Received: 7 April 2025 | Accepted: 29 September 2025

DOI: 10.1111/mve.70027

Medical and Veterinary Entomology

ORIGINAL ARTICLE

Mammalian ectoparasite threats and management under a changing climate in the Global South

Prevalence of lice infestation in alpaca crias from the southern Peruvian Andes

Prevalencia de infestación por piojos en crías de alpacas de los Andes del sur del Perú

Luis A. Gomez-Puerta[1] | Johan Carrasco[2] | Madeline Garcia[1] | Maria T. Lopez-Urbina[1] | Cesar M. Gavidia[1]

[1]Faculty of Veterinary Medicine, Universidad Nacional Mayor de San Marcos, Lima, Peru

[2]Sociedad Ganadera Carrasco, Pucatiana, Quenamari, Cuzco, Peru

Correspondence
Luis A. Gomez-Puerta, Faculty of Veterinary Medicine, Universidad Nacional Mayor de San Marcos, Av. Circunvalacion 2800, Lima 41, Peru.
Email: lgomezp@unmsm.edu.pe

Associate Editor: María Soledad Leonardi

Abstract

Lice are very common ectoparasites of humans and other animals. These ectoparasites cause various health problems in the hosts, like alpacas, such as intense itching, skin irritation, hair or wool loss, anaemia, and, in severe cases, reduced milk and meat production due to the stress they cause in the host. Epidemiological studies in alpacas are necessary to determine the magnitude and distribution of lice infestation, which would assist in the implementation of control measures. The aim of this study was to determine the prevalence of lice infestation in newborn and young alpacas (crias) from the provinces of Canchis and Espinar, located in the southern Peruvian Andes. Veterinarians examined a total of 383 alpaca crias less than 6 months of age to diagnose lice infestation. Lice were collected and preserved in 80% ethanol for morphological diagnosis. Also, all animal data such as sex, breed, province, and herd size were recorded for analysis. Lice were detected in 352 out of 383 (91.9%; confidence interval ($CI_{95\%}$) = 88.7%–94.4%) alpaca crias, and three species of lice were identified: two Anoplura from the Microthoraciidae family corresponding to *Microthoracius praelongiceps* (Neumann, 1909) (91.9%; 353/383) and *M. mazzai* Werneck, 1932 (18.5%; 71/383), and one Mallophaga from the Trichodectidae family corresponding to *Bovicola breviceps* (Rudow, 1866) (11.5%; 44/383). The parasite load was very high, especially in the areas of the neck, arms, legs, armpits, and groin in the infested animals. Only the infestation for *M. praelongiceps* was associated with provinces but not with other variables. *M. mazzai* and *B. breviceps* infestations were not associated with any variable. Future epidemiological studies will be necessary to better understand the interactions between the species of lice and risk factors such as local characteristics and livestock husbandry, as well as the negative effect caused by this parasitism in alpacas.

KEYWORDS
Anoplura, *Bovicola*, ectoparasites, Mallophaga, *Microthoracius*, Phthiraptera

INTRODUCTION

The South American camelids can act as hosts for various ectoparasites including lice. Lice infestation has a significant impact on the health and welfare of affected alpacas (Cheney & Allen, 1989; Windsor et al., 1992). Usually, neonates and juvenile animals, due to their still-developing immune system and increased vulnerability to infections, are more susceptible to lice infestation (James, 1999; Milnes et al., 2003a). Lice parasitism produces skin irritation, hair or fibre loss, and, in several cases, malnutrition or secondary infections, which affect the productivity and growth of animals (Weeks et al., 1995). Sucking lice (Phthiraptera, Microthoraciidae), which feed on blood, are the most harmful, as infestations could lead to anaemia in animals (Cortinas & Jones, 2006).

Sucking lice of alpacas include species of the genus *Microthoracius*, with *M. mazzai* Werneck being the most common species and causing economic losses to producers (Cicchino et al., 1998). The prevalence of lice in livestock varies according to factors such as age, environment, sanitary conditions, and season of the year, which makes research on their distribution and the factors that influence their spread essential (James et al., 1998; Milnes & Green, 1999).

