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Ectoparasites of Small Mammals in Grakahsu - Hugumbirda State Forest, Northern Tigray, Ethiopia

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Abstract: Rodents are known reservoirs of numerous pathogens of public health and veterinary importance, causing severe diseases such as plague, Lassa fever, rickettsiosis, leptospirosis, toxoplasmosis, leishmaniasis and trichinosis. The study was carried out from February 2011 to May 2012 in Grakahsu - Hugumbirda state forest with the aim of investigating ectoparasites on small mammals. Two 60 x 60 m square grids were set in bushland and grassland habitats. Each grid was consisted of 7 parallel lines, 10 m apart, with trapping station also 10 m apart (i.e. a total of 49 trapping stations per grid). The trapping stations were identified by labels A to G and numbered 1 to 7. In each gird, trapping was conducted intensively for 3 consecutive days. The trapped small mammals were anesthetized using ethyl ether. Fur of rodents emphasizing on their belly, ear and tail regions was combed with a fine tooth brush to release ectoparasites. Data collected on species composition and infestation rate of ectoparasites was analyzed. A total of 451 ectoparasites belonging to nine species parasitizing the rodents were collected. The recovered ectoparasites taxa were *Xenopsylla cheopis*, *Ornithodoros* sp, *Boophilus* sp, *Rhipicephalus* sp, *Ixodes* sp, *Amblyomma* sp, *Otobius* sp, *Laelaps* sp and *Polyplax* sp. Higher (65.6%) overall infestation of rodents by ectoparasites were recovered in the grassland and the least was (35.4%) in the bushland habitat. The most abundant ectoparasite species infesting the host was the mite *Laelaps* sp., except *Acomys* sp. most infested by the flea *X. cheopis*. *Laelaps* sp. recorded the highest prevalence in most of the hosts while *X. cheopis* prevalence was higher in *Acomys* sp. The highest mean abundance (10.1%) was calculated for *Laelaps* sp. in *G.robustus.* The highest ectoparasite prevalence (81.8%) was recorded for *Laelaps* sp. from *M. awashnesis* and the highest host preference (85%) was calculated for the tick *Ornithodoros* sp. from *Acomys* sp. *X. cheopis* and all the tick species preferred most *Acomys* sp. as a host. The work presented here provides baseline information on the species of ectoparasites of small mammals in Grakahsu - Hugumbirda state forest. Further Study on the ecology of medically important arthropod ectoparasites of small mammals should be done along human settlements of the state forest.

Key words: Grakahsu - Hugumbirda · Ectoparasites · Small Mammals · Rodents · Host

INTRODUCTION

Rodents are known reservoirs of numerous pathogens of public health and veterinary importance, causing severe diseases such as plague, Lassa fever, rickettsiosis, leptospirosis, toxoplasmosis, leishmaniasis and trichinosis [1]. Humans become infected when they get in touch with the rodents or their excretion, through vectors like fleas or ticks, or during utilization of other hosts that have been contaminated by rodents [2]. The most important negative impact of rodent – borne zoonosis is the loss of human health and lives, zoonotic diseases certainly contribute to poverty through lost days of productivity and medical treatment operating cost [3]. Arthropod ectoparasites are varied and highly adapted groups of animals that feed on their hosts, usually vertebrate hosts. Some ectoparasites species are host-specific, where as others are able to make use of a wider range of hosts. Most studies on rodent ectoparasite associations in Africa emphasize on rodents trapped

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around human housings to see their potential impact on public health [2] found highest infestation of rodent with ectoparasites in residential apartments as a result of poor housing and accumulation of solid waste near residential areas in Makurdi, Nigeria. Research regarding rodent ectoparasite associations is rare in Ethiopia. However, there are a number of reports on livestock - ectoparasite association in various parts of Ethiopia. Forty seven tick species of veterinary importance have been reported in different part of Ethiopia most of them have importance as vectors and damaging effect on skin and hide production of livestock [4] However, rodent ectoparasite association in relation to wild ecosystem is poorly studied in our locality. Therefore, this study is aimed at investigating ectoparasites of small mammals in Grakahsu - Hugumbirda State Forest, Northern Tigray, Ethiopia.

