectoparasites in the infested cats. Among the observed ectoparasites, fleas were the most prevalent, accounting for 20.75% (83 out of 400 cats). Followed by ear mite infestations, which were observed in 11.25% (45 out of 400 cats). But, 13.0% (52 out of 400 cats) were found flea infestation mixed with ear mite infestation. Also, the infestation with fleas and mites was 13.0% (52/400). While ticks and myiasis were observed with fleas and mites in only 0.5% (2 out of 400 cats) for each.

In addition, the research study explored the prevalence of various infestations based on age, sex, and season. Among individuals aged less than 1 year, the total infestation was 48.35%, fleas were found in 32.97% and ear mites in 28.57%, with lower occurrences of ticks and myiasis (0.55% for each). For those aged 1-3 years, the total infestation was 46.72%, fleas were slightly more prevalent at 40.18%, along with 27.68% for ear mites, and slightly higher rates of ticks and myiasis (0.89% for each). Individuals older than 3 years, the total infestation was 40.36%, exhibited a prevalence of 35.42% for fleas and 18.75% for ear mites, with no reported cases of ticks or myiasis.

The association between sex and infestation revealed that among the examined male cats (Tom), the total infestation was 47.45%, the prevalence of fleas was 36.22%, ear mites 25.51%, and myiasis 0.51%, with no observed ticks. While the examined female cats (Queen) had 44.61% total infestation. They exhibited a slightly lower prevalence of flea infestation (33.33%) and ear mites (25.0%), along with 0.98% for ticks and 0.49% for myiasis.

Analyzing the relationship between the ectoparasite infestation and seasons revealed variations. As in spring, the total infestation was 37.0%, the fleas were prevalent in 33.0%, ear mites in 19.0%, and myiasis in 1.0%, with no ticks. Summer showed a decrease in flea infestation (27.0%) and an increase in ear mites infestation (29.0%), along with a 1.0% prevalence for both ticks and myiasis. Also, the total infestation was 47.0%. Autumn has total infestation 54.0%. As same as, exhibited a prevalence of 34.0% for fleas, 33.0% for ear mites, and 1.0% for ticks, with no reported myiasis. Moreover, winter showed an increase in flea prevalence (45.0%) and a decrease in ear mites (20.0%), with no observed ticks or myiasis infestation. That recorded 46.0% total infestation rate.

Statistical analysis, including p-values, indicates a potential association between age and ear mites infection (p-value = 0.072). Conversely, there is no significant association between sex and the detected infestation. Regarding season, there is a marginal significance, with a possible association noted for fleas and ear mites (p-value = 0.06).

Table 2: Prevalence and risk factors of the detected ectoparasites in the examined cats.

Risk Factors / Infestation	Age			Sex		Season				Prevalence
	> 1 year (n=182)	1-3 years (n=122)	< 3 years (n=96)	Tom (n=196)	Queen (n=204)	Spring (n=100)	Summer (n=100)	Autumn (n=100)	Winter (n=100)	
Fleas	36 (19.78)	26 (21.31)	21 (21.88)	43 (21.94)	40 (19.61)	18	18	21	26	83 (20.75)
p.value	0.771			0.907		0.059				
Ear mites	28 (15.38)	12 (9.84)	5 (5.21)	22 (11.22)	23 (11.27)	4	20	20	1	45 (11.25)
p.value	0.072			0.554		0.059				
Fleas+Ear mites	22 (12.09)	17 (13.93)	13 (13.54)	27 (13.78)	25 (12.25)	14	7	12	19	52 (13.0)
p.value	0.422			0.554		0.059				
Fleas+Ear mite+Ticks	1 (0.55)	1 (0.82)	0	0	2 (0.98)	0	1	1	0	2 (0.5)
p.value	0.690			0.165		0.570				
Fleas+Ear mites+ Myiasis	1 (0.55)	1 (0.82)	0	1 (0.51)	1 (0.49)	1	1	0	0	2 (0.5)
p.value	0.690			0.977		0.570				
Total infestation	88 (48.35)	57 (46.72)	39 (40.63)	93 (47.45)	91 (44.61)	37	47	54	46	184 (46.0)
p.value	0.771			0.544		0.059				