Epidemiological studies on lice infestations in alpacas, particularly in newborn or young alpacas known as crias, are scarce (Chavez & Zaldivar, 1967; Sotomayor & Zaravia, 2023). On the other hand, early detection of infestations and epidemiological data are needed to set parasitism prevention strategies into action and stop the harmful effects of these ectoparasites on crias. Therefore, this study aims to assess the prevalence of lice in alpaca crias from the southern highlands of Peru, the largest alpaca-producing region in the country.

MATERIALS AND METHODS

Study area

The study was conducted in six alpaca farms located in the provinces of Canchis and Espinar, in the department of Cuzco, Peru. The farms are located at more than 4000 m above sea level and are characterized by the presence of mountains. The high density of alpacas in these areas motivated the selection of the study area. The sampling was conducted in March 2024 during the calving season, which coincides with the rainy season. The climate of the region is subhumid (60%–65%) and cold (0–17°C) (SENAMHI, 2025).

Study population

All alpaca crias on each farm were included in this study. A total of 383 alpaca crias under 6 months of age were selected from the farms. The animals were chosen randomly, ensuring that they adequately represented the alpaca cria population on each farm.

Parasitic load and sampling procedure

Alpaca crias were manually restrained and thoroughly inspected for the presence of lice, with particular attention to commonly infested areas such as the neck, ears, lumbar region, armpits, and groin. Veterinarians performed the inspection manually, separating the fibre with fingers or using a comb to facilitate detailed observation. To assess the lice infestation load, a 10 cm^2 area was selected in the chest region of each animal. It is worth noting that the same anatomical area was examined on each animal (Figure 1). To facilitate immobilization of the lice, this area was smeared with 1% cypermethrin using gauze. We identified the species and recorded the number of lice present in this area. The count was stopped when 20 lice were reached (low infestation), and it was recorded as >20 if this number was exceeded (high infestation). Lice were collected directly with fingers and placed in properly labelled plastic vials at room temperature and preserved in 80°C ethanol. The samples were sent to the Veterinary Epidemiology laboratory in Lima for morphological identification. This protocol was modified from the one proposed by Milnes et al. (2003b).

Lice identification

The samples were analysed in the laboratory to identify the lice species using an optical microscope (Leica DM500). The specimens were mounted on glass slides using Canada balsam (Palma, 1978). Species identification was carried out by morphological analysis, following the taxonomic keys proposed by Werneck (1935) and Ferris (1951). The specimens were deposited in the parasite collection of the Laboratory of Veterinary Epidemiology and Economics of the Faculty of Veterinary Medicine of the Universidad Nacional Mayor de San Marcos in Lima, Peru, under accession numbers (No. 2785–2814).

Statistical analysis

The data obtained were analyzed using R Statistical Analysis Software to determine the prevalence of lice in alpaca crias. Chi-square and difference of proportions tests were used to evaluate the relationship between the prevalence of infestations and risk factors, such as sex, breed, province, and herd size (<30, 31–100, and >100 crias). Prevalence is presented with its 95% confidence interval (CI). The results were considered significant when the p-value was < 0.05.

RESULTS

A total of 383 alpaca crias were examined, from which the majority of animals were males (56.4%, $n = 216$; females 43.6%, $n = 167$) and Huacaya breed (86.9%, $n = 333$; Suri 13.1%, $n = 50$). The majority of crias came from the Canchis province (65.8%). Lice were detected in 352 out of 383 (91.9%; $CI_{95\%} = 88.7\%–94.4\%$) alpaca crias. A greater number of adult stages was observed than immature stages such as

