Ectoparasites infesting dogs and cats in Bishoftu, central Oromia, Ethiopia

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ABSTRACT

A total of 200 dogs and 137 cats were examined for the presence of fleas, ticks and lice in Bishoftu, central Oromia, Ethiopia from September 2009 through April 2010. At least one ectoparasite species was found on 97% (194/200) of the dogs and 90.5% (124/137) of the cats. On dogs, fleas (*Ctenocephalides felis* (95%), *Pulex irritans* (20.5%), *Echidnophaga gallinacea* (9%) and *Xenopsylla cheopis* (0.5%)), ticks (*Haemaphysalis leachi* (17.5%), *Amblyomma variegatum* (8.5%), *Rhipicephalus sanguineus* (8%), *Rhipicephalus pulchellus* (5.5%) and *Rhipicephalus* (*Boophilus*) *decoloratus* (2.5%)) and lice (*Heterodoxus spiniger* (5%), *Linognathus setosus* (1.5%) and *Trichodectes canis* (0.5%)) were identified. On cats, fleas (*C. felis* (61.7%), *E. gallinacea* (24.1%), *P. irritans* (1.5%) and *X. cheopis* (0.7%)) and ticks (*Ha. leachi* (10.9%), *Am. variegatum* (1.5%) and *Rh. sanguineus* (0.7%)) were identified. *C. felis* was identified as the predominant ectoparasite on both dogs and cats. The overall frequency and count of ectoparasites was higher on dogs than on cats. Significantly higher overall frequency of fleas on young versus adult cats ($p = .01$) was recorded. However, ticks were significantly higher on adult cats than on young cats ($p = .01$). In conclusion, this study demonstrated great species diversity and high frequency of ectoparasites on dogs and cats in the study area. Further studies are required to investigate the role of these ectoparasites in transmission of zoonotic pathogens to humans and animals in Ethiopia.

1. Introduction

Dogs and cats are the preferred hosts of many species of ectoparasites including fleas, ticks and lice that are vectors and reservoirs for several zoonotic pathogens (Dobler and Pfeffer, 2011). *Ctenocephalides felis* (cat flea), *Ctenocephalides canis* (dog flea), *Pulex irritans* (human flea), *Echidnophaga gallinacea* (the sticktight poultry flea) and *Xenopsylla cheopis* (rat flea) are the flea species most commonly reported from dogs and cats around the world (Dobler and Pfeffer, 2011).

Ctenocephalides felis is a known vector for *Bartonella henselae*, *Bartonella clarridgeiae*, and *Rickettsia felis* which cause cat scratch disease, endocarditis and cat flea typhus in humans, respectively (Eisen and Gage, 2012). Flea-borne bacterial zoonoses (flea-borne spotted fever, murine typhus, cat scratch disease and plague) are common in east African countries but are poorly investigated (Rinaldi et al., 2007). *Xenopsylla cheopis* is the principal vector of *Rickettsia typhi* the causative agent of murine typhus and *Yersinia pestis* the causative agent of plague in human (Bitam et al., 2010). Fleas of pets are also intermediate hosts of helminths including the dog tapeworm *Dipylidium caninum*, which can parasitize humans (Dobler and Pfeffer, 2011). Recently, in Ethiopia, *Bartonella henselae* and *Rickettsia felis* (Kumsa et al., 2014), as well as

Acinetobacter spp. (Kumsa et al., 2012) were reported in fleas collected from dogs and cats. Moreover, Mediannikov et al. (2012) reported *R. felis* from a number of *P. irritans* and *C. felis* collected from human dwellings in south-western parts of the country.