3. Clinical manifestations and morphological characters of the detected ectoparasites

3.a. Fleas

Cats infested with fleas appeared suffering from different degrees of emaciation, hair loss, and scales. Moreover, there were small dark brown specks on the infested cats' fur (Fig.1). Fleas appeared as medium to dark brown insects, which could be seen by naked eyes with small laterally compressed and wingless. Adult cat fleas (*Ctenocephalides felis*) measure between 1 and 4 mm in length and have a laterally flattened wingless body with triangular head and pronotal and genal comb. The thorax has three pairs of legs. The abdomen of the male flea has two claspers (Fig.2).

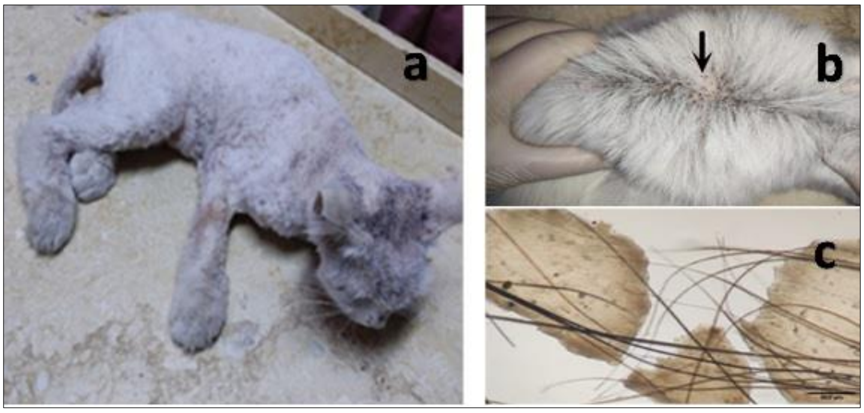

Figure 1: a) Showing signs of emaciation and hair loss. b) Fleas' fecal matter appears as small black or dark brown specks on the cat's fur. c) Close-up view of scales on the skin of the infested cat (x4).

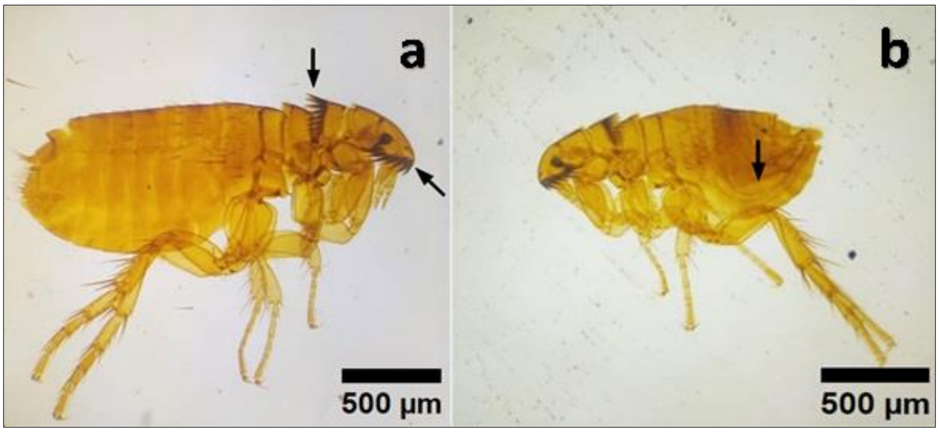

Figure 2: Showing morphological and microscopic appearance of adult fleas from the infested cats. a) Illustration of an adult female (*Ctenocephalides felis*) showing genal and pronotal combs (x4). b) Showing adult male flea with two claspers (x4).