MATERIALS AND METHODS

Descrption of the Study Area: Grakahsu-Hugumbirda state forest is located between 12° 22' and 12° 42'N, 39° 28' and 39° 40' E (Fig. 1) at an altitude ranging from 1560 - 3600 mater above sea level. The mean annual minimum temperature of the study area is 12.8°C and the mean annual maximum temperature is 25.3°C. The hottest month is June with a mean maximum temperature of 25.2°C and the coldest is October with a mean minimum temperature of 11.8°C. The mean annual rainfall of the study area is 628.8 mm.

Habitat Description

Floral Description: Grakahsu - Hugumbirda state forest has total area coverage of 21, 654.24 hectare [5] Out of this about, 532.75 hectare is forest plantation whereas the rest contains disturbed natural forest, bushland, agricultural plots and settlement area [5]. The forest holds 102 species belonging to 83 genera and 50 families. *Juniperus procera, Olea europaea, Nuxia congesta, Cassipourea mallosana* and *Olinia rochetiana* were the most dominant tree species [5].

Methods: Two 60 x 60 m square grids were set in bushland and grassland habitat. Each grid was consisted of 7 parallel lines, 10 m apart, with trapping station also 10 m apart (i.e. a total of 49 trapping stations per grid). The trapping stations were identified by labels A to G and numbered 1 to 7.

In each gird, trapping was conducted intensively for 3 consecutive days. Rodents were anesthetized with ether in the temporary laboratory in the field and handled following the ethical policies and guidelines approved by the department of biology (Mekelle University). Fur of rodents emphasizing on their belly, ear and tail regions was combed with a fine tooth brush to release ectoparasites.

Forceps were also used to remove ticks and mites from the skin of rodents when it was difficult to dislodge them by combing (Fig. 4). The ectoparasites were