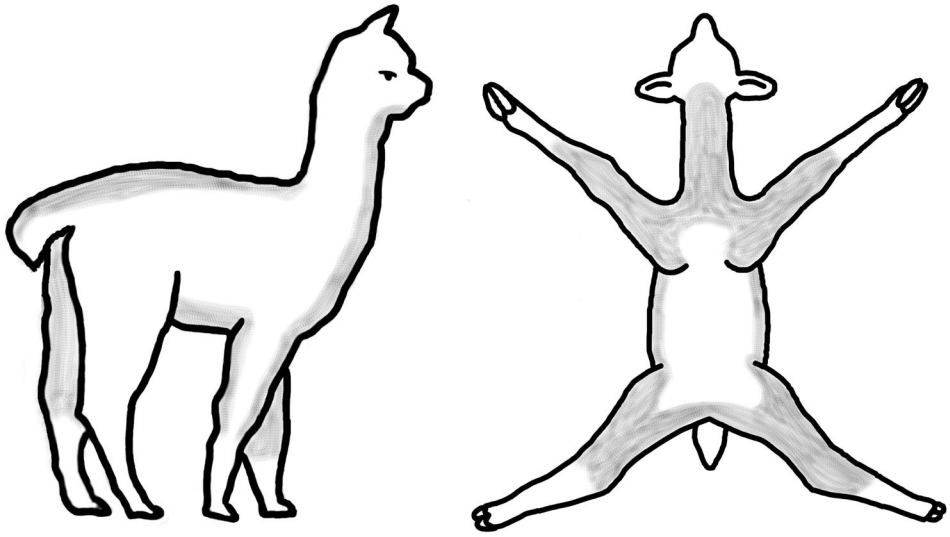

FIGURE 1 Body regions commonly infected by lice in alpaca crias (shaded in grey). The black area in the right image indicates the area examined to assess the parasitic load.

FIGURE 2 Lice infestation in alpaca crias. (a) High lice infestation in the groin and crotch area of a cria. (b) Infestation with *Microthoracius* spp. (c) Co-infestation of *Microthorcius praelongiceps* (indicated by black arrows) and *Microthorcius mazzai* (indicated by red arrow).

nymphs. The presence of eggs or nits was evident in the animal's fibres, which were adherent to the proximal part of the fibre. The presence of eggs was observed in all areas of the animal's body examined. The main areas of lice infestation in the animals were the ventral region of the neck, arms, and legs, including the armpits and groin. Lice were also detected in the dorsal area of the body, from the neck to the lumbar region (Figure 1). Regarding the parasitic load, 82.7% (291/352; $CI_{95\%}$ = 78.3%–86.5%) of the infested crias had a high lice infestation, while 17.3% (61/352; $CI_{95\%}$ = 13.5%–21.7%) had a low infestation (Figure 2).

Only three species of lice were found on crias: two Anoplura from the Microthoraciidae family corresponding to *Microthorcius praelongiceps* (Neumann) (91.9%; $n = 352$) and *M. mazzai* Werneck (18.5%; $n = 71$), and one Mallophaga from the Trichodectidae family corresponding to *Bovicola breviceps* (Rudow) (11.5%; $n = 44$), respectively. *M. praelongiceps* was significantly the most common louse in crias ($p < 0.001$). The main morphological differences between *M. praelongiceps* and *M. mazzai* are body size and head structure. *M. praelongiceps* has a larger body compared to *M. mazzai*. In addition, *M. mazzai* is characterized by having a narrow and elongated head, while in *M. praelongiceps* the head is wider (Figure 3).