3. b. Mites

Cats infested with ear mites showed various intense itching and scratching, which led to redness, inflammation, self-inflicted injuries, and wounds in the ear area. Also, dark, waxy discharges within the ear canal, which are similar to coffee grounds were observed during a visual examination of the ears (Fig. 3). Different stages of ear mite (*Otodectes cynotis*) were observed after the microscopical examination. The eggs are white 166-206 µm long, ellipsoidal and slightly flattened in one side. The body of the detected ear mites is rounded to oval in shape and covered with scales or hair. Female mites are usually larger than males (females: 250–400 µm long, males: 150–180 µm). The last pair of legs is reduced in the female. While the male has copulatory organs. Adult mites and nymphs have four pairs of legs, while the larvae have only three pairs (Fig.4).

Figure 3: Showing a cat infested with *Otodectes cynotis* with various clinical signs including: a) The presence of dark, crumbly discharge in the infested cat's ear canal. b) Redness, inflammation, and injuries in the affected ear.

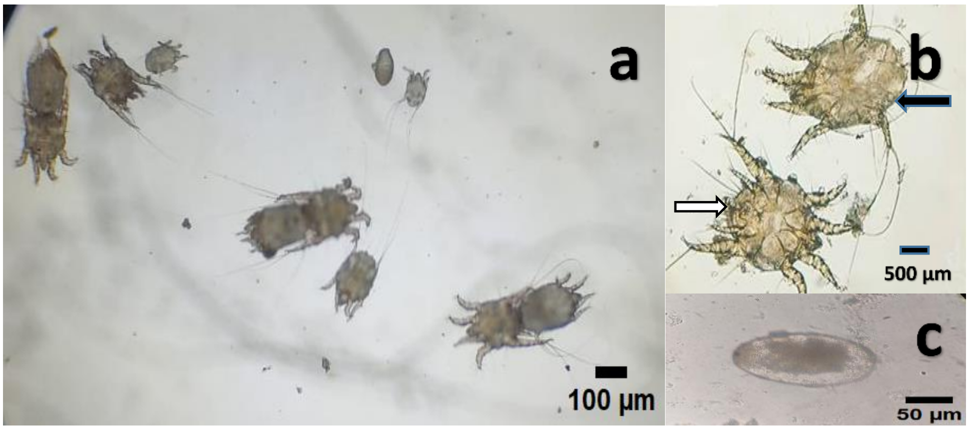

Figure 4: a) Showing different developmental stages of *Otodectes cynotis* from the infested cats' ears. b) Showing adult female (black arrow) and male (white arrow) mite (x10). c) *Otodectes cynotis* oval egg (x40).

3. c. Ticks

Ticks (*Rhipicephalus sanguineus*) were detected macroscopically and measured around 3-9 mm in length. They have an oval-shaped body and eight legs. The female tick is larger and more rounded than the male, and has a scutum that covers only the anterior third of the body. The whole body of the male tick is covered with scutum and has festoons at the posterior border. The mouthparts of adult ticks feature a barbed structure with a hexagonal basis capitulum (Fig.5).

Figure 5: a) Cat ear illustrated attachment of ticks. b) Adult female tick (*Rhipicephalus sanguineus*) collected from the infested cats with a scutum covering only the anterior part of the body (x4). c) Adult male tick with festoons on the posterior border and a scutum covering the entire dorsal surface (x4).

3.d. Myiasis

The infested cats showed signs of hypersalivation, erosion in the jaw area, including tissue injury and necrosis, leading to pain, discomfort, and refusing eating or drinking, causing severe emaciation (Fig.6). The lesions were distributed in XXX among the cat body with variable degrees of depth, and contained clotted blood, pus and lacerated tissue. The detected maggots were creamy to brown worm-like segmented larvae with two deep pits at the posterior end, which contain the respiratory spiracles (Fig.7). Microscopical examination revealed that the anterior end of the detected *Sarcophaga* larvae has cephalopharyngeal skeleton, which consists of two equal oral hooks, hypostome sclerite and two pharyngeal sclerites (dorsal cornua and ventral cornua). While the posterior end has two C-shaped posterior spiracles with three longitudinal spiracular slits (Fig.8). The puparium was 9 mm in length, barrel shape, and reddish brown to dark brown. The emerged *Sarcophaga* adult fly was medium-sized to large (9-12 mm) and grayish with a chessboard-like abdomen (Fig.7).

