

Ectoparasites are the major causes of various types of skin lesions in small ruminants in Ethiopia

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Abstract Ectoparasites are the major causes of skin lesions in animals. Clinical, skin scraping examination, and histopathological studies were conducted to identify and characterize skin lesions in small ruminants caused by ectoparasites. Mange mites, lice, sheep keds, and ticks were collected from the skin of affected animals for species identification. Skin biopsies were collected from affected part of the skin and fixed in 10% neutral buffered formalin for histopathology. Of 1,000 sheep and 600 goats examined, 815 (81.50%) sheep and 327 (54.5%) goats were infested with one or more types of ectoparasites. *Sarcoptes scabiei* var *ovis*, *Demodex ovis*, *Psoroptes ovis*, *Bovicola ovis*, *Melophagus ovinus*, and *Amblyomma variegatum* and other tick species were identified from sheep. *S. scabiei* var *caprae*, *Demodex caprae*, *Linognathus stenopsis*, and *A. variegatum* and other tick species were identified from goats. Gross skin lesions or defects observed on the skin include stained and ragged wool, loss of wool/hair, nodules, crusts, lichenification, and fissuring. Microscopic evaluation of H and E stained skin sections revealed lesions in the epidermal layer such as hyperkeratosis, acanthosis, and melanin inconsistency on the basal cells of the epidermis. Follicular keratosis, perifolliculitis, frunculosis, perivascu-

litis, and aggregates of inflammatory cells (of acute and chronic type) with fibrosis were experiential in the dermal layer of the skin. Most of the skin lesions caused by ectoparasites are overlapping. Thus, ectoparasites control program should be executed to reduce skin lesions as skins are the major export commodity of the country.

Keywords Ectoparasites · Ethiopia · Goats · Histopathology · Sheep · Skin lesions

Introduction

Sheep and goats represent the most important segment of the Ethiopian livestock system. The national sheep and goat population is estimated at 25.5 and 23.4 million, respectively (Central Statistical Authority, CSA 2008). Annually, 16.6 million pieces of skins are produced in the country, based on the off take rates of 33% and 32.5% for sheep and goats, respectively (Tadesse 2005). Although large number of sheep and goats are slaughtered per annum, the production of high quality skins remains very low (Kassa 2005; Zewdu 1995). In Ethiopian tanneries, 35% of sheep and 56% of goat skins have been downgraded and rejected due to defects caused by external parasites (Kassa 2005).

Ectoparasites cause skin lesions or defects in all layers of the skin. However, the extent and type of gross and microscopic skin lesions may vary with the specific causes of skin diseases. Characteristic gross skin lesions in animals affected by ectoparasites include encrustation, papules, nodules, and areas of superficial erosions and ulcerations on the skin (Wall and Shearer 1997). Microscopically, epidermal lesions in the skin of animals affected by ectoparasites include hyperkeratosis, acanthosis, and spongiosis. The main dermal lesions are

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vasculitis, follicular lesions, and aggregates of inflammatory cells (Jones et al. 1997). Various forms of collagen pathologies have been also described. So far, studies conducted in Ethiopia did not characterize and stereotype gross and microscopic skin lesions caused by ectoparasites (mange mites, lice, sheep keds, and ticks). Therefore, the aim of the present study was to identify and characterize the gross and microscopic skin lesions in sheep and goats naturally affected by ectoparasites.

Materials and methods

Description of study areas

The study was conducted from October 2006 to April 2007 in Yemenz Gera Midir, Kalu, and Bati districts of the Amhara National Regional State. All the three study sites are located in Northeast Ethiopia. The agro-climatic zones of Yemenz Gera Midir are 40% highlands, 50% midlands, and 10% lowlands. Kalu has 10%, 54%, and 36% highland, midland, and lowland agro-climatic zones, respectively. Bati has 80% lowland and 20% midland agro-climatic zones.

Study animals and management

Indigenous sheep and goats raised under extensive management system and visiting the veterinary clinics for various reasons were targeted for mange mites, lice, sheep keds, and ticks.

Study protocols

Clinical study A total of 1,000 sheep and 600 goats were randomly selected and clinically examined for ectoparasites and associated skin lesions. Clinical examination was conducted by parting the fleece in the direction opposite to that in which wool or hair rests. The skin was visually inspected and palpated to detect ectoparasites and skin lesions. All parts of the body were examined. Lice, sheep keds, and ticks were collected during clinical examination, preserved in 70% alcohol, and identified according to the keys provided by Okello-onen et al. 1999 for ticks, Wall and Shearer 1997 and Urquhart et al. 1996 for lice.