Ticks are one of the most important ectoparasites that impact the welfare and health of dogs and cats worldwide (Marchiondo et al., 2007). Blood feeding behaviour of ticks is associated with clinical signs such as anaemia and tick associated paralysis (Shaw et al., 2001; Walker et al., 2013). Furthermore, ticks are second to mosquitoes as vectors of human infectious diseases (Parola and Raoult, 2001; Jongejan and Uilenberg, 2004). Ticks are vectors and reservoirs of zoonotic bacteria such as *Borrelia burgdorferi*, *Rickettsia africae*, *R. aeschlimannii*, *R. massiliae*, *Anaplasma phagocytophilum*, *Ehrlichia chaffeensis*, *E. canis*, *E. ewingii* and *Coxiella burnetii* which cause emerging zoonoses in humans (Irwin and Jefferies, 2004; Otranto et al., 2009). Recent reports show the growing problems associated with ticks and tick-borne pathogens worldwide due to expanding tick population, global warming and increase in contact between humans, animals and ticks (De La Fuente and Estrada- Peña, 2012). There are several previous reports on hard ticks infesting ruminants (Beyecha et al., 2012; Kumsa et al., 2012), equines (Ferede et al., 2010; Kumsa et al., 2012)

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and camels (Bekele and Zeleke, 2004) in Ethiopia; however, information on ixodid ticks infesting dogs and cats are remarkably scarce.

Lice are also one of the most frequent ectoparasites of domestic animals including dogs and cats. In infested animals, lice may cause unthriftiness, dermatological lesions, anaemia, alopecia due to scratching, biting and rubbing and secondary skin infections (Wall and Shearer, 1997). Lice species known to infest dogs include *Heterodoxus spiniger*, *Trichodectes canis* and *Linognathus setosus* (Agbolade et al., 2008) whereas *Felicola subrostratus*, the sole lice species of cats, is reported to have worldwide distribution. Even though, infestations with *Felicola subrostratus* are not common on cats, it has been reported in Europe, Australia, North and South America, Asia and the Philippines (Bowman et al., 2002; Bahrami et al., 2012). Several earlier reports are available on lice infesting ruminants (Serste and Wossene, 2007; Kumsa and Bekele, 2008; Beyecha et al., 2012; Kumsa et al., 2012) and equines (Tafese et al., 2013), however, data on lice infesting dogs and cats are scarce in Ethiopia. Likewise, information is lacking on the role of lice as vectors of pathogens of veterinary and medical importance in Ethiopia. Recently Kumsa et al. (2012) reported the presence of zoonotic bacteria pathogens from *Heterodoxus spiniger* feeding on dogs, *Linognathus vituli* on cattle, *Bovicola ovis* and keds on sheep from various parts of Ethiopia.

Taken together, compiling information on ectoparasites of dogs and cats in our area of study is very important for public and animal health, and for wildlife conservation. Despite the large population of dogs and cats in Ethiopia, almost all the information on the diversity of ectoparasites infesting domestic animals in Ethiopia emanate from studies on ectoparasites of ruminants and equines. We herein present a report documenting ectoparasites infesting dogs and cats in Bishoftu. Thus, the present study was designed to assess the species diversity and occurrence of fleas, ticks and lice infesting dogs and cats in the town of Bishoftu, central Oromia, Ethiopia.

2. Materials and methods

2.1. Study area

The study was conducted in the town of Bishoftu (8°44′37.69″N 38°59′19.28″E) and its surroundings from September 2009 through April 2010. Bishoftu is located at about 45 km Southeast of Addis Ababa at an altitude of 1880 Meters above sea level (m.a.s.l). It has a total human population of 95,000. The area receives an average annual rainfall of 800mm^3 and has an average maximum and minimum temperature of 30.7 °C and 8.5 °C, respectively, and the mean relative humidity is 61.3% (CSA, 2013).

2.2. Study animals and methodology

A cross-sectional study design was used to assess ectoparasites of dogs and cats found in Bishoftu town by house-to-house visits. In addition, some animals that came to the College of Veterinary Medicine Hospital of Addis Ababa University located at Bishoftu town for consultation on various health reasons were also included in the study. All the study dogs and cats were selected by random sampling irrespective of their sex, age and breed. The sex (female, male), age (young, adult) and breed (indigenous, other) were recorded for each study animal. The animals were categorized into two age groups, as young (up to one year) and adult (greater than one year) as previously used by Kumsa and Mekonnen (2011).