Figure 6: Clinical aspects of cutaneous myiasis in a domestic cat with severe jaw infection due to maggot infestation, including: a) Tissue injury, necrosis, deep ulcers. b) Display the presence of Larvae embedded within the affected areas.

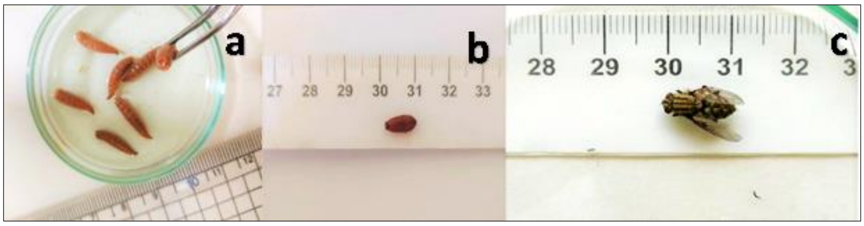

Figure 7: Showing various developmental stages of the *Sarcophaga species*. a) worm-like segmented *Sarcophaga* larvae with two deep posterior cavities. b) *Sarcophaga* brown, barrel-shaped puparium. c) Show the adult stage of *Sarcophaga argyrostoma* fly has a grayish segmented body, with a chess board-like abdomen.

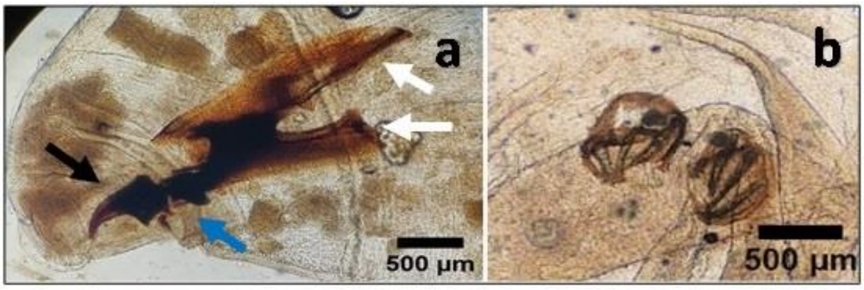

Figure 8: Shows the microscopical and morphological characters of the *Sarcophaga argyrostoma* larvae, including; a) Anterior cephalopharengeal skeleton, which consists of two equal oral hooks (black arrow), hypostomal sclerite (blue arrow) and two pharyngeal sclerites (dorsal cornue and ventral cornue) (white arrows) (x4). b) Two C-shaped posterior spiracles with three longitudinal spiracular slits (x4).

4. Molecular characterization and phylogenetic analysis of *Sarcophaga* species:

Molecular characterization of the collected emerged *Sarcophaga* flies was performed as a confirmatory diagnosis based on COI gene sequencing. A distinct 654bp band was observed under UV light on a 1.5% agarose gel (Fig. 9). Subsequent sequencing of the amplified product definitively identified our sample as *Sarcophaga argyrostoma*, with (OR965058) accession number in the GenBank. Moreover, the phylogenetic relationship between the COI nucleotide sequences of our isolate and various reference strains of *Sarcophaga* species is depicted in Fig.10. Remarkably, the high bootstrap value of 100% provides robust support for the grouping nodes of the isolated specimen under investigation. The obtained sequence of *S. argyrostoma* of the present study was identical to that in Belgium (JQ582089, JQ582081), France (JQ582086), and the USA (AF259512).

