

Ectoparasites of hares (*Lepus europaeus* Pallas) in Konya Province, Turkey

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Abstract: This study was conducted to detect ectoparasites of hares (*Lepus europaeus* Pallas) between the years of 2003 and 2015 in Konya Province, Turkey. In this period, 75 hares shot by hunters were examined for ectoparasites macroscopically. Ectoparasites detected on the hares were collected with pliers and stored in tubes containing 70% ethanol. The ticks were identified under a stereo zoom microscope. Other parasites were cleared in 10% KOH, rinsed in distilled water, and transferred to 70%, 80%, and 99% ethanol, respectively, and mounted on slides in Canada balsam. They were identified under a binocular light microscope. The results showed that 33 (44%) of the 75 hares were infested with a total of 309 ectoparasites. Four lice species (Phthiraptera), *Haemodipsus lyriocephalus*, *H. setoni*, *H. leporis*, and *Menacanthus* spp.; two flea species (Siphonaptera), *Pulex irritans* and *Nosopsyllus fasciatus*; three mite species, *Cheyletiella parasitivorax*, *Dermanyssus gallinae*, and *Neotrombicula* (*N.*) *autumnalis*; four ixodid tick genera, *Ixodes*, *Haemaphysalis*, *Rhipicephalus*, and *Dermacentor*; and one ixodid tick species, *Haemaphysalis parva*, were detected on the infested hares. In addition to these, thirteen ixodid and two argasid tick larvae were found on the hares.

Key words: Louse, flea, tick, mite, *Neotrombicula*, *Cheyletiella*

1. Introduction

Lepus europaeus is a cosmopolitan species and found in almost all parts of Turkey. The lice, fleas, and ticks, as well as some other ectoparasites found on hares, suck blood and cause irritation and anemia when found in large quantities on the host. It has been generally accepted that *Leporacarus gibbus* is a scavenger on skin and hair detritus and that *Cheyletiella parasitivorax* feeds on tissue fluids after piercing the skin of the rabbit and causes skin irritation on the back (1,2). Lice, ticks, and fleas are vectors of zoonotic pathogens and they can transmit some pathogenic agents to wild mammals and humans (1,3–6). *Haemodipsus lyriocephalus*, *H. ventricosus*, and *H. setoni* can transmit tularemia to their hosts (4,5), while *Spilopsyllus cuniculi* is an important vector of rabbit myxomatosis (1,3).

Two hundred and ninety-six hares (*L. europaeus*) were examined for endoparasites and ectoparasites, 272 of which were found to be infested with parasites and two ectoparasite species, *L. gibbus* and *S. cuniculi*, in northern Germany between years of 1990 and 1993 (7). In another study (2) in the Daejeon area of South Korea, 164 (65.3%) of 251 examined rabbits were found to be infested with ectoparasites of three species: *C. parasitivorax* (60.6%), *Psoroptes cuniculi* (2.8%), and *Ornithonyssus bacoti* (1.9%). The sucking lice occurring on wild rabbits are represented

by the genus *Haemodipsus*. It was reported that *H. ventricosus* from chickens (8) and *H. lyriocephalus*, *H. setoni*, and *Haemodipsus leporis* from hares (*L. europaeus*) were detected in earlier studies in Turkey (9–11).

There are relatively limited data published on ectoparasites of rabbits and hares in Turkey and some of these studies contain no information about the host species. The prevalence of ectoparasites was declared in some of these studies or reviews (8–14), while others were only case reports (15–18). It was reported that *Cimex hemipterus* (as *Cimex rotundatus* in the paper), *S. cuniculi*, *P. cuniculi*, *Otodectes cynotis*, *Neotrombicula* (*N.*) *autumnalis* (*Trombicula autumnalis* in the paper), *C. parasitivorax*, *Ornithodoros lahorensis*, *Ixodes hexagonus*, and *Hyalomma excavatum* were detected on rabbits and hares in Turkey up to 1965 (8). Aksin and Aksin (13) recorded 27 (71.05%) of 38 wild rabbits infested with 27 ectoparasites and detected five species: *C. parasitivorax*, *Rhipicephalus bursa*, *Hae. parva* (*Haemaphysalis otophila* in the paper), *T. autumnalis*, and *Ctenocephalides canis*. Until now, there has been no study carried out about ectoparasites of the hares in Konya Province as well as other regions of Turkey, except sucking lice of the hares (9–11). This study was performed to detect ectoparasites on the hares in Konya Province, Turkey.

