

Prevalence of ectoparasites found in cats (*Felidae, Felis catus*) of Imphal east and west districts of Manipur, India

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Abstract

Free-ranging domestic cats *Felidae, (Felis catus)* can potentially play host to some life-threatening zoonotic pathogens including ectoparasites such as fleas, and lice. These ectoparasites are capable of transmitting zoonotic diseases. The present investigation has undertaken by examining of altogether 105 Cats (*Felis catus*) which were captured, 55 cats from Imphal east and 50 cats from Imphal west, for a period of one year November 2023 up to October 2024), were tested for presence of ectoparasites in the Parasitology laboratory, Department of Zoology Dhanamanjuri University, Imphal, Manipur, India. The cats were examined and their ectoparasites were removed from their skin by forceps and combing for five minutes for each cat. Ectoparasites were stored in 70% ethanol and brought to the laboratory and later mounted for identification of species, using species identification keys. The cats were collected from the study areas of different localities of Imphal east and West districts of Manipur. Among all captured cats, 32 cats were infected in Imphal west (64%) and 37 cats from Imphal East (67.27%) were infected with around 220 ectoparasites and the average infection rate was 3.19. Two arthropod species were identified, including four fleas species (89.69%) and two louse species (12.67%). The three flea species included *Ctenocephalides felis* (39.68%) *Ctenocephalides canis* (30.15%), *Xenopsylla nubica* (15.87%). The two louse species was *Heterodoxus spiniger* (7.93%) and *Heterodoxus longitarsus* (6.45%). Based on the findings, *Ctenocephalides felis* was the most common ectoparasite species (39.76%). Fleas were the most prevalent ectoparasites on *Felis catus*, with the highest prevalence, observed for *Ctenocephalides felis*. Due to the large and growing population of cats and the high risk of transmission of common diseases between humans and cats, as well as the high contact and communication of people with cats, we were encouraged to study the ectoparasites of cats in 26 different localities of two different Districts of Imphal, which is an important urban areas of Manipur, India. The prevalence of ectoparasites among pet cats indicated that Cats were more susceptible to ectoparasite infestation. Only few of the respondents knew about the ectoparasites and diseases caused by them. The present study determined that high prevalence of parasites, and the low level of public awareness is the fundamental reason behind pet related zoonotic disease. Extensive public education about pet related zoonoses is needed to create awareness in public and to reduce the risk of harbouring zoonotic diseases of public health importance.

Keywords: Prevalence, ectoparasites, Imphal East, Imphal West.

Introduction

India is the largest continent in the world, known for its thriving biocultural diversity. Today, countries in Asia including India is one of the country experiencing a rapid social, demographic, and economic transformation, thereby placing this region as an ever-growing economic powerhouse in the years to come. In recent years, ecosystem change (climate, habitat, invasion, invasive species, over-exploitation, and pollution) and the abundance of anthropogenic food waste in Indian cities, including Manipur, have led to an increase in the number of dogs (*Canis familiaris*) and cats (*Felis catus*) in the urban environments [Eslamind *et al* 2018, Tamini and Zhong 2015]. A domesticated animal which is kept for pleasure rather than the utility is known as pet animal ^[1]. The popular species of pets are dogs, cats, fishes, birds, rabbits, hamsters and guinea pigs. However, dogs and cats are the most common pet animals worldwide. The benefits of having a pet animal are undisputed, yet they may harbour many parasites potentially transmissible to humans. Ectoparasites inhabit the skin or outgrowths of the skin of another organism (the host) for various periods. Many of these ectoparasites (lice) are host specific, while others (ticks) parasitize a wider range of hosts.

Imphal, the average temperature is of 14.4 °C (58 °F), with a minimum of 5.8 °C (42.5 °F) and a maximum of 23 °C (73.4 °F), at an altitude of 786 meters above sea level, Latitude: 24°48'28" N. Longitude: 93°56'39" E latitude. Imphal is the capital city of the Indian state of Manipur. It is the third largest city in northeast India after Guwahati and Agartala. The metropolitan centre of the city contains the ruins of Kangla Palace (officially known as Kangla Fort), the royal seat of the former Kingdom of Manipur, surrounded by a moat and spread over parts of the districts of Imphal West. It is bounded by the Indian states of Nagaland to the north, Mizoram to the south and Assam to the west. It also borders two regions of Myanmar, Sagaing Region to the east and Chin State to the south. The state covers an area of 22,327 km (8,621 sq m). The official and most widely spoken language is the Meitei language. Keeping pets without regard to their social and legal responsibilities has increased the risk of human infectious disease transmission by such animals [Eslamind *et al* 2018]. Free-ranging cats are reservoirs of many zoonotic diseases such as rabies, toxoplasmosis, giardiasis, cat-scratch disease, Q fever, and ehrlichiosis [Skerget *et al* 2003 ^[19] and Switzer *et al.* 2013] ^[22]. In addition, some zoonotic diseases such as plague and some rickettsia are mechanically or biologically transmitted to humans by some arthropod species, especially blood-sucking insects and ticks, which