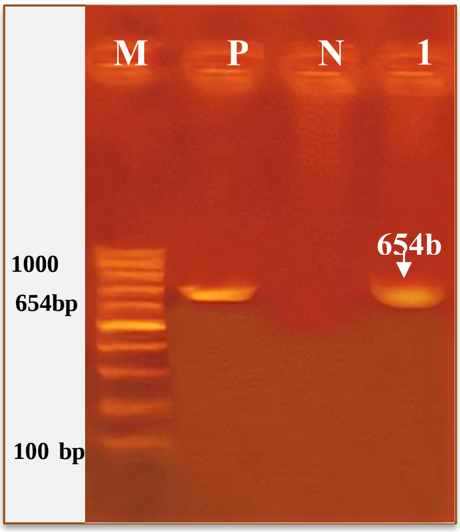

Figure. (9): Agarose (1.5%) gel showing the PCR products of *the Sarcophaga argyrostoma* COI gene, demonstrating the molecular weight of the gene band. (654bp). Lane (M) is the DNA size marker, lane (P) is positive control, lane (N) is negative control, and lane (1) is the positive tested sample.

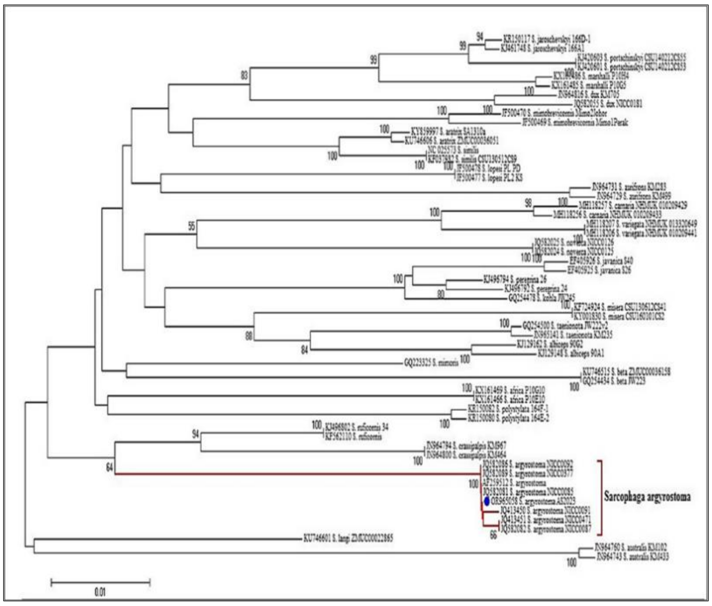

Figure 10: The phylogenetic tree constructed based on the COI gene sequences revealed distinct clades representing different genetic lineages of *Sarcophaga argyrostoma*. Evolutionary distance divergence is given by bar, which indicates 0.01 substitutions per site.

DISCUSSION

Cats (*Felis catus*) are popular pets that can live in different habitats. These cats are susceptible to ectoparasite infestations, causing many health issues. As cats can share a common environment with humans, they can transmit parasites to humans, posing a health risk (Liguori *et al.,* 2023). The feeding activity of the ectoparasites may result in hair loss, excoriation, hypersensitivity disorders, secondary infections, anemia, and in some cases, can cause death (Colella *et al.,* 2020 and Azarm *et al.,* 2023).

The present study aimed to provide a comprehensive understanding of the national situation regarding ectoparasite infestations in domestic cats in Giza Governorate, Egypt, by evaluating the prevalence and distribution of these parasites. These findings will facilitate applying effective control strategies and preventive measures against feline ectoparasitic infestations in Egypt. Consequently, this will reflect on the well-being and overall health of cats in the studied locality.