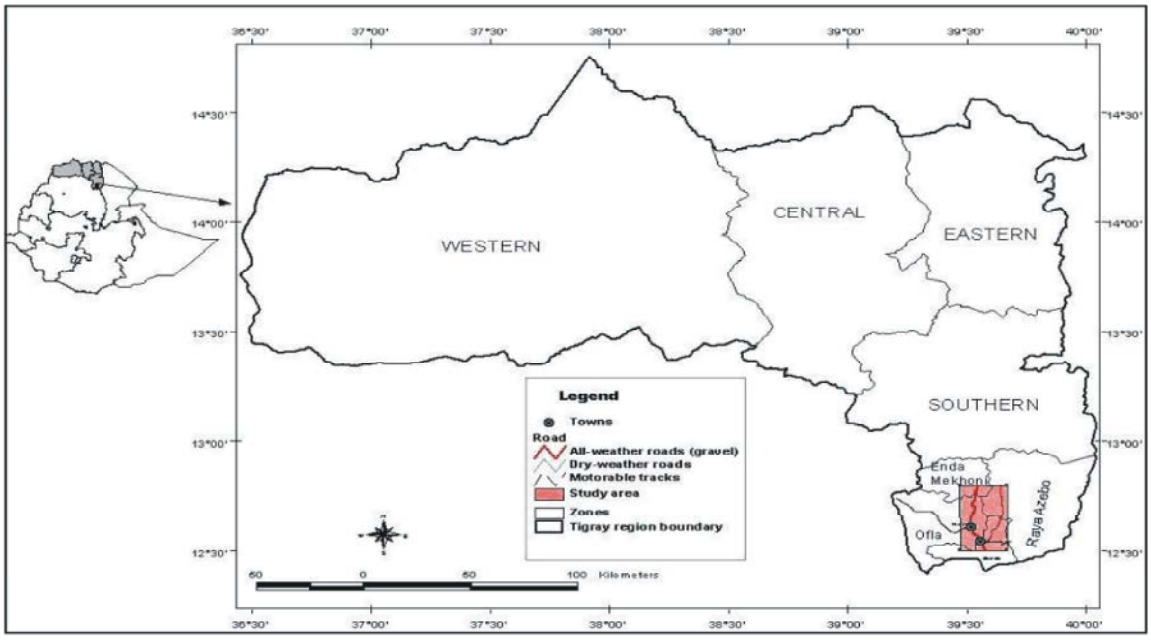

Fig. 1: Map of the study area (left Ethiopia, right map of Tigray: the study site)

Fig. 2: Field survey sites of small mammals for ectoparasites

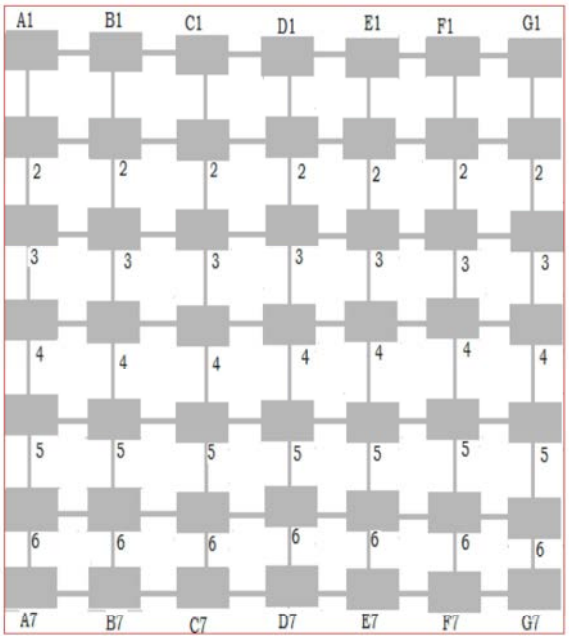

Fig. 3: Trap station of small mammals for ectoparasites

(A) 

(B) 

Fig. 4: A): Brushing of ectoparasites from rodents B) Dislodging of ectoparasites through forceps (Photo: by Kiros Weldegerima)

preserved in separate vials containing 70 % ethanol and transported to Mekelle University zoology laboratory. The ectoparasites were identified to genus and species levels according to Wall [2].

RESULTS

A total of 451 individual ectoparasites belonging to 9 species were recovered from the rodents trapped in the bushland and grassland habitats of Grakahsu - Hugumbirda state forest. The species recorded were: 1 flea species Xenopsylla cheopis, *6* tick species *Ornithodoros* sp, *Boophilus* sp., *Rhipicephalus* sp., *Amblyomma* sp., *Ixodes* sp, *Otobius* sp., 1 mite species *Laelaps* sp. and 1 louse *Polyplax* sp.

Of the 94 individual rodents 62 (66%) from bushland and 32 (34%) from grassland habitats, were examined for ectoparasites. Ectoparsite infestation was highest in the rodents trapped from the bushland habitat (63.8%) compared to rodents trapped from the grassland habitat (36.8%) (Table 2). Of the infested rodents single infestation was higher (59.1 %) in the rodents captured in the bushland habitat and the lower in the bushland habitat (40.99%). Coinfestation was also higher (65.8%) in the bushland and it was lower in the bushland habitat (34.2%).

Host Preference, Mean Abundance and Prevalence of Ectoparasite of Rodents: *Acomys* sp. was infested by the highest (9) ectoparasites species, followed Mastomys awashnesis by 8, Arvicanthis. dembensis by 5, *Gerbilliscus robustus, Promyaus* sp. and Mus setulosis were infested by *3* ectoparasite species each (Table 3). The most abundant ectoparasite species infesting the host was the mite *Laelaps* sp., except *Acomys* sp. most infested by the flea *X.cheopis* (Table 3).