are usually defined as ectoparasites [E.L. Sherbin 2011, Mc. Daniel 2012]. Sucking lice, fleas, and ticks represent some of the most common ectoparasites. Many of these ectoparasites are important in terms of human and veterinary medicine [Zendehtili *et al* 2015 ^[26], Ogenge *et al* 2009]. Sustained economic growth in India has resulted in increased demand for products and services and substantial urbanization (Coker *et al* 2011) ^[8]. These factors have triggered a series of human-mediated environmental alterations, such as deforestation and encroachment of humans into natural ecosystems, that now link previously isolated ecological niches and give pathogens new opportunities to thrive (Chongsuvivatwong *et al* 2011) ^[7]. During the past century, India has been in the limelight for emergence and pathogenicity of a large number of infectious diseases that have taken a substantial toll on the health of millions of persons (Coker *et al* 2011) ^[8]. Striking examples include the emergence of severe acute respiratory syndrome, infections with the highly pathogenic avian influenza A(H5N1) virus, and coronavirus disease (COVID-19). Recently, human modification of natural habitats resulted in the emergence of a tick vector of Kyasanur Forest disease virus, a zoonotic vector borne flavivirus that causes severe hemorrhagic fever with a fatality rate of 3%–10% (Shah *et al* 2018) ^[20]. Also implicated in the changing epidemiology of pathogens of public health concern in eastern and Southeast Asia are dogs and cats. In remote areas of eastern and Southeast Asia, three quarters of dogs are classified as stray or community dogs (Traub *et al* 2015) ^[24]. Ectoparasites, such as ticks, fleas and lice, have been reported on dogs and cats worldwide (Stork, 2018) ^[21]. In dogs and cats, ectoparasites are implicated to be responsible for life-threatening anaemia, allergic dermatitis and pruritic and non-pruritic skin disorders (Omonijo & Sowemimo, 2017) ^[17]. In addition, ectoparasites play great role in the transmission of pathogens of great veterinary and public health significance. Some ectoparasites can act as vectors of different pathogens, such as Babesia, Bartonella and Rickettsia species (Alcaíno *et al.*, 2002 ^[2]; Heukelbach *et al.*, 2012 ^[11]; Nuchjangreed & Somprasong, 2007) ^[15]. Vectors and vector-borne diseases (VBDs) are very common throughout India, including Manipur. Ectoparasites and their vectored pathogens have been well studied in livestock of Sub-Saharan Africa but poorly investigated in dogs and cats (Heylen *et al.*, 2021) ^[12]. Free-ranging cats are reservoirs of many zoonotic diseases such as rabies, toxoplasmosis, giardiasis, cat-scratch disease, Q fever, and ehrlichiosis. In addition, some zoonotic diseases such as plague and some rickettsia are mechanically or biologically transmitted to humans by some arthropod species, especially blood-sucking insects and ticks, which are usually defined as ectoparasites. Sucking lice, fleas, and ticks represent some of the most common ectoparasites. Many of these ectoparasites are important in terms of human and veterinary medicine. They are known to be the vectors of many zoonotic disease pathogens such as Lyme disease (*Borrelia burgdorferi*), plague (*Yersinia pestis*), and tularemia (*Francisella tularensis*). Additionally, ectoparasites are also a common cause of skin diseases of domestic animals, including skin lesions accompanied by pruritus, erythema, excoriation, papules, and crusts after feeding. For example, fleas are responsible for producing allergic dermatitis, the intermediate host of *Hymenolepis nana* (a worm that is the most common cestode, infecting

mankind, especially children), and the vector of plague and relapsing fever. Furthermore, some ectoparasites may transmit various bacterial, viral, or parasitic agents to hosts during feeding. Ticks, for example, are responsible for the transmission of many infectious diseases, such as rickettsiosis and babesiosis, some parasitic disease agents such as *Cercopithifilaria* sp., and finally viral diseases including Crimean-Congo hemorrhagic fever (CCHF). Besides, they can easily move between reservoirs, so some parasites found in animals can pass to humans, causing serious diseases. According to previous studies in many areas of the world, cats are the hosts of many ectoparasites of medical and veterinary concern. In Manipur, specially Imphal city, large populations of cats roam the streets, parks, and public places. We monitor free-ranging cat populations to assess potential for transmission of zoonotic pathogens. In this study, we examine the prevalence of ectoparasites in cats collected from urban areas of Manipur, from certain localities of two different areas namely, Imphal east and West Districts of Manipur from October 2023 upto October 2024 for a period of one year in the parasitology laboratory, Department of Zoology, Dhanamanjuri University, Imphal, to identify feline zoonosis.