Skin scraping examination Scrapings were made from various parts of the skin to detect mange mites and 1 cm² areas of the skin were scraped. The scrapings were placed in test tubes containing 5 mL of distilled water and 10% KOH and heated until hairs and epidermal scales were dissolved and then centrifuged at 2,500 rpm for 3 min. The sediment was suspended in distilled water and re-

centrifuged. After decanting the supernatant, the sediment was then again suspended in saturated sucrose solution and was centrifuged. Finally, samples were removed from the top of the solution and examined under the microscope for identifying mange mites (Urquhart et al. 1996).

Skin biopsy After inducing local anesthesia at biopsy sites with Lidocaine 2%, 4×4 mm skin biopsies were collected from 20 sheep and 25 goats typically affected with mange mites, lice, sheep keds, and ticks and fixed in 10% neutral buffered formalin.

Histopathology Skin biopsies were dehydrated, cleared, impregnated, and embedded in paraffin wax. Then, tissues blocks were sectioned at 4 μm thickness and stained either with hematoxylin and eosin or with van Gieson's staining (Bancroft and Harry 1994).

Describing skin lesions During clinical examination, skin lesions caused by ectoparasites were grossly characterized and predilection sites were determined. Microscopic skin lesions were also characterized.

Data analysis

Descriptive statistics was used to summarize data.

Results

Clinical study

Out of 1,000 sheep and 600 goats examined for ectoparasites, 815 (81.5%) sheep and 327 (54.5%) goats were infested with one or more types of ectoparasites. In sheep, *Sarcoptes scabiei* var *ovis*, *Demodex ovis*, *Psoroptes ovis*, *Bovicola ovis*, *Melophagus ovinus*, and *Amblyomma variegatum* and other tick species were identified. Similarly, in goats, *S. scabiei* var *caprae*, *Demodex caprae*, *Linognathus stenopsis*, and *A. variegatum* and other tick species were identified. In Yemenz Gera Midir district, large numbers of sheep were affected by a number of ectoparasites. *P. ovis* was the only mange mite identified from sheep in this district. *B. ovis* and *M. ovinus* were very common ectoparasites in sheep (Table 1).

In Kalu district, both sheep and goats were heavily infested with ectoparasites of different species. *B. ovis* was also most frequently observed in sheep than in goats (Table 2).

Ectoparasites were found to be the major causes of skin diseases in small ruminants in Bati district. *P. ovis* and *M. ovinus* were not reported from small ruminants in this study site (Table 3).

Table 1 Ectoparasites in sheep and goats identified from Yemanz Gera Midir district, in which *Bovicola ovis* and *Melophagus ovinus* are the most prevalent

Ectoparasites	No. of animals examined	No. of positive animals (%)
	Sheep	Goats
<i>Bovicola ovis</i>	322	280 (47.86)
<i>Linognathus stenopsis</i>		66 19 (28.79)
<i>Melophagus ovinus</i>	201	193 (32.99)
<i>Psoroptes ovis</i>	62	56 (9.58)
Total	585	66

Gross lesions

Sarcoptic mange Goats affected with sarcoptic mange developed grossly visible pruritic skin lesions at the base of the ear, head, neck, and shoulder. Goats also developed the generalized form of sarcoptic lesions where the entire body was involved with pruritic lesions. The chronic form of sarcoptic mange was detected in goats and affected skin was fissured, lichenified, and covered with thick gray crusts and scales (Fig. 1a). In sheep, skin lesions due to *Sarcoptes* were less severe and most sheep developed pruritic lesions on the head.