2.3. Ectoparasite collection and identification

Each study dog and cat was thoroughly examined visually for the presence of ectoparasites, including ticks, lice and fleas by going through all parts of the body for about 15–20 min. Feeding live ticks were removed from dogs and cats using forceps. For collection of lice and fleas, each animal was combed using a standard fine metal flea-
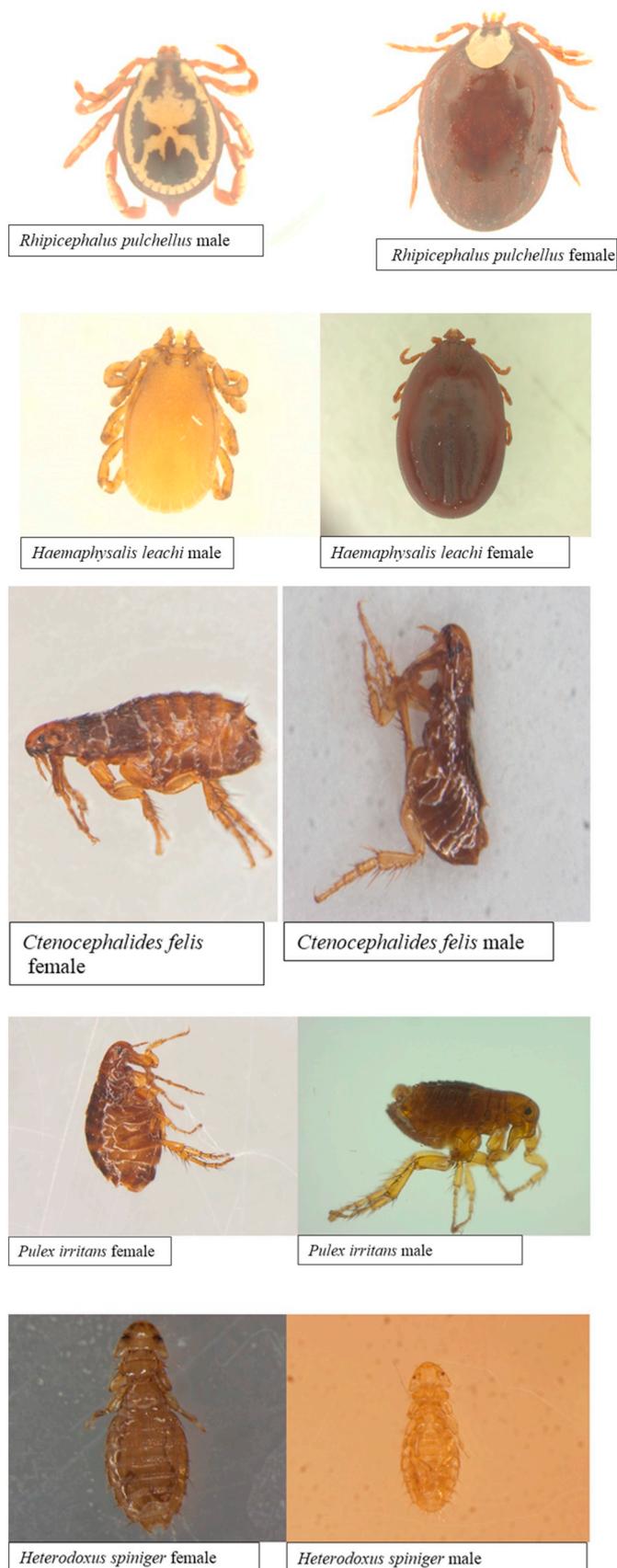

Fig. 1. Photos of some ectoparasites collected from dogs and cats in Bishoftu in central Oromia, Ethiopia.