The tick species were commonly infesting *Acomys* sp. and *M. awashnesis* but absent or rare in *G. robustus*., *Praomys* sp. and *M. setulosis*. *Laelaps* sp. recorded the highest prevalence in most of the hosts while *X. cheopis* prevalence was higher in *Acomys* sp.

The most abundant (29.2%) ectoparasite infesting *Acomys* sp. was the flea *X. cheopis* (Table 3). The most abundant ectoparasite was Laelaps sp. recovered from *G. robustus* (n=101) (Table 3). The highest mean abundance (10.1) was calculated for *Laelaps* sp. in *G. robustus.*

The highest ectoparasite prevalence (81.8%) was recorded for *Laelaps* sp. from *M. awashnesis* and the highest host preference (85) was calculated for the tick *Ornithodoros* sp. from *Acomys* sp. *X. cheopis* and all the tick species preferred most *Acomys* sp. as a host (see HP values). On the other hand *Laelaps* sp preferred most *G.robustus* as a host (HP=37.8).

Rodent - Ectoparasite Associations along Host Sex: Of the total 94 rodents examined for ectoparasites 45 (47.9%) were males and 49 were (52.1%) females (Table 4), (52.8%) infestation of ectoparasites was recorded in male rodents and (47.2%) in the female. There is no statistically significance difference in the overall abundance of ectoparasites on male and female rodents (P = 1.000).

Table 1: Species composition of ectoparasites on small mammals along Bush and Grassland habitat of Grakahsu - Hugumbirda state forest

Species	Bush	Grass	Total	Relative abundance (%)
Acarid (Mites)				
Laelaps sp.	171	96	267	59.2
Siphonaptera (Flea)				
X. cheopis	49	43	92	20.4
Acarid (Tick)				
Otobius sp.	7	20	27	6
Boophilus sp.	22		22	4.9
Ornithodoros sp.	18	2	20	4.4
Rhipicephalus sp.	11	1	12	2.7
Ixodes sp.	5	–	5	1.1
Amblyomma sp.	1	–	1	0.2
Anaplura (Louse)				
Polyplax sp.	2	3	5	1.1
Total	286	165	451	100

Table 2: Infestation rate of ectoparasites of small mammals along Bush and Grassland habitat of Grakahsu - Hugumbirda state forest

	No. of hosts examined		Number of hosts infested		Single infestation		Coinfesation		Bushland		Grassland	
Host species	Bushland	Grassland	Bushland	Grassland	Bushland	Grassland	Bushland	Grassland	Min	Max	Min	Max
Acomys sp.	34(55)	15(46.9)	19(55.9)	8(53.3)	9(47.4)	5(62.5)	10(52.6)	3(37.5)	1	5	1	3
A. dembeensis	10(16)	3(9.4)	7(70)	2(66.7)	3(30)	1(50)	3(42.9)	1(50)	1	3	1	3
M. awashensis	6(10)	5(15.6)	6 (100)	4(80)	–	–	6(100)	4(100)	2	6	2	3
G. robustus	6(10)	4(12.5)	5(83.3)	3(75)	1(20)	1(33.3)	4(80)	2(66.7)	1	2	1	2
Praomys sp.	2(3)	3(9.4)	1(50)	3(100)	–	1(33.3)	1(100)	2(66.7)	2	2	1	2
M. setulosus	3(5)	1(3.1)	2 (66.7)	1(100)	–	1(100)	2(100)	–	2	2	1	1
Gerbillus sp.	1(2)	1(3.1)	–	–	–	–	–	–	–	–	–	–
Total	62(66)	32(34)	40(64.5)	21(65.6)	13(32.5)	9(42.9)	26(65)	12(57.1)				

Table 3: Percent infestation (in parenthesis), mean abundance (MA), prevalence (P) and host species preference (HP) for every ectoparasites associated with rodents trapped from bush and grassland habitats on Grakahsu - Hugumbirda state forest