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2. Materials and methods

This study was conducted to detect ectoparasites of *L. europaeus* between October 2003 and February 2015 in Konya Province, Turkey, including the regions of Çaltı, Kızılören, Ulumuhsine, Beyşehir, Çumra, Kadınhanı-Kestel, Sarayönü, and Seydişehir. During this period, 75 hares (12 in October, 6 in November, 17 in December, and 40 in January) were shot by hunters and then each hide of the hares was packed separately in a nylon bag and brought to the laboratory. Distribution of the hares is shown according to months in Figure 1.

The hares were examined for ectoparasites macroscopically. The material content of each bag was shaken into a plastic bag and examined by a Nikon SMZ 745T stereo zoom microscope. All of the parasites collected from the hares were stored in 70% ethanol until examination. The ticks collected from the hares were identified to the genus or species level under a stereo zoom microscope and other parasites were stored in individually labeled vials containing 70% ethanol. The lice, fleas, and mites were cleared in 10% KOH for a day or more until they are clear. They were rinsed in distilled water and transferred to 70%, 90%, and 99% ethanol for one day for each step. They were mounted on slides in Canada balsam for microscopic examination. The slides were dried in an incubator for a few weeks and then examined under a Leica DM750 binocular microscope. The genera or species were identified according to the original descriptions or other papers (4,19–24).

3. Results

The results showed that 33 (44%) of the 75 hares were infested with at least one ectoparasite species from all 309 collected individuals, as seen in Table 1, including four lice

species, *Haemodipsus lyriocephalus* (Figure 2A), *H. setoni* (Figure 2B), *H. leporis* (Figure 2C), and *Menacanthus* spp.; two fleas species, *Pulex irritans* (Figure 2D) and *Nosopsyllus fasciatus* (Figure 2E); three mites species, *Cheyletiella parasitivorax* (Figure 2F), *Dermanyssus gallinae*, and *Neotrombicula (N.) autumnalis* (Figure 2G); and four ixodid tick genera, *Haemaphysalis* spp., *Ixodes* spp., *Rhipicephalus* spp., and *Dermacentor* spp. Only *Hae. parva* (Figure 2H) of the ixodid ticks could be identified to the species level; the others were either in a nymphal stage, such as *Haemaphysalis* spp., *Dermacentor* spp., and *Rhipicephalus* spp., or some parts of the body had been destroyed, as in *Ixodes* spp. In addition to these identifications, 13 ixodid tick larvae and two argasid tick larvae were found on two hares.

As seen in Table 1, *Neotrombicula (N.) autumnalis* (87 larvae) comprised a large part of all ectoparasites collected from the hares, followed by *H. lyriocephalus* (25♀, 15♂, 27 nymphs), *Haemaphysalis* spp. (54 nymphs), and *P. irritans* (27♀, 20♂). Other genera and species were detected in small numbers.

The infestation rate of the hares according to months is shown in Figure 1 and it was found as 41.66% in October, 66.66% in November, 52.94% in December, and 37.50% in January.

Approximately half of the hares examined in this study were found to be infested with ectoparasites, and the prevalence of ticks of the genus *Haemaphysalis* was the highest. They were found on the 20 hares and they were both imago and nymph of *Hae. parva* in 6 cases and only nymph of *Haemaphysalis* spp. in 14 cases, followed by *P. irritans* (10 cases) and *H. lyriocephalus* (5 cases).