comb (12 teeth per 1 cm) for 10–15 min (Marchiondo et al., 2007; Kumsa and Mekonnen, 2011). After combing, the flea comb was held over a white plastic tray and fleas and lice collected with forceps from the tray. Ectoparasites collected from each dog and cat were placed in pre-labelled small plastic tubes containing 70% ethanol. Subsequently, each ectoparasite was identified to species level and their sex was determined under a microscope according to the descriptions of Hoogstraal (1956), Okello-onen et al. (1999), Walker et al. (2000) and Walker et al. (2013) (ticks) and Wall and Shearer (1997) and Taylor et al. (2007) (lice and fleas). Adult ticks were identified to species level whereas larvae and nymphs were identified only to genus level (Hoogstraal, 1956; Walker et al., 2000; Walker et al., 2013). Fleas' head shape, length of the first and second spines of the genal comb, number of setae-bearing notches of the dorsal aspect of the hind tibiae and number of setae on the first segment of the neck were used to differentiate *C. felis* as previously described (Beaucournu and Ménier, 1998, Dunnet and Mardon, 1999). Photographs of representative species of the different ectoparasites found were captured (Fig. 1).

2.4. Data analysis

Statistical Package for Social Sciences (SPSS) version 17 was used for statistical analysis. Descriptive statistics such as prevalence and percentages were used to summarize the proportion of infested and non-infested animals. Chi-square (x^2) test was applied to assess significant differences with 95% confidence interval. Differences were considered significant at $P < .05$.

2.5. Ethical statement

Ethical approval for the collection of lice, fleas and ticks from dogs and cats from the study area was obtained from the animal research ethics board (Agreement # 17/168/550/2009) of the College of Veterinary Medicine and Agriculture of Addis Ababa University. All necessary permits were obtained for collection of ticks, lice and fleas from dogs and cats of the study area including permission of administration and agricultural office of the district and from each animal owner.

3. Results

Out of the total 200 domestic dogs examined, 194 (97%) were infested by one or more species of ectoparasites. Similarly, of the 137 cats examined, 124 (90.5%) were infested at with at least one species of ectoparasite (Tables 1). We collected a total of 3554 ectoparasites from infested dogs while a total of 621 specimens were collected from cats (Tables 1).

Our study showed *C. felis* as the predominant species of ectoparasite on dogs with overall frequency of 95% (190/200) and with overall collection of 2706 (1781 females, 925 males) specimens. *Pulex irritans* with overall frequency of 20.5% (41/200) and with total collections of 72 (54 females, 18 males) was the second common flea species infesting dogs followed by *E. gallinacea* 9% (18/200), 138 (91 females, 47 males) and *X. cheopis* 0.5% (1/200), 1 (1f) on dogs. Tick species collected from dogs in order of their respective overall frequency and total collections were: *Ha. leachi* 17.5% (35/200), 167 (36 females, 113 males, 9 larvae, 9 nymphs), *Am. variegatum* 8.5% (17/200), 48 (0 female, 1 male, 29 nymphs, 18 larvae), *Rh. sanguineus* 8% (16/200), 251 (69 females, 159 males, 23 nymphs), *Rh. pulchellus* 5.5% (11/200), 15 (8 females, 7 males), *Rh. decoloratus* 2.5% (5/200), 6 (5 females, 1 male) (Table 1). Lice collected from dogs were *H. spiniger* 5% (10/200), 91 (77 females, 14 males), *L. setosus* 1.5% (3/200), 44 (31 females, 13 males), and *T. canis* 0.5% (1/200), 15 (9 females, 6 males) with their overall and total collections, respectively (Table 1).

Similarly, on cats *C. felis* was encountered as the predominant species with overall frequency of 75.2% (103/137) and 438 (307 females,

131 males) total collections followed by *E. gallinacea* 24.1% (33/137), 150 (113 females, 37 males), *P. irritans* 1.4% (2/137), 3 (2 females, 1 male) and *X. cheopis* 0.7% (1/137), 1 (1female) with overall frequency and total collections, respectively (Table 1). Only two species of ticks were recorded on cats: *Ha. leachi* 10.9% (15/137), 26 (7 females, 18 males, 1 nymphs); and *Am. variegatum* 1.5% (2/137), 2 (0 female, 0 male, 1 larva, 1 nymph) (Table 1) with their overall frequency and total collections, respectively. Lice were not detected on any cats. In both dog and cat hosts *Ha. leachi* was the most frequent tick species followed by *Am. variegatum* and *Rh. sanguineus* (Tables 1). However, *Rh. sanguineus* was the most abundant tick species on dogs. *Heterodoxus spiniger* was the most frequent lice species on dogs (Table 1).