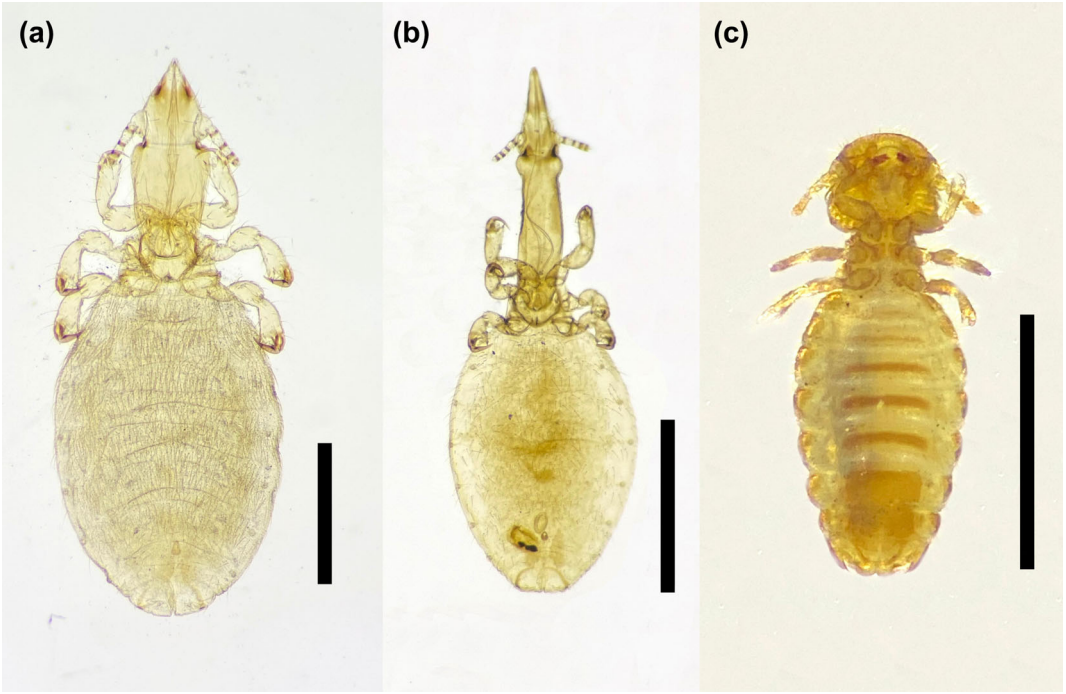

FIGURE 3 Diagnosis of lice collected from alpaca crias. (a) *Microthorcius praelongiceps* (female). (b) *Microthorcius mazzai* (female). (c) *Bovicola breviceps* (female). Scale bar = 1000 μm.

TABLE 1 Prevalence and factors associated with lice infestation (*M. praelongiceps*, *M. mazzai*, and *B. breviceps*) in alpaca crias from the southern Peruvian Andes.

	Microthoracius praelongiceps		*Microthoracius mazzai*		*Bovicola breviceps*	
Variable	**Positive/Total (%)**	***p*-value***	**Positive/Total (%)**	***p*-value***	**Positive/Total (%)**	***p*-value***
Sex		0.575		0.284		0.701
Female	152/167 (91.0)		35/167 (21.0)		18 (10.8)	
Male	200/216 (92.6)		36/216 (16.7)		26/216 (12.0)	
Breed		0.101		0.775		0.550
Suri	43/50 (86.0)		10/50 (20.0)		7/50 (14.0)	
Huacaya	309/333 (92.8)		61/333 (18.3)		37/333 (11.1)	
Department		**0.009****		0.635		0.510
Espinar	127/131 (96.9)		26/131 (19.8)		17/131 (13.0)	
Canchis	225/252 (89.3)		45/252 (17.9)		27/252 (10.7)	
Herd size		0.619		0.734		0.578
<30	49/50 (98.0)		11/50 (22.0)		7/50 (14.0)	
31–100	121/131 (92.4)		25/131 (19.1)		17/131 (12.9)	
>100	182/202 (90.1)		35/202 (17.3)		20/202 (9.9)	

**p*-values from Chi-square.
***Statistical significant difference.

The study discovered that *M. praelongiceps* was more frequent in crias from Espinar province than those from Canchis province (96.9% vs. 89.3%; $p = 0.009$), and none of the other variables showed a significant relationship with *M. praelongiceps* infestation in alpaca crias in Peru. Parasitism caused by *M. mazzai* and *B. breviceps* did not show association with any of the variables analysed (Table 1). Regarding co-parasitism, nine crias were parasitized with all three lice species, and 72 crias were parasitized with *M. praelongiceps* and *M. mazzai*. None of the crias were parasitized only with *M. mazzai* and *B. breviceps*.