The current study revealed that the overall prevalence of ectoparasite infestations in the examined cats was 46.0%. Single infestations were identified in 32.0% of the cases, with 20.75% attributed to fleas and 11.25% to ear mites. Additionally, mixed infestations were observed in 14.0% of the examined cats. Among these, 13.0% presented with a combination of fleas and ear mites. Furthermore, infestations involving fleas, ear mites, and ticks were detected in 0.5% of the cases, and a similar percentage exhibited infestations with fleas, ear mites, and myiasis. Compared to other studies, the infestation rate was 35.7% in Italy (Genchi *et al.,* 2021). The detected prevalence varies in other research, such as 29.2% infested cats in Damietta governorate (Aboelela *et al.,* 2022), mange mite was 70.0% (Al-Hosary and Mostafa 2022). While a higher result (63.41%) was obtained by (Azarm *et al.,* 2023) in Iran.

The recorded incidence of different investigated ectoparasites in the present study proved that fleas (*Ctenocephalides felis)* were the most prevalent (20.75%) followed by ear mites (*Otodectes cynotis*) infestations (11.25%). While ticks and myiasis were observed in 0.5% for each. This was in agreement with Elom et al. (2020) and Genchi *et al.* (2021). On the other hand, Siagian *et al.* (2021) and Authoy *et al.* (2023) recorded higher ear mite infestation than fleas.

Fleas are the most ectoparasites recorded in this study. This may be due to the environmental and climatic conditions in the studied area, which support the development of fleas. Moreover, *Ctenocephalides felis* can lay up to 25 eggs per day during a month. So the prevalence of ectoparasite still exists. In addition, *C. felis* can infest many parts of the body and has a specific ability and a high jumping speed that enable it to move from one infested host to others (Furqoni *et al.,* 2020). Oppositely, *Otodectes cynotis* is very active within the ear canals only and transmitted by direct contact.

Rhipicephalus sanguineus is mainly a dog tick and rarely collected from cats due to shedding of ticks during grooming or contacts between the infested dogs and non-infested cats. This explains the low percentage of ticks reported in our study (Siagian *et al.,* 2021). Myiasis is rare in feline species because of its self-grooming behavior. However, when that behavior is not happening because of physical problems, cats can be affected (Christ et al. 2022). In addition, debilitating fractures and untreated wounds with lack of hygiene may attract flies and cause myiasis (Pezzi *et al.,* 2021).

The present work studied the prevalence of various infestations based on age, sex, and season. It was found that cats, less than 1 year, had the highest prevalence (48.35%). This agrees with Aboelela *et al.* (2022) and

Al-Hosary and Mostafa (2022) in Egypt, as young cats are more playful and likely to have more direct contact with infested cats. Moreover, the proximity of young cats to the ground and low immunity may increase the ectoparasites' prevalence in them. However, lower prevalence was recorded by Fanelli *et al.* (2020) and Genchi *et al.* (2021).

Regarding the gender, it was founded that infestation in Tom cats (47.45%) was near to that in Queen cats (44.61%). There is no significant difference between the prevalence of the ectoparasites' infestations in both sexes. These findings agree with Che Kamaruddin *et al.* (2020), Fanelli *et al.* (2020), Genchi *et al.* (2021), Aboelela *et al.* (2022), and Al-Hosary and Mostafa (2022). However, Authoy *et al.* (2023) found that the ectoparasites' infestation in the female cats was 76.92% and in male cats was 53.70%.

Considering seasons, it was found that autumn had the highest infestation rate, followed by summer, winter, and spring. In Egypt, Aboelela *et al.* (2022) detected an increase in the ectoparasites' infestation rate during spring and fall, with no significant differences between the two seasons compared to winter and summer, respectively. Further, Al-Hosary and Mostafa (2022) demonstrated the highest infestation rates during cold months (84.44%). Moreover, Furqoni *et al.* (2020) reported that low temperatures increase the ectoparasites' infestation and also facilitate their transmission.

The variation between the infestation rate and findings in our study and others may refer to the nature of the cats' habitats, the hygienic conditions, the geographical area of residence and the locality climatic conditions which have been found to affect the prevalence and diversity of parasites (Chalkowski *et al.,* 2019 and Farid *et al.,* 2021).