Demodectic mange Goats infested with *Demodex* had non-pruritic papules and nodules containing waxy materials stuffed with cigar-shaped organisms over the face, neck, shoulder, and sides (Fig. 1b). Nodular and ulcerative lesions were also observed on the muzzle of goats. Other less common gross lesions with demodicosis were alopecia and encrustation. The distribution of nodular skin lesions of sheep infested with *Demodex* was similar to that of goats

Table 2 Ectoparasites in sheep and goats identified from Kalu district, Ethiopia

Ectoparasites	No. of animals examined	No. of positive animals (%)
	Sheep	Goats
<i>Bovicola ovis</i>	157	115 (34.43)
<i>Linognathus stenopsis</i>		79 51 (20.16)
<i>Demodex spp.</i>	32	19 (5.69)
		53 15 (5.93)
<i>Sarcoptic spp.</i>	79	65 (19.46)
		78 43 (16.99)
<i>Melophagus ovinus</i>	45	38 (11.38)
<i>Amblyomma variegatum</i>	21	43 13 (3.89)
Total	334	253 32 (12.65)

Table 3 Ectoparasites in sheep and goats identified from Bati district, Ethiopia

Ectoparasites	No. of animals examined	No. of positive animals (%)
	Sheep	Goats
<i>Bovicola ovis</i>	21	5 (6.17)
<i>Linognathus stenopsis</i>		73 39 (13.88)
<i>Demodex spp.</i>	18	5 (6.17)
		46 21 (7.47)
<i>Sarcoptic spp.</i>	25	15 (18.52)
		90 74 (26.33)
<i>Amblyomma variegatum</i> and other ticks	17	72 11 (13.58)
Total	81	281 33 (11.74)

and appeared on the head, ear, muzzle, and on less woolled areas of the body.

Psoroptic mange Sheep severely infested with *Psoroptes* were presented with generalized pruritic dermatitis with ragged and stained wool due to intense itching and scratching. The skin was also covered with dry, gray crusts and scales, and devoid of wool.

Pediculosis The most characteristic skin lesions in sheep and goats infested by lice were the presence of erythema and excoriative lesions on the skin. The wool of sheep infested with *B. ovis* appeared ragged and shaggy in appearance. *B. ovis* eggs (nits) were glued to the wool (Fig. 1c). *B. ovis* also caused alopecia and yellowish crusts were detected on the skin. Infestation with *L. stenopsis* caused alopecia and white crusts were detected on the skin of affected goats.

***M. ovinus* (sheep ked) infestation** Sheep keds were mainly detected on the neck, breast, shoulder, flank, and on the rump. The wool of affected sheep was ragged and stained with the excreta of sheep ked (Fig. 1d). Grossly, skin lesions caused by sheep keds were characterized by scaly crust.

Tick infestation Skin lesions due to tick bites were characterized by papules and wheals. Hyperemic and edematous lesions were also detected at the site of tick attachment. In the subcutis of the skin, bleeding points were detected in areas where the mouthparts of ticks were attached.

Microscopic lesions

Sarcoptic mange The epidermal layer of the skin of sheep and goats affected by sarcoptic mange were hyperkeratotic