DISCUSSION

The results of the present study showed a prevalence of lice infestation in alpaca crias of 91.9%, indicating that this parasitism is common in alpacas in the southern highlands of Peru. Previous research has found that ectoparasites are common in animals that are raised in large-scale, non-intensive systems, and in areas with heavy seasonal rain and cold, such as where this study took place. Rain and cold make a suitable microhabitat for the development of lice in hosts (Durden, 2019). This high prevalence suggests that lice infestation could be a significant concern for the health of alpacas and the welfare of the crias in the study region.

Based on their morphological diagnosis, three types of lice were found on alpaca crias: two Anoplurans (*M. mazzai* and *M. praelongiceps*) and one Malophagus (*B. breviceps*). While mixed infestations of *M. mazzai* and *M. praelongiceps*, and *M. praelongiceps* and *B. breviceps*, were found, no mixed infestations of *M. mazzai* and *B. breviceps* were found. We found that 91.9% of the crias had *M. praelongiceps*, 18.5% had *M. mazzai*, and 11.5% had *B. breviceps*. Epidemiological studies on lice in South American camelids are very limited. A study carried out in the central highlands of Peru found that 40% of alpacas older than 3 years of age and about 20% of young alpacas (tuis) aged 10 to 14 months were infected with *M. mazzai* (Cicchino et al., 1998). Likewise, a study performed on alpacas in the Chilean Andes reported prevalences of 11% in two-month-old alpacas and 38% in adult alpacas (over 3 years of age) (Rojas et al., 1993). Our study found a high prevalence of lice in crias under 6 months of age, and among the three species of lice identified, only *M. praelongiceps* (91.9%) showed a significant association with the host province. Environmental factors and livestock practices may likely have an effect on lice infestation in livestock (James et al., 1998; Milnes et al., 2003a; Milnes & Green, 1999). Furthermore, our results indicate that lice infestation begins at a very early age in alpacas. This would indicate that there is a persistent infestation in the mothers or in the entire farm that exposes the crias from birth. This parasitism in the crias harms their adaptation or survival to face other diseases (Sotomayor & Zaravia, 2023).

Similar to Cicchino et al. (1998) findings, the animals infested with lice in this study showed a high infestation (>20 lice per 10 cm^2). This effect is due to several factors, including the immaturity of the immune system in crias. In our study, the crias were < 6 months old, and it is well known that at this age crias have a less developed immune system (Rynkiewicz et al., 2013). Another relevant factor is the high density and close contact between the animals. The study was carried out during the alpaca calving season in Peru, which begins at the end of December and ends in March. During this period, the crias are usually kept in closed groups together with their mothers in corrals known as "dormideros". This close contact between the crias and their mothers might facilitate the direct transmission of lice. In addition, the lower grooming capacity of the crias must be considered. Adult animals tend to groom or scratch themselves more effectively, frequently using the ground in areas called "revolcaderos", which contributes to the control of the parasitic load (Miranda-de la Lama & Villarroel, 2023; Pezo et al., 2014). However, the crias depend exclusively on maternal grooming, which might be insufficient in cases of high infestations.

On the other hand, a significant association between lice infestation and other variables, such as sex and breed, in any of the identified lice species was not found. The result is congruent with other studies that have observed that these factors do not always correlate clearly with the prevalence of ectoparasites (Cha et al., 2024; Disasa, 2020; Legesse et al., 2022; Seyoum et al., 2015). This could suggest that environmental and management factors have a greater influence on lice infestation than individual animal characteristics.

Management of livestock, such as shearing frequency, animal facility infrastructure, and animal housing cleaning, helps to prevent and control lice infestations. However, our study was conducted in the calving season, and in this period, no shearing programs in crias and mothers are carried out (Pezo et al., 2014). This leads us to assume that mothers are responsible for transmitting lice to their crias. The high prevalence of lice observed in this study underlines the importance of this parasitism in alpaca crias. Preventive sanitary programs will be necessary, especially during the peripartum period, to control lice infestation in animals. These programs include improving animal husbandry practices and using new-generation, long-lasting ectoparasiticides such as isoxazolines.