Microscopical examination and morphological characterization of the detected ectoparasites were performed in the current study, according to Soulsby (1982), Giangaspero *et al.* (2017) and Colella *et al.* (2020). The morphological descriptions of the recovered ectoparasites provide important information for their identification and diagnosis (Beard *et al.,*2021).

Cats infested with fleas demonstrated clinical signs such as emaciation, hair loss and scales. Moreover, there were small dark brown specks on the infested cats' fur. These signs refer to the flea allergic dermatitis (FAD) that is caused by flea saliva, which contains a histamine-like compounds, enzymes, polypeptides, and amino acids. Therefore, adult flea biting is followed by a delayed reaction, skin irritation, erythema, alopecia, excoriation, papules, crusts, which often lead to self-trauma (Iannino *et al.,* 2017).

Fleas could be seen by naked eyes as small laterally compressed, brown insects. Microscopical examination revealed that the detected adult cat fleas (*Ctenocephalides felis*) measure between 1 and 4 mm in length and have a laterally flattened wingless body with triangular head and pronotal and genal comb. Moreover, the male flea has two claspers in the abdomen. These criteria were similar to that described before (Che-Kamaruddin *et al.,* 2020; Ningsih and Mahatma 2023).

Regarding cats infested with ear mites, they showed intense itching and scratching, which caused inflammation, injuries and wounds in the ear area. Also coffee grounds like dark, waxy discharges were observed within the ear canal. Microscopical examination revealed different stages of the ear mite *(Otodectes cynotis)*. The detected ear mites were rounded to oval in shape and covered with scales or hair. Female mites are larger than males (females: 250–400 μm long, males: 150–180 μm). The last pairs of legs is reduced in the female. While the male has copulatory organs. Adult mites and nymphs have four pairs of legs, while the larvae have only three pairs. These findings were comparable to those reported by

Aboelela *et al.* (2022) and Rachmawati, *et al.* (2022).

As recorded by Beard *et al.* (2021) and Saleh *et al.* (2021), the ticks (*Rhipicephalus sanguineus*) in our study were detected macroscopically and measured around 3-9 mm in length. They have an oval-shaped body and eight legs. The female ticks were larger and more rounded than the male, and had a scutum that covers only the anterior third of the body. While the whole body of the male tick is covered with scutum and has festoons at the posterior border. The mouthparts of adult ticks had a barbed structure with hexagonal basis capitulum.

Creamy to brown worm-like larvae were observed in the jaw area of the infested cat in our study, with signs of erosion, injury and necrosis. Moreover, signs of hypersalivation, pain, discomfort, and severe emaciation were observed. This was in agreement with (Pezzi *et al.,* 2021 and Ribeiro Campos *et al.,* 2021) who mentioned that myiasis is a serious phenomenon that can affect cats of any age or breed, with a higher incidence in warm regions with unhygienic environments, leading to varying degrees of damage and discomfort. The detection of myiasis type is crucial for the selection of an effective control (Ribeiro Campos *et al.,* 2021). Therefore, rearing the detected larvae and morphological identification is necessary.

Microscopical examination revealed that the detected larvae were *Sarcophaga* larvae, which have cephalopharyngeal skeleton in the anterior end. While the posterior end has two C-shaped posterior spiracles with three longitudinal spiracular slits. The puparium was 9 mm in length, barrel shape and reddish brown to dark brown in colour. Moreover, the emerged *Sarcophaga* adult fly was medium-sized to large (9-12 mm) and grayish in colour with chess board like abdomen (Giangaspero *et al.,* 2017). Ayalon *et al.* (2020) reported that the larvae of dipteran families can transmit different pathogens and cause myasis, involving the active feeding of these larvae on the host tissues, which cause serious problems. In addition, the cutaneous myiasis in cats in Italy were caused only by *Sarcophaga tibialis* and *Sarcophaga argyrostoma* flies (Pezzi *et al.,* 2019; Pezzi *et al.* 2021).