Out of 75 hares, ticks in 22 hares (28.95%), fleas in 11 hares (14.47%), lice in 7 hares (9.21%), *Neotrombicula (N.)*

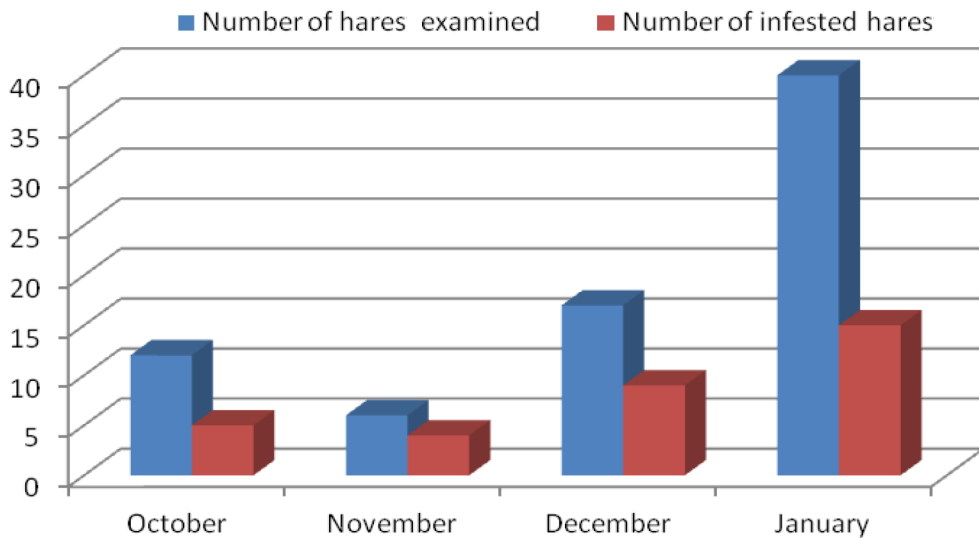


Figure 1. Distribution and infestation rates of the hares according to the months.

Table 1. Ectoparasites collected from the hares.

Parasite species	Larva	Nymph	Male	Female	Total	Hare no.
<i>Haemodipsus lyriocephalus</i>	-	27	15	25	67	10, 11, 12, 14, 70
<i>Haemodipsus setoni</i>	-	1	5	3	9	14, 41
<i>Haemodipsus leporis</i>	-	-	2	-	2	70
<i>Menacanthus</i> spp.	-	-	-	1	1	40
<i>Pulex irritans</i>	-	-	20	27	47	18, 25, 27, 31, 33, 41, 46, 50, 51, 62
<i>Nosopsyllus fasciatus</i>	-	-	-	1	1	48
<i>Haemaphysalis parva</i>	-	2	1	8	11	19, 20, 23, 37, 41, 60
<i>Haemaphysalis</i> spp.	-	54	-	-	54	1, 4, 7, 10, 13, 18, 26, 27, 38, 40, 45, 46, 49, 55
<i>Rhipicephalus</i> spp.	-	1	2	-	3	1, 13
<i>Ixodes</i> spp.	-	-	1	-	1	46
<i>Derma-centor</i> spp.	-	1	-	1	2	70
Ixodidae spp.	13	-	-	-	13	1,14
Argasidae spp.	2	-	-	-	2	13
<i>Neotrombicula (N.) autumnalis</i>	87	-	-	-	87	2, 11, 40, 41
<i>Cheyletiella parasitivorax</i>	-	-	2	5	7	14
<i>Dermanyssus gallinae</i>	-	-	-	2	2	23
Total	102	86	48	73	309	

autumnalis in 4 hares (5.26%), and both *C. parasitivorax* and *D. gallinae* in 1 hare (1.31%) were detected.

Sixteen of 33 (48.48%) hares were infested with at least two or more species in the same animal while the remaining 17 (51.52%) were infested with only one species. *P. irritans* and *Haemaphysalis* spp. (in 3 cases), and *Haemaphysalis* spp. & *N. (N.) autumnalis* (in 2 cases) were detected together during the study (Table 2).