Our study showed higher overall frequency of ectoparasites on dogs than on cats. On dogs a total of 12 different species of ectoparasites were identified while on cats only 7 species of ectoparasites were found. Similarly, significantly higher ($p = .01$) overall count of ectoparasites was recorded in dogs than in cats (Tables 1). Fleas and lice were female biased on both hosts. An overall frequency of 96%, 30.5% and 7% of fleas, ticks and lice was noted on dogs respectively, while on cats the overall frequency of 88.3% of fleas and 12.4% of ticks was obtained (Tables 1-3). The study revealed that the overall frequency and counts of fleas was greater than all the other types of ectoparasites on both dog and cat hosts.

In our study a statistically significant ($p < .05$) difference was not noted in the overall frequency of ticks, fleas and lice between female versus male, young versus adult and indigenous breed versus exotic breed in dogs (Table 2). However, in cats the overall frequency of ticks was significantly higher in adult than young ($p = .01$) whereas the overall frequency of fleas was significantly higher in young than adult cats ($p = .01$) (Table 3).

4. Discussion

The very high overall frequency of ectoparasites recorded on both dogs (97%) and cats (90.5%) in the present study is in line with previous report of overall frequency of 99.5% in dogs and 91.5% in cats of Hawassa in southern Ethiopia (Kumsa and Mekonnen, 2011). This high frequency may be attributed to the presence of favourable climatic conditions important for survival, reproduction and development of various stages of ectoparasites of dogs and cats in the study area. Possibly, it also reflects the nationwide fact that in Ethiopia dogs and cats are normally not treated with ectoparasite preventatives, and only food-producing livestock species receive preventive treatments for ectoparasites to prevent disease transmission (Kumsa and Mekonnen, 2011).

In the present study, the findings of higher frequency, overall count, and total number of species of ectoparasites in dogs than in cats is in agreement with the earlier report of 6 different ectoparasite species in dogs and 3 in cats from other regions in Ethiopia (Kumsa and Mekonnen, 2011), together with the 7 different ectoparasite species in dogs and only 1 species in cats reported in Albania (Xhaxhiu et al., 2009). Taking together, these findings suggest that dogs are preferred hosts for fleas, ticks and lice, while in cats, due to their strong grooming behaviour lower numbers of ectoparasites are found (Eckstein and Hart, 2000). Moreover, dogs have thicker, longer and denser fur that provides a suitable environment with temperature and humidity conditions that allow the survival and development of different stages of ectoparasites, making them preferred hosts over cats (Cañón-Franco and Pérez-Bedoya, 2010).

In the present study, the finding of high overall frequency of *C. felis* in both dogs and cats is in line with the earlier report from Ethiopia (Kumsa and Mekonnen, 2011) and other previous studies elsewhere in the world (Akucewich et al., 2002; Durden et al., 2005; Gracia et al., 2008; Farkas et al., 2009; Tavassoli et al., 2010; Slapeta et al., 2011). *C. felis* is generally regarded as the predominant flea species found on dogs and cats, replacing *C. canis* on domestic dogs in many countries worldwide. This is possibly due to the greater adaptation to wider range

Table 1
Frequency of tick, flea and lice species on domestic dogs (*n* = 200) and cats (*n* = 137) in Bishoftu.