	Acomys sp. (n=49)				*G. robustus* (n=10)				*M. awashensis* (n=11)			
Ectoparasites	Count	MA	P (%)	HP	Count	MA	P (%)	HP	Count	MA	P (%)	HP
Siphonaptera (flea)												
X.cheopis	38(29.2)	0.8	26.5	41.3	19(15.6)	1.9	60	20.6	10 (9)	0.9	45.5	10.9
Acarid (tick)												
Ornithodoros sp.	17(13.1)	0.3	14.3	85	–	–	–	–	3 (2.7)	0.3	18.2	15
Boophilus sp.	14 (11)	0.3	16.3	63.6	–	–	–	–	4 (3.6)	0.4	9.1	18.2
Rhipicephalus sp.	8 (6)	0.2	12.2	66.7	–	–	–	–	1(0.9)	0.1	9.1	8.3
Amblyomma sp.	1 (1)	0.02	2.04	100	–	–	–	–	–	–		
Ixodes sp.	4 (3)	0.1	4.08	80	–	–	–	–	1 (0.9)	0.1	9.1	20
Otobius sp.	14 (11)	0.3	8.16	51.9	–	–	–	–	7 (6.3)	0.6	27.3	26
Acarid (mite)												
Laelaps sp.	32(24.6)	0.7	18.4	12.0	101(82.2)	10.1	60	37.8	84(75.7)	7.6	81.8	31.5
Anoplura (louse)												
Polyplax sp.	2 (2)	0.04	2.04	40	2 (1.6)	0.2	20	40	1(0.9)	0.1	9.1	–
Total	130(28.8)				122(27.1)				111(24.6)			

Table 4: Percent infestation (in parenthesis), mean abundance (MA), prevalence (P) and host species preference (HP) for every ectoparasites associated with rodents trapped from bush and grassland habitats on Grakahsu - Hugumbirda state forest

	A. dembensis (n=13)				*Praomys* sp. (n=5)				*M. setulosis*(n=4)				
Ectoparasites	Count	MA	P (%)	HP	Count	MA	P (%)	HP	Count	MA	P (%)	HP	Overall
Siphonaptera (flea)													
X. cheopis	19(36.5)	1.5	38	20.7	3 (17.6)	0.6	40	3.3	3 (15.8)	0.8	25	3.3	92(20.4)
Acarid (tick)													
Ornithodoros sp.	–	–			–	–	–	–	–	–			20 (4.4)
Boophilus sp.	2(3.8)	0.2	7.7	9.1	–	–	–	–	2 (10.5)	0.5	25	9.1	22 (4.9)
Rhipicephalus sp.	3 (5.8)	0.2	7.7	25	–	–	–	–	–	–	–	–	12 (2.7)
Amblyomma sp.	–	–		–	–	–	–	–	–	–	–	–	1 (0.2)
Ixodes sp.	–	–		–	–	–	–	–	–	–	–	–	5 (1.1)
Otobius sp.	5 (9.6)	0.4	15	18.5	1 (5.9)	0.2	20	3.7	–	–	–	–	27 (6)
Acarid (mite)													
Laelaps sp.	23(44.2)	1.8	46	8.6	13(76.5)	2.6	80	4.9	14(73.7)	3.5	50	5.2	267 (59.2)
Anoplura (louse)													
Polyplax sp.	–	–	–	–	–	–	–	–	–	–			5(1.1)
Total	52(11.5)	–	–	–	17(3.8)	–	–	–	19(4.2)	–			–

Table 4: Ectoparasites infestation in relation to host sex (Percent contribution in parenthesis)