Materials and Methods

Study Area and Data Collection

This study was conducted in different localities of two Districts of Manipur namely Imphal east and west, from October 2023 up to October 2024 in the parasitology laboratory, Department of Zoology, Dhanamanjuri University, Imphal, Manipur, India. Imphal has a semi - arid continental climate and is largely defined by its geographical location, with different ranges of Mountains encircling all sides and the town Imphal City, the central plain area which is very beautiful and home of all nature loving animals. In the present study, cats (*Felis catus*) were examined in 26 different localities of two districts, located in Imphal, Manipur.

Data collection and analysis

A door-to-door screening of pet cats were conducted in randomly selected 92 houses. Cats were examined for ectoparasites with cooperation of the owners. Semi-structured questionnaires were set up to achieve the essential information from 92 cat pet owners. Questionnaires included knowledge about zoonosis, mode of ectoparasite transmission, lifestyle of pet, medical history, treatment measures of ectoparasites. Cats were examined for ectoparasites such as fleas, and lice by a complete examination of skin. Then, their ectoparasites were removed from their skin via combing, the skin was carefully inspected, and remaining ectoparasites were separated with forceps (5 minutes for each cat). The entire body surface of pet animals was observed for ectoparasites, collecting them by handpicking. A total of 105 pet cats were inspected. The ectoparasites were stored in 70% ethanol and later mounted for identification of the species level using general and specialist identification keys. The collected fleas and lice were also preserved in glass containers with ethanol until identification. Fleas were cleaned with water and immersed in 10% potassium hydroxide (KOH) with slight warming for 10–15 hours. Then, the samples were transferred to 2.5% acid alcohol for 5 min to adjust the samples' pH. For dehydration, the specimens were

dehydrated using a series of ethanol solutions from 50, 60, 70, 80, 90, 95 to 100% (absolute) for 5 min, and then transparency by xylene for 5 min. After mounting, the identification of fleas and lice species was done under light microscopic examination as described by CDC key [Microbes and infection 2018] [6] and [Bowmann, 2014] [5].

Results and Discussion:

Cats are known to shed many ectoparasites during grooming. Therefore, the 64% and 67.27% rate of infestation in cats may show relatively much ectoparasite infestation of the local environment. This observation suggests that cats may serve as indicators of the ectoparasite infestation level of an environment. Ectoparasites have the potential to transmit zoonotic diseases. The effects of zoonotic diseases may range from general weakness and discomfort to increased mortality. The present study is the first research on the prevalence of infestations on cats in Imphal East and West Districts of Manipur, India.

The study animals i.e. cats, we found no association between age group and detection of parasites, whereas clinical signs (i.e., enlarged lymph nodes and skin abnormalities) were statistically associated with detection of ectoparasitic infestation. The detection of zoonotic pathogens in client-owned cats living in metropolitan areas of different localities of Imphal east and west Districts of Manipur, indicates that these animals serve as hosts for several parasitic diseases. We provide data for an extended geographic distribution of zoonotic pathogens (e.g., zoonotic species *Ctenocephalides felis*, and *Ctenocephalus canis*,) commonly known as cat flea and lice which can give useful information in the treatment and disease control strategies and preventive measures for controlling diseases of domestic cats owned in Manipur.

Further complicating knowledge of the transmission of zoonotic parasites in these regions of Manipur, are the large populations of free-roaming animals; the increased number

of pet dogs and cats; and the complex social, economic, and ecologic changes currently occurring in India, the integrated strategies that address all of these factors are therefore fundamental for the control of such parasitic agents. Thus, the present investigation has taken up to evaluate the presence of pathogens and ectoparasites in pet cats living in Imphal East and West Districts of Manipur, India, which is a metropolitan areas in close proximity to humans. These animals share a common environment with humans, which makes them likely key reservoirs for pathogens with the potential to infect persons living in such areas and settings. The epidemiologic data presented in this study can be pivotal for building knowledge bases about the occurrence of zoonotic parasites infecting companion cats in different localities of Imphal east and west Districts of Manipur, India.

This information could help epidemiologists and policy makers provide tailored commendations in the blueprint of future surveillance and prevention strategies. Hence, for development and enactment of global elimination programs, surveillance of filarial species should be extended to animal populations in filariae-endemic countries specially in India.

The current study reveals a high prevalence of ectoparasites in cats from Imphal East (67.27%) and Imphal West (64%), underscoring the significant parasitic burden among feline population in these districts. These findings align with similar studies conducted in other regions. The prevalence rates reported in this study are comparable to findings from Mahapatra *et al* (2021) [13], who reported a prevalence of 62.5% in cats from rural areas of Odisha, India. Similarly Rust *et al* (2013) [18] documented ectoparasites prevalence rates of over 60% in cats from humid regions. However, our prevalence rates are higher than those observed in arid or urbanized regions, such as the study by Buegnet *et al* (2014) in urban France, which reported a prevalence of 45%. This difference can be attributed to variations in climate, cat population density and management practices.