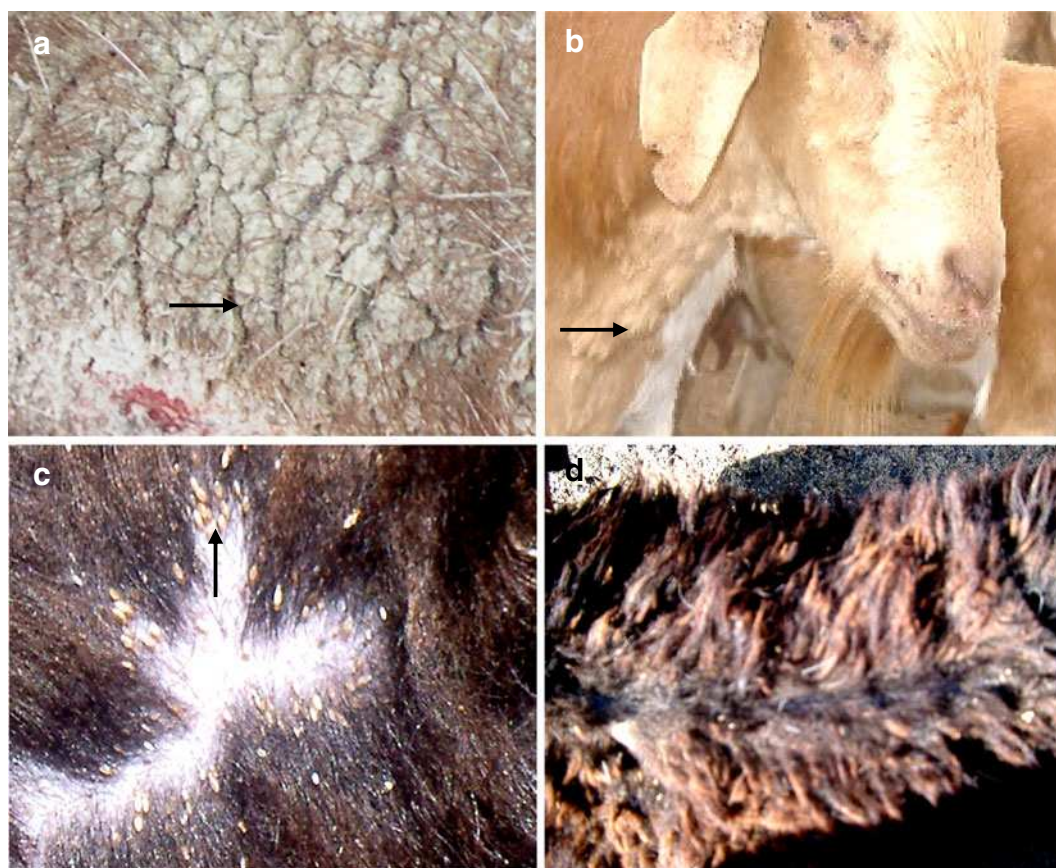


Fig. 1 Gross skin lesions in sheep and goats affected with ectoparasites **a** fissures (*arrow*) on the skin of goats affected with *Sarcophytes*, **b** nodules (*arrow*) on the neck and face of goats affected

with *Demodex*, **c** sheep heavily infested with *Bovicola ovis* and eggs (nits) glued to the wool (*arrow*), and **d** unattractive, damaged, and ragged wool due to sheep ked infestation

and mildly hyperplastic, resulting in prominent rete ridge formation. In the dermal layer, mild folliculitis, perifolliculitis, frunculosis and follicular keratosis were observed. Inflammatory cells such as eosinophils and neutrophils were infiltrated into the papillary and reticular layers of the dermis. Fibrosis of the papillary layer of the dermis was also evident (Fig. 2a).

Demodectic mange Microscopic skin lesions observed in sheep and goats affected by demodectic mange include epidermal hyperplasia and follicular pigmentary inconsistency, epidermal and follicular hyperkeratosis, degeneration and necrosis of follicular basal cells, and inflammation of the sebaceous glands. Aggregates of lymphocytes, macrophages, eosinophils, and neutrophils were observed in the dermis. Moreover, perifollicular pyogranulomas, lymphoplasmacytic perifolliculitis and frunculosis were detected around the hair follicles. van Gieson's staining has clearly depicted extensive collagen deposition in the papillary layer of the dermis due to extensive fibroblast cells proliferation in response to chronic inflammation and healing.

Pediculosis Skin biopsies from sheep and goats infested by lice showed mild parakeratotic hyperkeratosis, crusts, and infiltrated with eosinophils. Initially, very small acellular crust was formed and latter contain large number of necrotized epidermal cells. Perivascular or diffuse dermatitis with eosinophils, plasma cells, and lymphocytes were encountered in the dermis. Lice infestation has caused extensive fibroblast cells and elastic fibers proliferation in the dermis. Perifolliculitis and perivascularitis also characterized skin lesions caused by pediculosis (Fig. 2b).

***M. ovinus* (sheep ked) infestation** Crusts and extensive hyperkeratosis were detected in the epidermal layer of the skin of sheep infested by sheep keds. Sheep infested with sheep keds had also many empty capillaries and arteries in the dermis and follicular keratosis were also common. Extensive inflammatory leukocytic infiltrations consisting of lymphocytes, plasma cells, and eosinophils were observed in the upper dermal layer (Fig. 2c). Perivascularitis, perifolliculitis, and granulation tissue formation in the dermis also characterizes infestation by sheep keds.