4. Discussion

There are few studies conducted on ectoparasites of the hares in Turkey. Some of them have been reported as case reports and general information about the ectoparasite species found on wild rabbits. In an earlier study on the prevalence of ectoparasites on wild rabbits in Turkey, Aksin and Aksin (13) found that the prevalence of ectoparasites in some of the wild rabbits was 71.05% in Elazığ, Turkey, and they detected *C. parasitivorax*, *R. bursa*, *Hae. parva*, *N. autumnalis*, and *C. canis*. In the present study, the infestation rate of ectoparasites was found as 44% on the hides of hares in Konya Province in Turkey. Although some of the parasites could not be identified to the species level due to damage to some parts or larval or nymph stages, 13 species were detected.

The genus *Haemodipsus* has been detected with 7 lice species so far in the world, *H. lyriocephalus*, *H. setoni*, *H. ventricosus*, *H. africanus*, *H. conformalis*, *H. leporis*, and *H. brachylagi*, on hares, of which *H. lyriocephalus* and *H. setoni* live on *Lepus europaeus* (25,26). *H. lyriocephalus* and *H. setoni* were found at the rates of 20% and 5%, respectively, on hares in Poland, with the highest rate of infestation occurring in spring and summer and the lowest in autumn (27). On the other hand, *H. setoni* was detected more frequently (n = 67) than *H. lyriocephalus* (n = 30) in a total of 351 *L. europaeus* in the Netherlands. Infestation with both *H. lyriocephalus* and *H. setoni* was found to be much more severe in spring and summer than autumn and winter (5). Two lice species, *H. lyriocephalus* and *H. setoni*, were detected on *Lepus saxatilis* in South Africa (28). *H. leporis* was described from *Lepus timidus* in Yakutia (21), and this species was later reported from the same hare species in Norway (29). However, *H. leporis* was found on *L. europaeus* for the first time in the world in Konya Province in Turkey (11). In the present study, *H. lyriocephalus* was the most common species found among the lice detected on the hares, although no hare samples could be examined in spring or summer because hunting is forbidden from February to October in Turkey (30). For