Table 1: Prevalence of Ectoparasites in cats of Imphal West Districts of Manipur.

| Sl No. | Site of Collection | District | No. of host examined | No. of host infested | Prevalence % |
|--------|----------------------------|-------------|----------------------|----------------------|--------------|
| 1 | Kwakeithel Laishram Leikai | Imphal West | 4 | 2 | 50 |
| 2 | Kwakeithel Thokchom Leikai | Imphal West | 3 | 2 | 66.66667 |
| 3 | Uripok Achom Leikai | Imphal West | 4 | 3 | 75 |
| 4 | Uripok Bachaspati Leikai | Imphal West | 5 | 4 | 80 |
| 5 | Singjamei Thongam leikai | Imphal West | 3 | 2 | 66.66667 |
| 6 | Singjamei Chingamakha | Imphal West | 5 | 3 | 60 |
| 7 | Keisamthong Laishom Leirak | Imphal West | 7 | 4 | 57.14286 |
| 8 | Keisamthong Hodam Leirak | Imphal West | 4 | 3 | 75 |
| 9 | Sagolband Nepra Menjor | Imphal West | 5 | 3 | 60 |
| 10 | Tera Tongbram Leikai | Imphal West | 3 | 1 | 33.33333 |
| 11 | Kakwa asem leikai | Imphal West | 3 | 2 | 66.66667 |
| 12 | Kakwa Naorem Leikai | Imphal West | 4 | 3 | 75 |
| | Total | | 50 | 32 | 64% |

The predominance of *Ctenocephalides felis* observed in this study is consistent with the findings of Bond *et al* (2007) [4] who reported that *Ctenocephalides felis* and *Ctenocephalides canis* are among the most prevalence flea species in tropical and subtropical regions. The adaptability of *C. canis* to a wide range of hosts and its ability to thrive in humid climates may explain its dominance in Imphal. The detection of *Ctenocephalides canis* as the second most

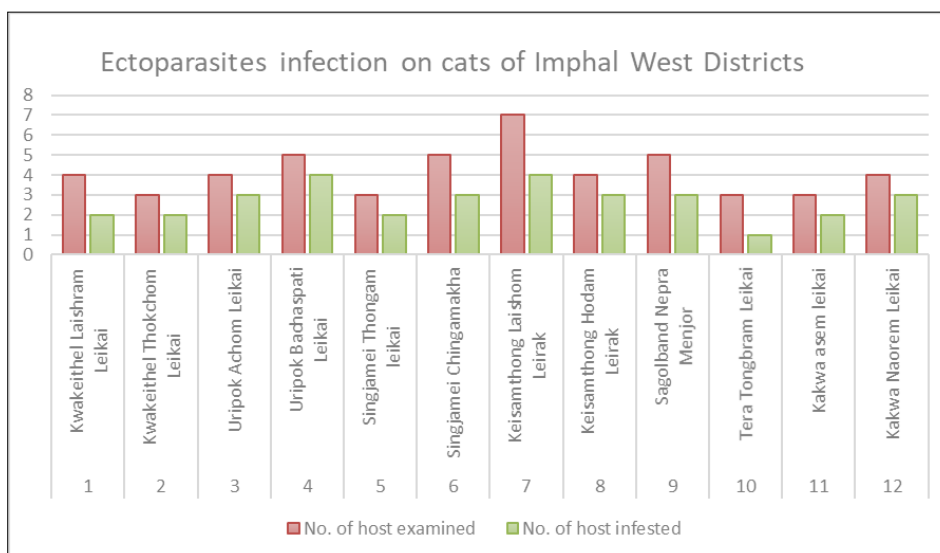
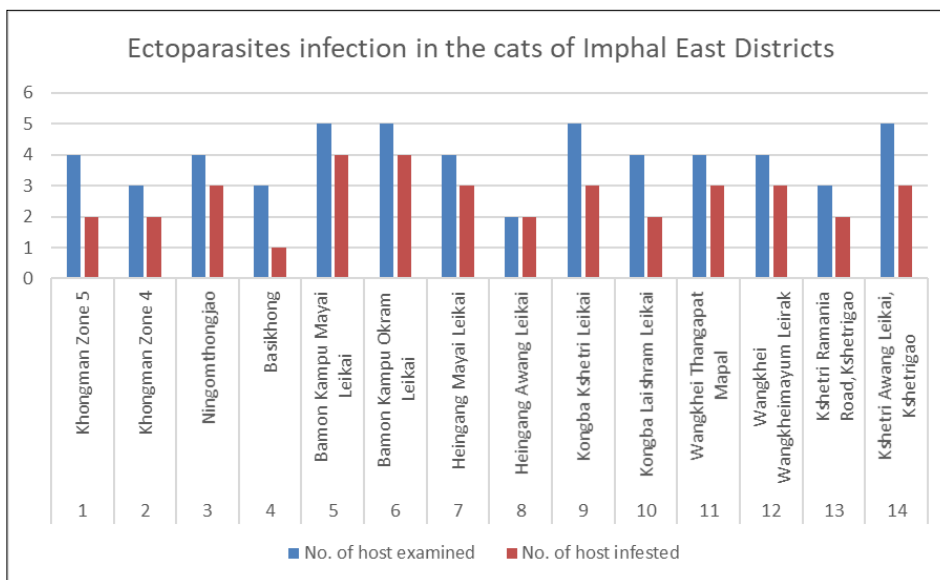
prevalent ectoparasites is in agreement with the work of Abdullah *et al* (2019) [1] who documented its widespread presence in both cats and dogs. The less frequent occurrence of *Xenopsylla nubica*, *Heterodoxus spiniger* and *Heterodoxus longitarsus* in our study reflects findings from Younes *et al* (2017) [25] where these ectoparasites were reported as less common but significant contributors to the overall ectoparasite burden.