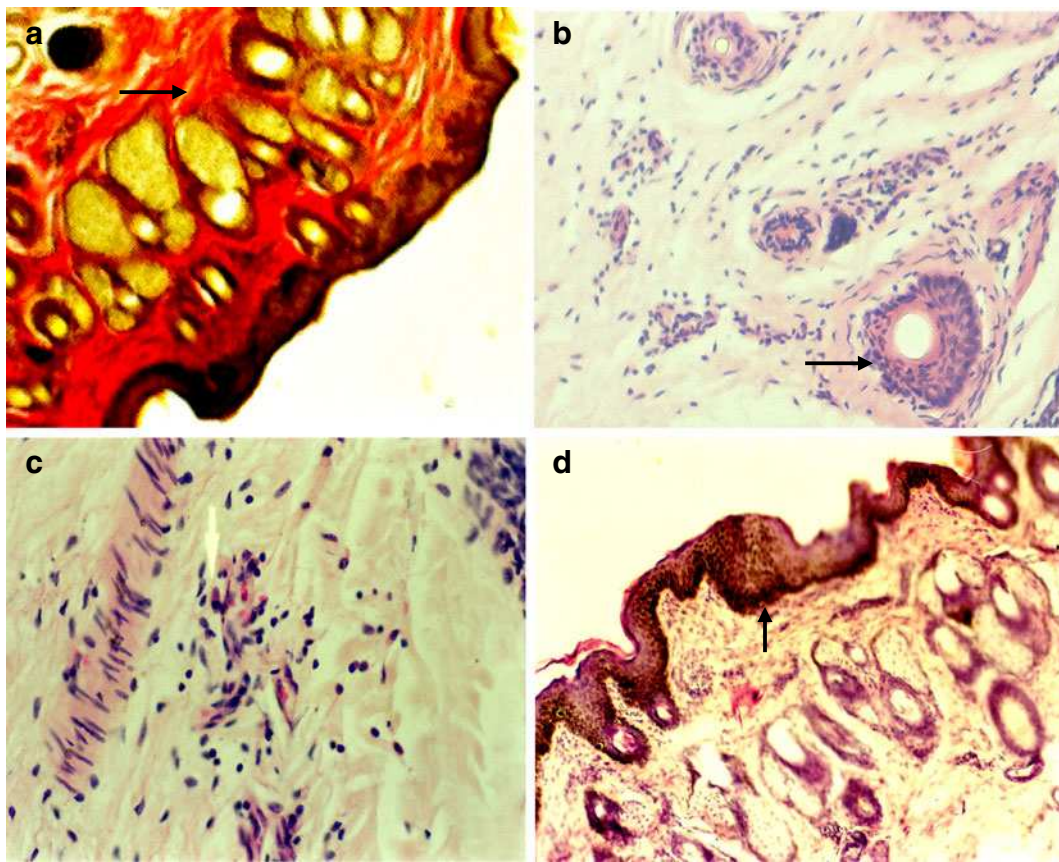


Fig. 2 Microscopic skin lesions in sheep and goats affected with ectoparasites **(a)** extensive collagen deposit (red) in the papillary layer of the skin (arrow) of goats affected by sarcoptic mange (100 \times , van Gieson), **b** perifolliculitis (arrow) in the dermis of sheep with pediculosis (400 \times , H and E), **c** extensive inflammation in the reticular

layer consisting of eosinophils (arrow), lymphocytes and plasma cell infiltrates due to sheep ked infestation in sheep (400 \times , H and E), and **d** melanin deposition (arrow) in the epidermis due to tick infestation in goats (100 \times , H and E)

Tick infestation Epidermal hyperplasia in the epidermal layer and dermal necrosis, perivascularitis to diffuse dermatitis, and perifolliculitis were observed microscopically in the dermal layer of the skin of sheep and goats affected by ectoparasites. The inflammatory exudates were consisting of eosinophils, macrophages, and lymphocytes. Some of the skin lesions were granulomatous (arthropod-bite granuloma) in characteristic. Excess fibroblast cells proliferation was seen in the papillary layer of the dermis. There was also extensive melanin in the basal epidermis and around the hair follicles (Fig. 2d).

Discussion

Out of 1,000 sheep and 600 goats examined for ectoparasites, 815 (81.5%) sheep and 327 (54.5%) goats were infested with different types of ectoparasites. Thus, the present study has clearly depicted ectoparasites as being the

major causes of skin lesions. Previous studies have also demonstrated the widespread nature of ectoparasites in sheep and goats in Ethiopia (Sertse and Wossene 2007b; Woldemeskell and Ashenafi 2000), which have caused severe skin defects (Kassa 2005).