No available reports about cases of domestic cats which suffer from cutaneous myiasis in Egypt. Also, there is no available data about *Sarcophaga argyrostoma* sequencing and phylogeny in Egyptian cats. Therefore, alongside the traditional morphological identification techniques, molecular identification of the collected emerged *Sarcophaga* flies was performed as a confirmatory diagnosis based on COI gene characterization and analysis. As the mitochondria-encoded cytochrome C oxidase subunit I (coxI) gene is considered a pivotal candidate gene and the most widely used genetic marker for the molecular identification of flies and differentiating Diptera species (Fuentes-Lopez *et al.,* 2020 and Talebzadeh *et al.,* 2020).

The nucleotide sequence (654bp) of the tested product in this study was recorded as *Sarcophaga argyrostoma*, with (OR965058) accession number in the GenBank. Moreover, the phylogenetic relationship between the COI nucleotide sequences of our isolate and various reference strains of *Sarcophaga* species was performed by the neighbor-joining method (Abdel-Radi *et al.,* 2022) and showed that the obtained sequence of *S. argyrostoma* of the present study was identical to that in Belgium (JQ582089, JQ582081), France (JQ582086), and the USA (AF259512).

The recorded findings in our study emphasize the need for implementing targeted preventive measures and control efforts to ensure comprehensive protection against ectoparasites and reducing health hazards.

CONCLUSION

In conclusion, the present study examined the prevalence and significant that of ectoparasites infesting domestic cats in Giza Governorate, Egypt. Fleas were found to be the most common ectoparasite, followed by ear mites, ticks, and myiasis. The detected parasites were identified based on morphological and molecular characterization, with a focus on the COI gene for *Sarcophaga* species. Risk factor analysis revealed that age, sex, and season influenced infection rates, as younger cats and the autumn season showed higher prevalence. The present study emphasizes the importance of addressing ectoparasitic infestations in cats for their welfare and public health. Future initiatives should involve collaboration among veterinarians and cat owners to effectively manage these infections and promote cat well-being.

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دراسة طفيلية وجزيئية على بعض الطفيليات الخارجية التي تصيب القطط المنزلية في محافظة الجيزة ، مصر

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باعتبارها رفاقًا يتم احتضانها بالانسان على نطاق واسع في بيئات متنوعة، تواجه القطط تهديدات صحية كبيرة بسبب الطفيليات الخارجية. يتناول هذا البحث مدى انتشار الإصابة بالطفيليات الخارجية في القطط المنزلية في محافظة الجيزة، مصر. امتدت الدراسة من ديسمبر ٢٠٢٢ إلى نوفمبر ٢٠٢٣، وتضمنت ٤٠٠ عينة من مجموعات القطط المتنوعة. تم تشخيص وجود البراغيث وعث الأذن في ٢٠,٧٥% و١١,٢٥% من القطط المفحوصة على التوالي. بينما لوحظ القراد والنغف بنسبة ٠,٥% لكل منهما. تم توثيق المظاهر السريرية والتركيبات المورفولوجية للطفيليات المكتشفة. علاوة على ذلك، يدمج البحث التوصيف الجزيئي، باستخدام جين COI لتحديد أنواع التابوت. وحللت الدراسة أيضًا تاثر الخطر الناجم عن هذه الأصابات مقارنة بالعمر والجنس والموسم، وقد كشف هذا عن الاختلافات في معدلات الإصابة. أظهرت القطط التي يقل عمرها عن عام واحد أعلى معدل إصابة (٤٨,٣٥%). وأظهر التباين الموسمي أعلى معدل انتشار في فصل الخريف، يليه الصيف والشتاء، مع انخفاضه في فصل الربيع. توفر هذه الدراسة الاستقصائية رؤى قيمة حول الإصابة بالطفيليات الخارجية في القطط المنزلية لتكون بمثابة خطوة محورية نحو تعزيز رعاية القطط وحماية الصحة العامة للمربيين.