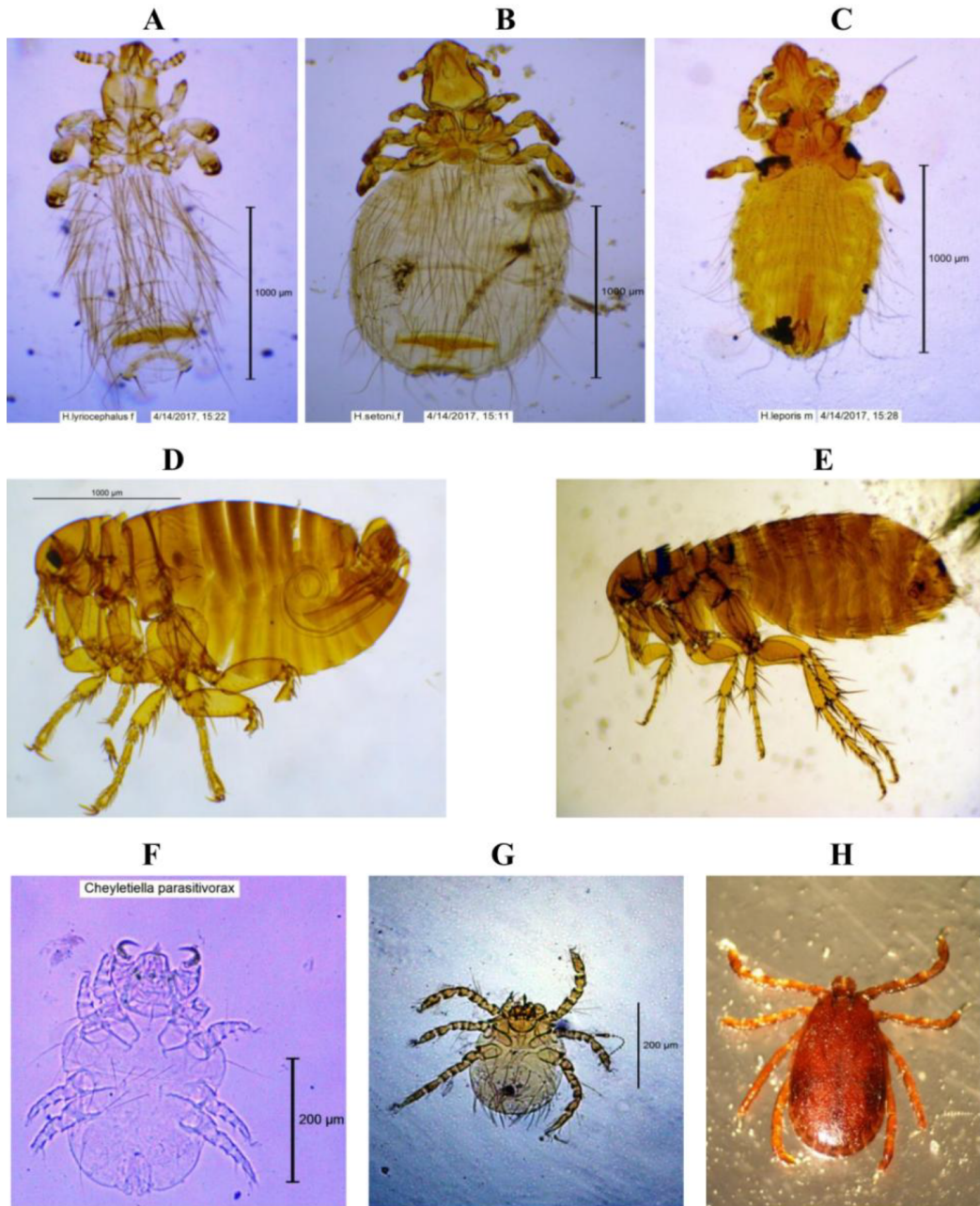


Figure 2. Ectoparasites collected from hares: A- *Haemodipsus lyriocephalus*, female; B- *Haemodipsus setoni*, female; C- *Haemodipsus leporis*, male; D- *Pulex irritans*, male; E- *Nosopsyllus fasciatus*, female; F- *Cheyletiella parasitivorax*, female; G- *Neotrombicula (N.) autumnalis*, larva; H- *Haemaphysalis parva*, male, original.

this reason, infestation rates and seasonal distributions of the lice, as well as other ectoparasites on the hares examined in the study, could not be evaluated between February and October. The results of the present work showed that the highest infestation rates were in November and December. Normally, *Haemodipsus* species occur in hares (9–11,31); however, in the current study, a female louse specimen of the genus *Menacanthus*, seen in birds, was found on a

hare. This might have resulted from contamination, with transfer to the hare from a bird in the hunter's bag.

Fleas are cosmopolitan ectoparasites and they live in several different host species. The normal hosts of *S. cuniculi* are domestic rabbits and hares (3). Mead-Briggs and Page (3) recorded 14 flea species, including *P. irritans* and *N. fasciatus*, as well as *S. cuniculi*, infesting rabbits in Great Britain. *N. fasciatus* was reported from one wild rabbit (*O.*

Table 2. Infestation types with ectoparasites of the hares.