Table 2: Prevalence of ectoparasites of cats in Imphal East Districts of Manipur.

| Sl. No. | Site of collection | No. of host examined | No. of host infested | Prevalence % |
|---------|----------------------------------|----------------------|----------------------|--------------|
| 1. | Khongman Zone 5 | 4 | 2 | 50 |
| 2. | Khongman Zone 4 | 3 | 2 | 66.66667 |
| 3. | Ningomthongjao | 4 | 3 | 75 |
| 4. | Basikhong | 3 | 1 | 33.33333 |
| 5. | Bamon Kampu Mayai Leikai | 5 | 4 | 80 |
| 6. | Bamon Kampu Okram Leikai | 5 | 4 | 80 |
| 7. | Heingang Mayai Leikai | 4 | 3 | 75 |
| 8. | Heingang Awang Leikai | 2 | 2 | 100 |
| 9. | Kongba Kshetri Leikai | 5 | 3 | 60 |
| 10. | Kongba Laishram Leikai | 4 | 2 | 50 |
| 11. | Wangkhei Thangapat Mapal | 4 | 3 | 75 |
| 12. | Wangkhei Wangkheimayum Leirak | 4 | 3 | 75 |
| 13. | Kshetri Ramania Road, Kshetrigao | 3 | 2 | 66.66667 |
| 14. | Kshetri Awang Leikai, Kshetrigao | 5 | 3 | 60 |
| | Total | 55 | 37 | 67.27 |

Table 3: Species distribution and prevalence of different ectoparasite species in cats of Imphal East and West Districts of Manipur

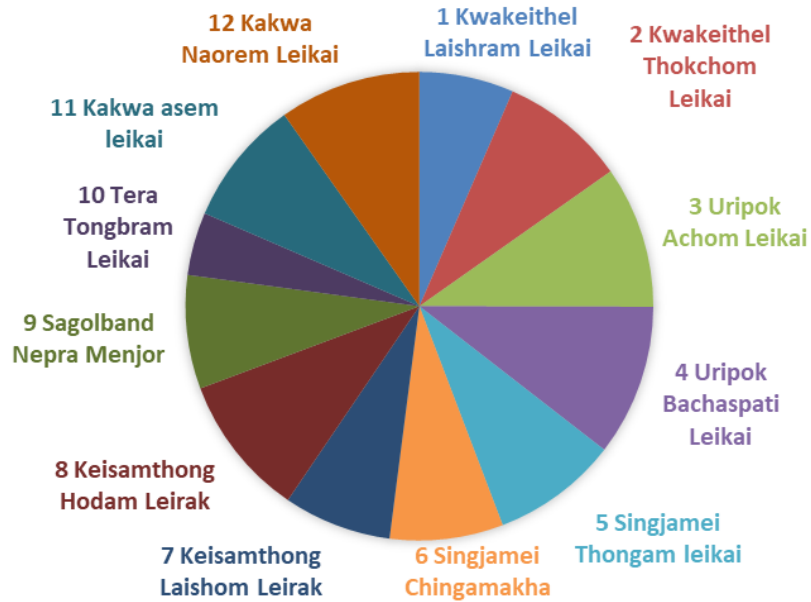
| Parasite species | Positive | Prevalence |
|--------------------------------|----------|------------|
| <i>Ctenocephalides felis</i> | 50 | 39.6825397 |
| <i>Ctenocephalides canis</i> | 38 | 30.1587302 |
| <i>Xenopsylla nubica</i> | 20 | 15.8730159 |
| <i>Heterodoxus longitarsus</i> | 10 | 7.93650794 |
| <i>Heterodoxus spiniger</i> | 8 | 6.34920635 |