Host species	Ectoparasites	Male	Female	Total
Acomys sp. (n = 49)	Siphonaptera (flea)			
	X. cheopis	16(22.9)	22 (36.7)	38(29.2)
	Acarid (tick)			
	Ornithodoros sp.	15(21.4)	2 (3.3)	17(13.1)
	Boophilus sp.	5 (7.1)	9 (15)	14(10.8)
	Rhipicephalus sp.	3 (4.3)	5 (8.3)	8 (6.2)
	Amblyomma sp.	–	1 (1.7)	1 (0.8)
	Ixodes sp.	4 (5.7)	–	4 (3.1)
	Otobius sp.	7 (10)	7 (11.7)	14(10.8)
	Acarid (mite)			
	Laelaps sp.	18(25.7)	14 (23.3)	32(24.6)
	Anoaplura (louse)			
	Polyplax sp.	2 (2.9)	–	2(1.5)
	Total	70(53.8)	60 (46.2)	130(100)
G. robustus (n= 10)	*X. cheopis*	13(20.3)	6 (10.3)	19(15.6)
	Laelaps sp.	50(78.1)	51 (87.9)	101(82.8)
	Polyplax sp.	1 (1.6)	1 (1.7)	2 (1.6)
	Total	64(52.5)	58 (47.5)	122(100)
M. awashensis (n= 11)	*X. cheopis*	4 (7.3)	6 (10.7)	10 (9)
	Ornithodoros sp.	–	3 (5.4)	3 (2.7)
	Boophilus sp.	–	4 (7.1)	4 (3.6)
	Rhipicephalus sp.	–	1 (1.8)	1(0.9)
	Ixodes sp.	–	1 (1.8)	1 (0.9)
	Otobius sp.	1 (1.8)	6 (10.7)	2 (1.8)
	Laelaps sp.	50 (91)	34 (61)	84(75.7)
	Anaplura (louse)			
	Polyplax sp.	–	1 (1.8)	1 (0.9)
	Total	55 (50)	56 (50)	111(100)
A. dembeensis (n = 13)	*X. cheopis*	6 (30)	13 (40.6)	19 (36.5)
	Boophilus sp.	2 (10)	–	2 (3.8)
	Rhipicephalus sp.	–	3 (9.4)	3 (5.8)
	Otobius sp.	1 (5)	4 (12.5)	5 (9.6)
	Laelaps sp.	11 (55)	12 (37.5)	13 (25)
	Total	20 (38.4)	32 (61.5)	52(100)
Praomys sp. (n = 5)	*X.cheopis*	3 (30)	–	3 (17.6)
	Otobius sp.	–	1 (14.3)	1 (5.9)
	Laelaps sp.	7 (70)	6 (85.7)	13 (76.5)
	Total	10 (58.8)	7 (41.2)	17(100)
M. setulosus (n = 4)	*X. cheopis*	3 (15.8)	–	3 (15.8)
	Ornithodoros sp.	2 (10.5)	–	2 (10.5)
	Laelaps sp.	14 (73.7)	–	14 (73.7)
	Total	19 (100)	0	19 (100)
Overall		238(52.8)	213(47.2)	451(100)

More male individuals of *Acomys* sp., *G. robustus* and *Proamys* sp. were infested by ectoparasites compared to the female individuals. On the other hand more female individuals of *A. dembensis* were infested by with ectoparasites than the males. Ectoparsite infestation was almost even between male and female individuals of *M. awashnesis*.

DISCUSSION

A total of 451 arthropod ectoparasites belonging to four groups (flea, tick, mite and louse) and nine different species were recovered from the rodents trapped in both the bushland and grasslands habitats along the five altitudinal gradients. Flea, mite and louse were

represented by one species each and ticks were represented by six species. This was in agreement with a study conducted on ectoparasites infesting rodents in agricultural fields and human settlement in the highlands of Tigray where they recovered similar set of four ectoparasite groups from rodents [6] However, they have reported five flea species infesting rodents (compared to one species in the current study) of which *X. cheopis* was the most abundant flea species in both agricultural fields and human settlement.

The overall ectoparasite infestation in the rodents was ~65%, while it infestation was 63.8% in bushland and 36.8% in grassland habitats (irrespective of altitude). The study by Meheretu *et al.* [6] reported 66% and 47% ectoparasite infestation in rodents trapped from crop fields and household compounds, respectively, in Tigray.