Infestation type	Species	Case number (n)
One species	<i>Pulex irritans</i>	6
	<i>Haemaphysalis</i> spp.	5
	<i>Haemaphysalis parva</i>	4
	<i>Haemodipsus lyriocephalus</i>	1
	<i>Nosopsyllus fasciatus</i>	1
Two species	<i>P. irritans</i> + <i>Haemaphysalis</i> spp.	3
	<i>Haemaphysalis</i> spp. + <i>N. (N.) autumnnalis</i>	2
	<i>H. lyriocephalus</i> + <i>Haemaphysalis</i> spp.	1
	<i>H. lyriocephalus</i> + <i>N. (N.) autumnnalis</i>	1
	<i>Haemaphysalis</i> spp. + <i>Rhipicephalus</i> spp.	1
	<i>Haemaphysalis parva</i> + <i>Dermanyssus gallinae</i>	1
Three species	<i>H. lyriocephalus</i> + <i>H. setoni</i> + <i>C. parasitivorax</i>	1
	<i>H. lyriocephalus</i> + <i>H. leporis</i> + <i>Dermacentor</i> spp.	1
	<i>H. setoni</i> + <i>P. irritans</i> + <i>Haemaphysalis</i> spp.	1
	<i>Menacanthus</i> spp. + <i>Haemaphysalis</i> spp. + <i>N. (N.) autumnnalis</i>	1
	<i>P. irritans</i> + <i>Ixodes</i> spp + <i>Haemaphysalis</i> spp.	1
	<i>Haemaphysalis</i> spp. + <i>Rhipicephalus</i> spp. + argasid larva	1
Four species	<i>H. setoni</i> + <i>P. irritans</i> + <i>Haemaphysalis</i> spp. + <i>N. (N.) autumnnalis</i>	1

cuniculi) in Victoria, Australia (32). Some flea species were not reported in Europe, and *P. irritans* were recorded from wild rabbits in the United States (33) and Canada (31). Another study detected four flea species, *Ctenocephalides felis damariensis*, *Echidnophaga gallinacea*, *E. larina*, and *Dinopsyllus* sp., on scrub hares in South Africa and *Ct. felis damariensis* was the most widely distributed species on the hares (28). Until now, two flea species, *S. cuniculi* (8), and *C. canis* (13), had been reported on rabbits in Turkey. In the present study, *P. irritans* and *N. fasciatus* were detected, while neither *S. cuniculi* and *Ct. canis* nor other flea species could be found on the hares. *P. irritans* was the most abundant flea species on the hares and was detected on 10 hares, whereas *N. fasciatus* was found on 1 rabbit.

It was stated that 32 mite species including three *Ixodes* species were represented on hares in Great Britain, and three of them, *N. autumnnalis*, *C. parasitivorax*, and *Leporacarus gibbus*, have been found frequently (1). Kim et al. (2) reported that 65.3% of rabbits were infested with ectoparasites in Korea and they found three species: *C. parasitivorax* (60.6%), *P. cuniculi* (2.8%), and *O. bacoti* (1.9%). Three Ixodid species, *I. ricinus* Linnaeus, *I.*

hexagonus Leach, and *I. trianguliceps* Birula, were reported from the hares in Great Britain (1). In previous studies in Turkey (8,13), *O. lahorensis* Neumann, *I. hexagonus*, *H. excavatum*, and *Hae. parva* were detected on wild rabbits. Imago and nymphs of *Hae. parva* were found on the hares, whereas a male *Ixodes* spp. and nymph stages of *Dermacentor* and *Rhipicephalus*, with some larvae of the families Ixodidae and Argasidae, have been found, but *O. lahorensis*, *I. hexagonus*, and *H. excavatum* could not be detected on the hares in the current study. A single imago of *Ixodes* spp. collected from a hare in 2006 could not be identified to the species level because it had no capitulum with dark black color images.

Cheyletiella parasitivorax has been recorded from wild rabbits in Turkey previously (8,13,18). It is a zoonotic mite and can infest humans. It was stated that this mite could be a possible vector of myxomatosis in rabbits (34). Three reports were related to cheyletiellosis in humans in Turkey; one etiologic agent was *Cheyletiella blakei* (35) and one was *Cheyletiella parasitivorax* (36), and in the other the *Cheyletiella* species was not identified (37). It was reported that *C. parasitivorax* has been found in the

highest prevalence in wild rabbits (1,2). In contrast to the above studies, *C. parasitivorax* was detected only on one hare with five females and two males in the current study.