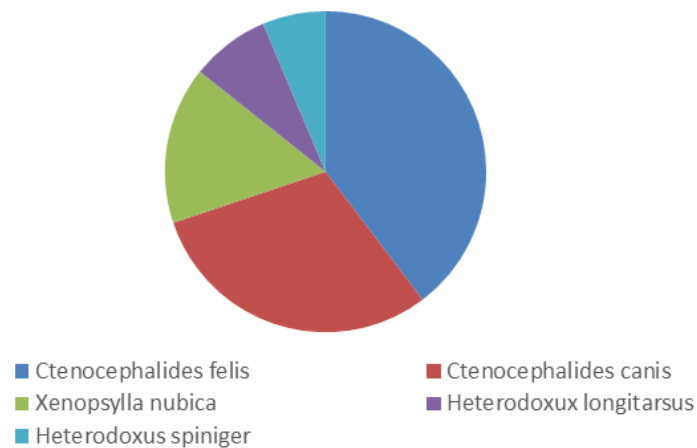
PREVALENCE % OF ECTOPARASITES IN IMPHAL EAST



PREVALENCE % OF ECTOPARASITES IN IMPHAL WEST



Species composition of ectoparasites in cats of Imphal East and West Districts of Manipur



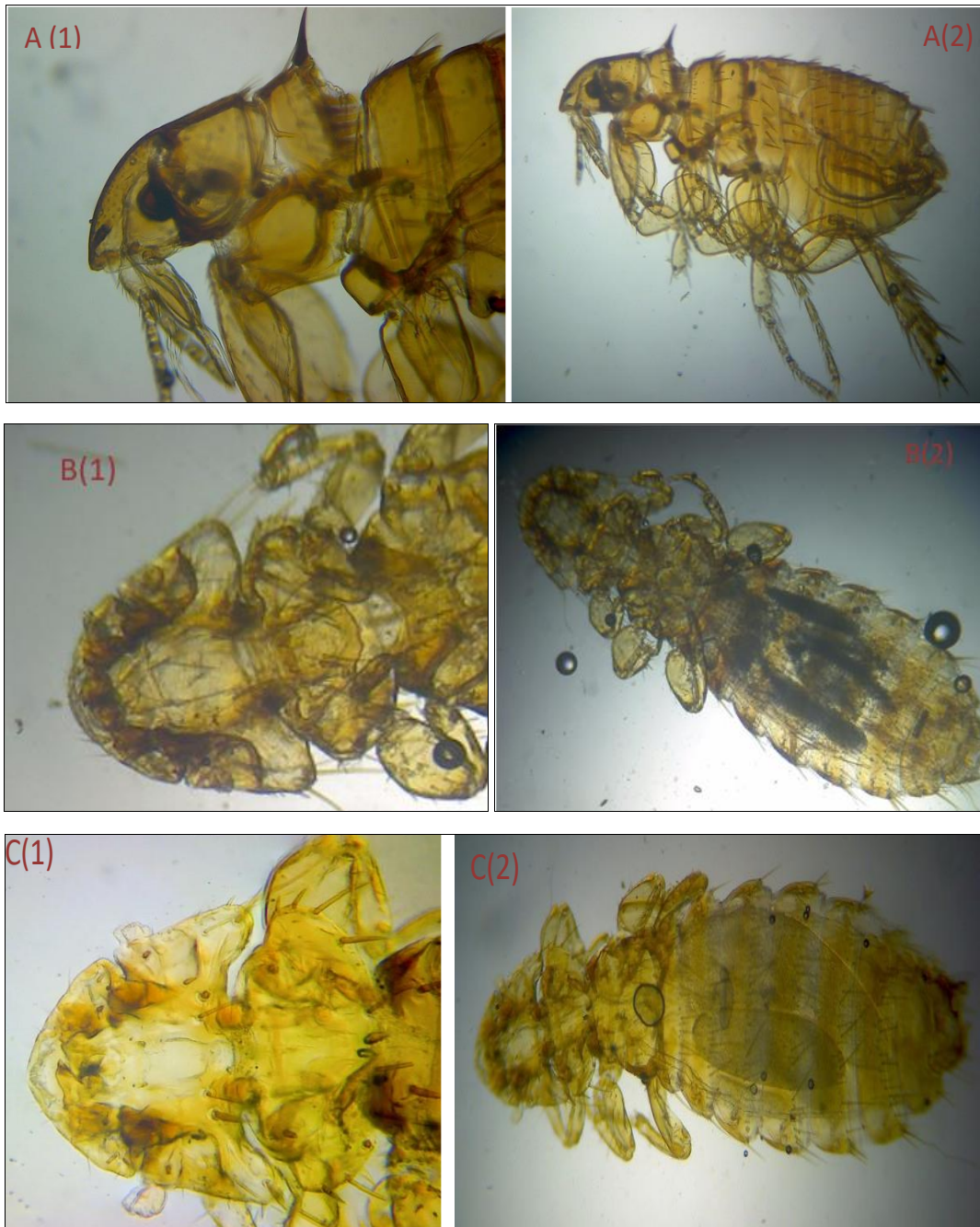


Fig 1: Identified species A(1) & A(2) head and body of *Xynopsulla* sp., B(1) & B(2) head and body of *Heterodoxus longitarsus*, C(1) & C(2) head and body of *Heterodoxus spiniger*.



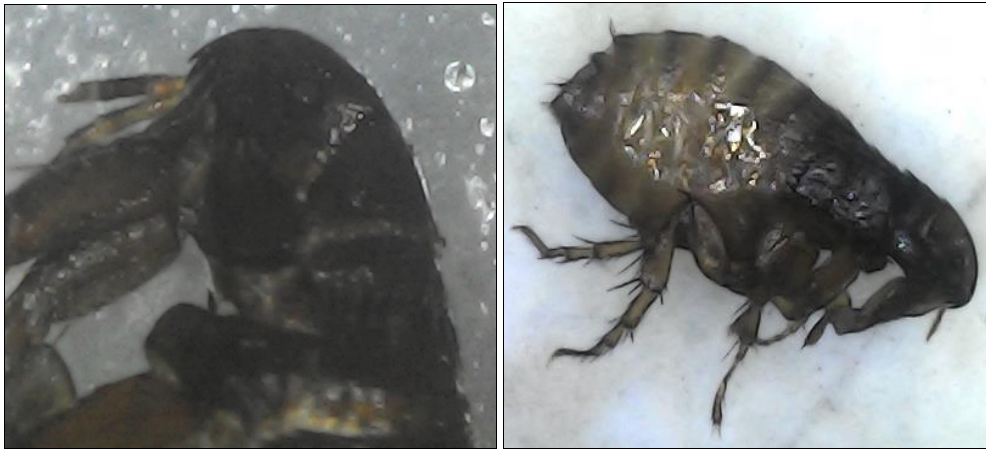


Fig 2: Identified species D (1) & D (2) head and body of *Ctenocephalides felis* and E (1) & E (2) head and body of *Ctenocephalides canis*

Conclusion

High prevalence of ectoparasites among free-ranging domestic cats (*Felidae*, *Felis catus*), especially fleas, may pose serious health risk for residents of Tehran. Also, given the significant role of some ectoparasites in the transmission of arthropod-borne disease agents to humans, we suggest that regular monitoring of infested cats in urban societies is necessary, especially in the urban areas in Imphal city where risk of zoonotic pathogen transmission may be high due to increased contact among humans and free-ranging domestic cats.