Finally, our study showed that *M. praelongiceps* was the most prevalent louse species and the one that presented an association with the province. This could suggest that the identified louse species has different adaptation capacities to environmental conditions, which deserves further investigation. Future epidemiological studies will be necessary to more thoroughly evaluate the interactions between lice species, local characteristics, and livestock management to obtain a clearer picture of the risk factors associated with this parasitism in alpacas. In addition to epidemiological studies, the economic impact of lice infestations in alpacas should be assessed. These ectoparasites could affect alpaca growth, fibre production, offspring mortality, and comorbidity with other infectious diseases.

AUTHOR CONTRIBUTIONS

Luis A. Gomez-Puerta: Conceptualization; investigation; writing – original draft; writing – review and editing; methodology; validation; resources; supervision. **Johan Carrasco:** Investigation; methodology; resources; writing – original draft. **Madeline Garcia:** Investigation; methodology; resources; writing – original draft. **Maria T. Lopez-**

Urbina: Investigation; writing – original draft; conceptualization; methodology. **Cesar M. Gavidia:** Conceptualization; validation; formal analysis; writing – review and editing; writing – original draft; investigation.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data are available on the Zenodo platform at this link: https://zenodo.org/records/15540295.

ETHICS STATEMENT

The handling of animal samples in this project has been approved by the Ethics Committee of the Faculty of Veterinary Medicine (Universidad Nacional Mayor de San Marcos).

ORCID

Luis A. Gomez-Puerta https://orcid.org/0000-0002-7909-979X

REFERENCES

Cha, W., Fungbrant, K., Grandi, G. & Persson, Y. (2024) Prevalence and risk factors for hair loss in outdoor-wintered beef cattle under cold weather conditions. *Research in Veterinary Science*, 166, 105094. Available from: https://doi.org/10.1016/j.rvsc.2023.105094

Chavez, C.E. & Zaldivar, R. (1967) *Zooparasites of livestock in Peru (Project FG-Pe-102)*. Lima, Perú: United States Department of Agriculture, Foreign Agricultural Research Grant Project, University of San Marcos, School of Veterinary Medicine.

Cheney, J.M. & Allen, G.T. (1989) Parasitism in llamas. *Veterinary Clinics of North America: Food Animal Practice*, 5, 217–225. Available from: https://doi.org/10.1016/s0749-0720(15)31011-2

Cicchino, A.C., Cobenas, M.E., Munoz Bulman, G., Diaz, J.C. & Laos, A. (1998) Identification of *Microthoracius mazzai* (Phthiraptera: Anoplura) as an economically important parasite of alpacas. *Journal of Medical Entomology*, 35, 922–930. Available from: https://doi.org/10.1093/jmedent/35.6.922

Cortinas, R. & Jones, C.J. (2006) Ectoparasites of cattle and small ruminants. *Veterinary Clinics of North America: Food Animal Practice*, 22, 673–693. Available from: https://doi.org/10.1016/j.cvfa.2006.06.003

Disasa, D.D. (2020) Lice infestations in sheep and goats in Kombolcha district, east Hararghe zone, Oromia regional state, Ethiopia. *Veterinary Medicine International*, 2020, 8889755. Available from: https://doi.org/10.1155/2020/8889755

Durden, L.A. (2019) Lice (Phthiraptera). In: Mullen, G.R. & Durden, L.A. (Eds.) *Medical and veterinary entomology*. CA, United States: Academic Press, Elsevier, pp. 79–106.

Ferris, G.F. (1951) *The sucking lice*, Vol. 1. San Francisco: Memoirs of the Pacific Coast Entomological Society, pp. 1–320.

James, P.J. (1999) Do sheep regulate the size of their mallophagan louse populations? *International Journal for Parasitology*, 29, 869–875. Available from: https://doi.org/10.1016/s0020-7519(99)00055-7

James, P.J., Moon, R.D. & Brown, D.R. (1998) Seasonal dynamics and variation among sheep in densities of the sheep biting louse, *Bovicola ovis*. *International Journal for Parasitology*, 28, 283–292. Available from: https://doi.org/10.1016/s0020-7519(97)00188-4