Skin fissures with marked lichenification of the skin could grossly characterize the severe form of infestation of sheep and goats with *Sarcoptes*. Wall and Shearer 1997 described the presence of papules, crusts, excoriations, and alopecia in sheep and goats affected by *Sarcoptes*. It has been concluded that due to small number of mange mites in the tunnel formed by active female *Sarcoptes*, eggs may not be detected in tissue sections similar to the present findings. Microscopically, epidermal lesions caused by *Sarcoptes* were characterized by hyperkeratosis, hyperplasia, and marked rete ridge formation. Fthenakis et al. 2001 described the presence of pseudocarcinomatous hyperplasia in the epidermal layer of the skin of sheep and goats affected by *Sarcoptes*. *Sarcoptes* has induced perivascular dermatitis with infiltration of the dermis by eosinophils and

neutrophils. The presence of neutrophilic infiltrates indicates complication of sarcoptic mange lesions by bacterial contamination via fissured skin.

Psoroptic mange caused by *P. ovis* was characterized by pruritic dermatitis leading to generalized alopecia. These findings were consistent with the results of previous findings (van den Broek and Huntley 2003; van den Broek et al. 2003). Although skin biopsies were not collected from sheep infested with *P. ovis*, psoroptic mange initiate allergic dermatitis whereby eosinophils, lymphocytes, and mast cells were the dominate infiltrating leukocytes (van den Broek and Huntley 2003).

D. caprae has caused generalized and palpable nodular lesions on the face, brisket, and forelegs of goats. The nodules were visible in smooth-coated goats, but in rough-coated goats, nodules were detected by palpation. *D. ovis* has caused localized nodular lesions on the face of sheep. Previous research also demonstrated the nodular lesions of demodicosis (Starost et al. 2005). Skin biopsies collected from sheep and goats infested by *Demodex* revealed acanthotic and hyperkeratotic epidermis. Other studies also describe several forms of dermal pathologies associated with *Demodex* (Jones et al. 1997). Extensive collagen deposition in the papillary layer of the dermis indicates the chronic nature of demodicosis.

The irritation caused by lice leads to scratching (James and Moon 1998, 1999 and rubbing that could damage the skin (Asp and Tauni 1988; Heath et al. 1996; Ward and Armstrong 2000) resulting in alopecia, a description similar to our observation. On histological sections, epidermal lesion such as hyperkeratosis and diffuse dermatitis characterize skin lesions caused by lice. Halligan and Johnstone 1992 described excess collagen fiber deposition in the dermis due to lice infestation similar with the present findings.

The puparial and adult sheep keds were detected on the chest, forequarters, and rib region with few on the back or abdomen of sheep. Some authors have indicated that the neck, tail, and ventral part of the body of sheep are the preferred sites of sheep keds (Asp and Tauni 1988; Legg et al. 1991). The excreta from sheep keds stained the wool and reduced wool quality. Initially, skin lesions caused by sheep keds were characterized by the presence of wheals and papules centered up on a puncture wound, which were then covered by scales and crusts (Small 2005). Sheep keds spent their entire life on the host; hence could cause severe skin lesions (Wall and Shearer 1997). Sheep keds causes a wide spread pruritis, exacerbated by scratching and biting (Legg et al. 1991). Sheep keds and lice causes a rash called cockle on the skin, which is the principal cause of skin rejection at tanneries (Sertse and Wossene 2007a). The characteristic microscopic skin lesions caused by sheep ked was the presence of many empty capillaries in the dermis.

The findings of Heath et al. 1995 have indicated that arteriolar vasoconstriction and fibrinoid degeneration of the tunica media of capillaries and arteries may be responsible for the detection of empty capillaries. Various types of dermal pathologies varied from follicular lesions to perivascular and/or diffuse dermatitis was described in other studies (Jones et al. 1997).

The preferential sites of attachment of ticks were the axilla, inguinal region, ears, and under the tail. Skin lesions caused by ticks are described by several authors (Wall and Shearer 1997). On the subcutis, tick bites left bleeding points to which the mouthparts of the ticks were attached (Asp and Tauni 1988). Microscopically, tick bites have caused necrotic lesions in the epidermis and dermis at the attachment sites. Moreover, perivascular to diffuse dermatitis consisting of eosinophils, macrophages, and lymphocytes were recognized. Tick lesions may develop granulomas (arthropod-bite granulomas) in which the inflammatory cells were interspersed between collagen fibers and lymphoid follicles formed in the dermis. This study has indicated various forms of skin lesions caused by ectoparasites and thus appropriate control methods must be designed and executed to minimize the effects of ectoparasites on the skins of animals.

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