In earlier studies, *Neotrombicula (N.) autumnnalis* was detected in several reptile species as well as rabbits in Turkey (8,13,22). The prevalence of this species was very limited in wild rabbits in previous studies. Aksin and Aksin (13) detected this species only on a wild rabbit (3.70%) in Elazığ Province in Turkey. According to Stekolnikov and Daniel (24), *Neotrombicula (N.) autumnnalis* occurred on almost all mammals within its range and also on many birds and some reptile species, but many of these records were stated as misidentifications. Some researchers (2,7,32–34) did not find this mite on wild rabbits, whereas some researchers (1) reported this species more frequently. In the present study, *Neotrombicula (N.) autumnnalis* was detected on four hares in mixed infestations with other ectoparasites.

Some species of mites belonging to the order Mesostigmata were found on wild rabbits. Although *D. gallinae* lives on poultry, it can infest mammals, as well as humans. There could be no reference found stating that this species occurred in wild rabbits. Several species of the order Mesostigmata were reported from wild rabbits in Great Britain (1), but these researchers have not recorded *D. gallinae* from wild rabbits. However, *O. bacoti*, which is very similar to *D. gallinae*, was detected in five of 251 wild rabbits in Korea (2). *D. gallinae* was detected on a hare together with a tick species, *Hae. Parva*, in the current study.

It was reported that *Leporacarus gibbus* was found on *O. cuniculi* in Germany and Australia (7,34) and *L. leporicolus* on *L. saxatilis* in South Africa (28). However, these mite species were not detected on the hares in the present study. In the earlier studies in Turkey, ear mange cases due to *P. cuniculi* were recorded from rabbits (16,17), but neither psoroptic nor sarcoptic mange was detected in the current study.

Ectoparasites of hares may be found alone or as mixed infections. It was found that 8 of 27 wild rabbits were infested with a single species, 16 with two, and 3 with three in Elazığ Province in Turkey (13). In Korea, *C. parasitivorax* with *P. cuniculi* in 3 cases (1.2%) and *C. parasitivorax* with *O. bacoti* in 5 cases (1.9%) were found as mixed infestations (2). In the present study, 16 of 33

(48.48%) hares were infested with at least two or more species, while the remaining 17 (51.52%) were infested with only one species. *P. irritans* and *Haemaphysalis* spp. (in 3 cases) and *Haemaphysalis* spp. and *N. (N.) autumnnalis* (in 2 cases) were detected together during this study.

Aksin and Aksin (13) reported a very high infestation rate of 71.05% in wild rabbits in Elazığ Province in Turkey; on the other hand, the infestation rate was lower at 44% in the current study. This is probably due to the fact that Aksin and Aksin (13) examined the wild rabbits immediately after they were shot, while all the hares were examined after a few days in the present study. Therefore, some ectoparasites such as fleas or ticks could have escaped from the nylon bags during this period.

A very high number of lice (more than 1000) was reported in some infested hares, while 166,249 lice samples were collected from only one hare in Manitoba, Canada (31). The number of ectoparasites on the hares was very low in the current study, and the highest number of ectoparasites found on a hare was 66 (*Neotrombicula (N.) autumnnalis*), while other species were found in lower numbers.

Cimex hemipterus, *S. cuniculi*, *Ct. canis*, *P. cuniculi*, *O. cynotis*, *O. lahorensis*, *I. hexagonus*, *R. bursa*, and *H. excavatum*, reported from rabbits in previous studies in Turkey, could not be detected in the current study. Argasid and ixodid tick larvae, few in numbers, and imago of *Ixodes* sp. obtained from the hares could not be identified to the genera and species due to identification problems. However, *Menacanthus* spp., *N. fasciatus*, *P. irritans*, and *D. gallinae* were recorded from hares for the first time in Turkey in the current study.

As a result, it was concluded that approximately half of the hares were infested with ectoparasites, including 4 lice, 2 flea, and 3 mite species; 4 ixodid tick genera; and 1 ixodid tick species. In addition, 13 ixodid tick larvae and 2 argasid tick larvae were found on the hares in this study. In spite of these findings, further investigations are needed to detect the fauna, prevalence, and seasonal distribution of ectoparasites of hares in Konya and other parts of Turkey.

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