This shows that most of the ectoparasites were not host-specific (able to exploit a wider spectrum of hosts) and also explains the possibility of high interspecific competition among the ectoparasites on the hosts. On the other hand, from biological point of view, the fitness of a host (e.g. competitive ability, immune strength and reproductive capacity) is more likely to be compromised when infested by several ectoparasites [2]. From medical point of view, the probability that a given host would be infected with vector-borne diseases is potentially higher when infested by diverse ectoparasites, given the ectoparasites are known vectors of diseases [7]. Conversely the probability that a given host would act as reservoir/host of zoonotic diseases would be higher when infested by diverse ectoparasite vectors [3]. It is worth mentioning here that particularly the lower and upper altitudes (edges) of the Grakahsu forest were not free from grazing animals and human presence (e.g. collecting firewood, fodder, agricultural expansion). The likelihood of transmission of rodent-borne diseases to humans and domestic animals depends up on the rate/frequency of contact between rodents and man and domestic animals [7]. The conditions that facilitate transmission of infectious agents from rodents to man and domestic animals vary and transmission can occur either by direct contact or through the bite of arthropod ectoparasites carrying the pathogens. For instance, the flea *X. cheopis*, the second most common ectoparasite species recovered from the rodents in the study area has been known as a vector of murine typhus [2]. *Xenopsylla cheopis* has also been reported to have relevance with respect to flea-borne zoonoses, including plague, in neighboring Kenya and Tanzania [8]. *Amblyomma* sp. has been reported as the major tick infesting cattle in eastern Ethiopia where it was associated with the infection of ehrlichiosis among the cattle [9]. The louse *Polyplax* sp. collected from rodents in Addis Ababa has been tested positive for murine typhus [10].

Acomys sp. (the most abundance host species) was infested by the highest number (9) of ectoparasites species, followed by *M. awashnesis* (7) and *A. dembensis* (5). In the current study more *X. cheopis* was recovered from *Acomys* sp (HP values also confirm this). Contrary to this result, more *X. cheopis* was recovered from *M. awashnesis* and *A. dembensis* than *Acomys* sp. in human settlements and agricultural fields [6].

The occurrence and abundance of a particular ectoparasite species on host species might be related to several factors, including as a result of the behavior of the host as well as habitat/microhabitat features [8]. The tick species were commonly infesting *Acomys* sp. and *M. awashnesis* but absent or rare in *G. robustus*, *Proamys* sp. and *M. setulosis* (HP values also confirm this). Contrary to this result, ticks were very commonly recovered from *A. dembensis* in human settlement and agricultural fields, but rarely in *Acomys* sp. [6] In the current study, the most abundant ectoparasite *Laelaps* sp. recovered predominantly from *G. robustus* and *M. awashensis* (HP values also confirm this). [6] also recovered more *Laelaps* sp. from *M. awashensis* in both human settlements and agricultural fields. However, they did not trap *G. robustus* from both habitats.

Although the proportion of male individuals infested by ectoparasites was higher (52.8%) than those of the females (47.2%), the difference was not statistically significant (P = 1.000). Theoretically the proportion of males infested by ectoparasites is expected to be higher than that of the females due to obvious intersexual difference in home-range size, where males show large home-range and increased movement (e.g. in search of mates) [3] and therefore, have increased likelihood of being infested by ectoparasites.

CONCLUSION AND RECOMMENDATIONS

Rodent-ectoparasite association was influenced by variation in habitat type and altitudes. It was observed that the proportion of ectoparasite recovered from the rodents was higher in the bushland habitat compared to the grassland habitat, in line with the abundance of the hosts. From the current result and [6] it could be inferred that the two dominant ectoparasites infesting rodents in Tigray (*Laelaps* sp. and *X. cheopis*) have wider

distribution and host species. The veterinary and medical importance of the rodents and their associated ectoparasites might also be a topic of interest for future research work particularly at the lower and higher edges of the forest where human settlements were observed.

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