Legesse, S., Hailemelekot, M., Tamrat, H. & Alemu, Y.F. (2022) Epidemiological and therapeutic studies on sheep lice in Sayint district, south Wollo zone, Northeast Ethiopia. *Frontiers in Veterinary Science*, 9, 1008455. Available from: https://doi.org/10.3389/fvets.2022.1008455

Milnes, A.S. & Green, L.E. (1999) Prevalence of lice on dairy cattle in England and the bordering counties of Wales. *Veterinary Record*, 145, 357–362. Available from: https://doi.org/10.1136/vr.145.13.357

Milnes, A.S., O'Callaghan, C.J. & Green, L.E. (2003a) A longitudinal study of a natural lice infestation in growing cattle over two winter periods. *Veterinary Parasitology*, 116, 67–83. Available from: https://doi.org/10.1016/s0304-4017(03)00208-5

Milnes, A.S., O'Callaghan, C.J. & Green, L.E. (2003b) A longitudinal study of a natural lice infestation in growing cattle over two winter periods. *Veterinary Parasitology*, 112, 307–323. Available from: https://doi.org/10.1016/s0304-4017(02)00390-4

Miranda-de la Lama, G.C. & Villarroel, M. (2023) Behavioural biology of south American domestic camelids: an overview from a welfare perspective. *Small Ruminant Research*, 220, 106918. Available from: https://doi.org/10.1016/j.smallrumres.2023.106918

Palma, R.L. (1978) Slide-mounting of lice: a detailed description of the Canada balsam technique. *New Zealand Entomologist*, 6, 432–436. Available from: https://doi.org/10.1080/00779962.1978.9722313

Pezo, D., Franco, E., García, W., Franco, F., Bravo, W., Alarcón, V. et al. (2014) *Manual del técnico alpaquero*, 2nd edition. Lima, Peru: Soluciones Practicas.

Rojas, C., Lobato, M.Y. & Montalvo, V.M. (1993) Fauna parasitaria de camelidos Sudamericanos y ovinos en pequenos rebanos mixtos familiares. *Revista De Investigaciones Pecuarias*, 6, 22–27.

Rynkiewicz, E.C., Hawlena, H., Durden, L.A., Hastriter, M.W., Demas, G.E. & Clay, K. (2013) Associations between innate immune function and ectoparasites in wild rodent hosts. *Parasitology Research*, 112, 1763–1770. Available from: https://doi.org/10.1007/s00436-013-3335-1

Seyoum, Z., Tadesse, T. & Addisu, A. (2015) Ectoparasites prevalence in small ruminants in and around Sekela, Amhara regional state, Northwest Ethiopia. *Journal of Veterinary Medicine*, 2015, 216085. Available from: https://doi.org/10.1155/2015/216085

Sotomayor, E.A. & Zaravia, C.E. (2023) Relación del perfil hematológico y nivel de infestación por *Microthoracius* spp. en crías de alpacas (*Vicugna pacos*). (Universidad Nacional De Huancavelica: Huancavelica, Perú.). Thesis for Animal Science Engineer degree. 73p. Available from: https://hdl.handle.net/20.500.14597/5923

Weeks, C.A., Nicol, C.J. & Titchener, R.N. (1995) Effects of the sucking louse (*Linognathus vituli*) on the grooming behaviour of housed calves. *Veterinary Record*, 137, 33–35. Available from: https://doi.org/10.1136/vr.137.2.33

Werneck, F.L. (1935) *Microthoracius minor* e demais especies do mesmo genero (Anoplura, Haematopinidae). *Revista De Entomologia*, 5, 107–116.

Windsor, R.H., Teran, M. & Windsor, R.S. (1992) Effects of parasitic infestation on the productivity of alpacas (*Lama pacos*). *Tropical Animal Health and Production*, 24, 57–62. Available from: https://doi.org/10.1007/BF02357238

How to cite this article: Gomez-Puerta, L.A., Carrasco, J., Garcia, M., Lopez-Urbina, M.T. & Gavidia, C.M. (2025) Prevalence of lice infestation in alpaca crias from the southern Peruvian Andes. *Medical and Veterinary Entomology*, 1–6. Available from: https://doi.org/10.1111/mve.70027