Animal species	Dog			Cat		
Ectoparasite species	No. positive	Frequency (%)	Infestation intensity (range)	No. positive	Frequency (%)	Infestation intensity (range)
Ticks						
Amblyomma variegatum	17	8.5	48 (1 − 21)	2	1.5[d]	2 (1)
Haemaphysalis leachi	35	17.5[c]	167 (1–17)	15	10.9[c]	26(1–8)
Rhipicephalus pulchellus	11	5.5[d]	15 (1–2)	0	NA	NA
Rhipicephalus sanguineus	16	8	251 (1–181)	1	0.7	1 (1)
Rhipicephalus (Bo.) decoloratus	5	2.5	6 (1–2)	0	NA	NA
Lice						
Heterodoxus spiniger	10	5	91 (1 − 20)	0	NA	NA
Trichodectus canis	1	0.5	15 (15)	0	NA	NA
Linognathus setosus	3	1.5	44 (1–40)	0	NA	NA
Fleas						
Ctenocephalides felis	190	95[a]	2706 (1–35)	103	75.2[a]	438 (1 − 10)
Pulex irritans	41	20.5[b]	72 (1–5)	2	1.4	3 (1–2)
Echadnophaga gallinacea	18	9	138 (1–42)	33	24.1[b]	150 (1–27)
Xenopsylla cheopis	1	0.5	1 (1)	1	0.7	1 (1)

a*b = (shows significantly higher (*p* = .0000) frequency of *C. felis* than *P. irritans* in dogs).
C*d = (shows significantly higher (*p* = .01) frequency of *Ha. leachi* than *Rh. pulchellus* in dogs).
a*b = (shows significantly higher (*p* = .001) frequency of *C. felis* than *E. gallinacea* in cats).
c*d = = (shows significantly higher (*p* = .007) frequency of *Ha. leachi* than *Am. variegatum* in cats).

of environmental factors in *C. felis* than the other flea species (Gracia et al., 2008; Slapeta et al., 2011). The absence of *C. canis* on dogs and cats in Bishoftu town might reflect the previous argument that *C. felis* is the most common flea in urban areas whereas *C. canis* is most common in rural areas (Durden et al., 2005; Marchiondo et al., 2007).

The findings of *P. irritans* as a second most frequent species followed by, *E. gallinacea* and *X. cheopis* on dogs and cats in the current study agrees with several previous reports from Spain (Gracia et al., 2008), USA (Durden et al., 2005), Greece (Koutinas et al., 1995) and southern Italy (Rinaldi et al., 2007). This might reflect the narrow environmental requirements for their survival, development and reproduction by this flea species as compared to *C. felis*.

Significantly higher frequency of *P. irritans* in dogs than cats may reflect the closer association of dogs to humans than cats. Similarly, the higher frequency of *E. gallinacea* in cats than in dogs may reflect the greater association and exposure of cats to chickens or wild birds than dogs, as has been suggested earlier by others (Gracia et al., 2008). It has been accepted that *E. gallinacea* is a species frequently found on birds, and occasionally reported on dogs and cats, due to transient infestations through contact with infested birds. In our study we only retrieved one specimen from a dog and another *Xenopsylla cheopis* from a cat, suggesting the incidental and transient infestation of dogs and cats by this flea species. We can speculate that such infestations were most possibly acquired during hunting activities or from contact with rodents or other wild vertebrates (Koutinas et al., 1995).

The higher count of female than male fleas and lice recorded in our

study is in line with other studies (Koutinas et al., 1995; Alcaino et al., 2002). It might be attributed to factors such as in many flea species females feed on blood for a much longer time period than male fleas, higher female survival rates, greater ability of females to evade capture during host grooming, or possibly, males may spend more time off the host. Thus, males are more prone to predation or to starvation (Durden et al., 2005; Gracia et al., 2008).