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References

1. Abdullah S, *et al.* *Ctenocephalides felis*: Prevalence and Impact. *Veterinary Parasitology*, 2019.
2. Alcaíno HA, Gorman TR, Alcaíno R. Flea species from dogs in three cities of Chile. *Veterinary Parasitology*, 2002;105:261–265. [DOI] [PubMed] [Google Scholar]
3. Beugnet F, Franc M. Flea Control in urban Areas: Challenges and Strategies. *Parasites & Vectors*, 2014.
4. Bond R, *et al.* Prevalence of Fleas in Cats and Dogs in the UK. *Medical and Veterinary Entomology*, 2007.
5. Bowman DD. *Georgis' parasitology for veterinarians*. 10th ed. Saunders, 2014.
6. Cdc Center for Disease Control and Prevention, Bartonella infection (cat scratch disease, trench fever, and carrion's disease), *Microbes and Infection*, 2018.
7. Chongsuvivatwong V, Phua KH, Yap MT, Pocock NS, Hashim JH, Chhem R, *et al.* Health and health-care systems in southeast Asia: diversity and transitions. *Lancet*, 2011;377:429–37. [https://doi.org/10.1016/S0140-6736\(10\)61507-3](https://doi.org/10.1016/S0140-6736(10)61507-3)
8. Coker RJ, Hunter BM, Rudge JW, Liverani M, Hanvoravongchai P. Emerging infectious diseases in southeast Asia: regional challenges to control. *Lancet*, 2011;377:599–609. [https://doi.org/10.1016/S0140-6736\(10\)62004-1](https://doi.org/10.1016/S0140-6736(10)62004-1)
9. El-Sherbini GT. The role of insects in mechanical transmission of human parasites, *Iranian Red Crescent Medical Journal*, 2011;13(9):678–679, <https://doi.org/10.5812/kowsar.20741804.2253>, 2-s2.0-80052677322.CAS PubMed Web of Science@Google Scholar
10. Eslamirad Z. Toxocariasis: the sanitary hazard in urban communities of Iran, *Arak Medical University Journal (AMUJ)*, 2018, 21(3). Google Scholar
11. Heukelbach J, Frank R, Ariza L, de Sousa Lopes I, de Assis E Silva A, Borges AC, *et al.* High prevalence of intestinal infections and ectoparasites in dogs, Minas Gerais State (Southeast Brazil). *Parasitology Research*, 2012;111:1913–1921. [DOI] [PubMed] [Google Scholar]
12. Heylen D, Day M, Schunack B, Fourie J, Labuschagne M, Johnson S, *et al.* A community approach of pathogens and their arthropod vectors (ticks and fleas) in dogs of African Sub-Sahara. *Parasites & Vectors*, 2021;14:576. [DOI] [PMC free article]
13. Mahapatra S, *et al.* Prevalence of Ectoparasites in Cats in Rural Odisha, India. *Journal of Parasitology Research*, 2021.
14. McDaniel CJ, Cardwell DM, Moeller RB, Gray GC. Humans and cattle: a review of bovine zoonoses, *Vector Borne and Zoonotic Diseases*, 2014;14(1):1–19, <https://doi.org/10.1089/vbz.2012.1164>, 2-s2.0-84891676808.PubMe [PubMed] [Google Scholar]
15. Nuchjangreed C, Somprasong W. Ectoparasite species found on domestic dogs from Pattaya district, Chon Buri province, Thailand. *Southeast Asian Journal of Tropical Medicine and Public Health*, 2007, 38, 203. [Google Scholar]
16. Oguge NO, Durden LA, Keirans JE, Balami HD, Schwan TG. Ectoparasites (sucking lice, fleas and ticks) of small mammals in southeastern Kenya, *Medical and Veterinary Entomology*, 2009;23(4):387–392. <https://doi.org/10.1111/j.1365-2915.2009.00820.x>, 2-s2.0-70450247179.CAS PubMed Web of Science@Google Scholar
17. Omonijo AO, Sowemimo OA. Prevalence of ectoparasites of dogs and cats in Ijero and Moba LGAs, Ekiti state, Nigeria. *Nigerian Journal of Parasitology*, 2017;38:278–283. [Google Scholar]
18. Rust M, *et al.* Fleas and Their Importance in Animal and Human Health. *Veterinary Parasitology*, 2013.

19. Skerget M, Wenisch C, Daxboeck F, Krause R, Haberl R, Stuenzner D. Cat or dog ownership and seroprevalence of ehrlichiosis, Q fever, and cat-scratch disease, *Emerging Infectious Diseases*,2003;9(10):1337–1340, <https://doi.org/10.3201/eid0910.030206>, 2-s2.0-0141561846.PubMed Web of Science®Google Scholar
20. Shah SZ, Jabbar B, Ahmed N, Rehman A, Nasir H, Nadeem S, *et al.* Epidemiology, pathogenesis, and control of a tick-borne disease—Kysanur Forest disease: current status and future directions. *Front Cell Infect Microbiol*,2018;8:149. <https://doi.org/10.3389/fcimb.2018.00149>
21. Stork NE. How many species of insects and other terrestrial arthropods are there on earth? *Annual Review of Entomology*,2018;63:31–45. [DOI] [PubMed] [Google Scholar]
22. Switzer AD, Kasten RW, Kass PH, McMillan-Cole AC, Stuckey MJ, Chomel BB. Bartonella and Toxoplasma infections in stray cats from Iraq, *The American Journal of Tropical Medicine and Hygiene*,2013;89(6):1219–1224. <https://doi.org/10.4269/ajtmh.13-0353>, 2-s2.0-84890410103.PubMed
23. Tamimi N, Zhang C. A survey of feline behavioral problems in Tehran, *Veterinary Research Forum*, 2015. Faculty of Veterinary Medicine, Urmia University, Urmia, Iran.Google Scholar
24. Traub RJ, Irwin P, Dantas-Torres F, Tort GP, Labarthe NV, Inpankaew T, *et al.* Toward the formation of a Companion Animal Parasite Council for the Tropics (CAPCT). *Parasit Vectors*,2015;8:271. <https://doi.org/10.1186/s13071-015-0884-4>
25. Younes A, *et al.* Ectoparasites in Domestic Cats: Diversity and Significance. *Parasitology International*.
26. Zendehtili H, Zahirnia AH, Maghsood AH, Khanjan M, Fallah M. Ectoparasites of rodents captured in hamedan, western Iran, *Journal of Arthropod-Borne Diseases*,2015;9(2):267–273. PubMedWeb of Science®Google Scholar