The finding of *Ha. leachi* as the most frequent tick species on both dogs and cats in our study shows that this tick species normally infests dogs and cats in East Africa. This observation agrees with the previous work of Mekonnen et al. (2007) in Ethiopia. The highest abundance of *Rh. sanguineus* than all the other tick species on dogs most probably reflects the variation in the biology and biotic potential of different tick species (Dantas-Torres, 2008). Dogs are the preferred hosts for *Rh. sanguineus* (Wall and Shearer, 1997). The other tick species recorded in small numbers on dogs and cats in the present study are the main tick species infesting domestic ruminants in Ethiopia (Pegram et al., 1981). This suggests that in fact, in Ethiopia ruminants usually share the same environment with dogs and cats, and thus their ectoparasites.

The frequency of *H. spiniger* (5%) in the present study is higher than previously reported by Kumsa and Mekonnen (2011) but lower than the reports by Temessegen (1990) (45%) in eastern Harerge in Ethiopia. This might be attributed to several factors including differences in the time of the study and animal management among these study areas.

A possible explanation for the higher frequency of ticks on adult than young cats might be due to the fact that those young cats of less

Table 2
Overall frequency of ticks, fleas and lice in dogs by sex, age and breed.

	Number examined			Ticks		Lice		Fleas	
	Total	Positive	Frequency	Positive	Frequency	Positive	Frequency	Positive	Frequency
Sex									
Male	135	132	97.8%	45	33.3%	10	7.4%	128	94.8%
Female	65	62	95.4%	16	24.6%	4	6.1%	64	98.5%
Age									
Young	56	55	98.2%	14	25%	6	10.7%	52	92.9%
Adult	144	139	96.5%	47	32.6%	8	5.6%	140	97.2%
Breed									
Indigenous	123	122	99.2%	36	29.3%	8	6.5%	121	98.4%
Exotic	77	72	93.5%	25	32.5%	6	7.8%	71	92.2%
Total	200	194	97%	61	30.5%	14	7%	192	96%

Table 3
Overall frequency of ticks and fleas in cats by sex and age in Bishoftu.

	Number examined			Ticks		Fleas	
	Total	Positive	Frequency	Positive	Frequency	Positive	Frequency
Sex							
Male	50	46	92%	5	10%	44	88%
Female	87	78	89.6%	12	13.8%	77	88.5%
Age							
Young	45	43	95.5%	2	4.4%[b]	43	95.6%[c]
Adult	92	81	88.04%	15	16.3%[a]	78	84.8%[d]
Total	137	124	90.5%	17	12.4%	121	88.3%

a*b = (shows significantly higher (p = .01) overall frequency of ticks on adult than young cats).
c*d = (shows significantly higher (p = .01)overall frequency of fleas on young than adult cats).

than one year of age are usually confined to the house and had less exposure to tick infestation as has been suggested before (Kumsa and Mekonnen, 2011). Significantly higher frequency of fleas on young than adult cats observed in our study reflects less developed immunity and grooming in young animals (Gracia et al., 2008). Also, fleas are normally found in and around houses and hence there is greater chance of infestation on young cats that are usually confined to the houses.

In conclusion, this study demonstrated high species diversity and frequency of different ectoparasites that may play an important role in compromising the health and welfare of dogs and cats of the study area. Given that the majority of human population in Ethiopia live in close contact with domestic animals including dogs and cats, humans in the study area could be at risk of infection with zoonotic pathogens transmitted by these ectoparasites. Further studies are urgently needed to clarify the role of these ectoparasites in transmission of zoonotic pathogens and detail studies utilizing molecular and MALDI TOF (Murugaiyan and Roesler, 2017) methods are also required to investigate the exact identity of very closely related species and subspecies of these arthropods in different parts of Ethiopia.

Declarations of interest

None

Ethical statement

Ethical approval for the collection of lice and flies from dogs and cats from the study area was obtained from the animal research ethics board (Agreement # 17/168/550/2010) of the College of Veterinary Medicine and Agriculture of Addis Ababa University. All necessary oral permits were obtained for collection of ticks, lice and fleas from dogs and cats of the study area including permission of administration and agricultural office of the district and from each animal owner. Ectoparasite collections are not harmful and are not against the welfare of animals. No collection had been done from privately owned, wildlife, national park or other protected areas and endangered or protected species.

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