Identification of *Microthoracius mazzai* (Phthiraptera: Anoplura) as an Economically Important Parasite of Alpacas

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**ABSTRACT** The hematophagous sucking louse *Microthoracius mazzai* Werneck, 1932, is redescribed and identified as a parasite of alpacas, *Lama pacos*. Specimens were collected on animals 10–14 mo old, located on a large community farm at 4,600 m above sea level in the Peruvian Andes. In total, 26 scanning electron microscope (SEM) figures are included that highlight salient and differential characteristics, especially the unique elongated spindle-shaped head, which is almost as long as its abdomen. Alpacas, 1 of the 4 species of South American cameldids, are important for their production of high-quality wool in the Andes Mountain range countries, especially Peru and Bolivia; to a lesser degree Chile; and more recently Argentina, where breeding and disease control programs are receiving increased technical support. Information is given on the prevalence of lice infestations in the flock, clinical signs, and economic losses. We report the efficacy of moxidectin (SC, 200 mcg/kg, b.w.) in a repeated treatment program of 7–10 d, which is currently used for mange control in these ruminants.

**KEY WORDS** *Microthoracius mazzai*, lice, alpacas, differential description, economic importance, treatment program

*Microthoracius mazzai* Werneck 1932 is 1 of the 4 species included in the genus *Microthoracius* (Fahrenholz 1916) and the only genus in the family Microthoracidae (Kim and Ludwig 1978). All 4 species are external parasites of cameldids. One species occurs in the Old World, *M. cameli* (L.), from the camel; 6 the other 3 have been described from ruminants in the New World as follows: (1) *M. praelongiceps* (Neumann, 1909) on guanaco; *Lama guanicoe* Muñoz; llama, *Lama glama* L.; and vicuña; (2) *M. aninor* Werneck 1935 on the same hosts; and (3) *M. mazzai*, previously reported occurring only on llamas because of a mistaken identification of specimens collected on alpacas and classified as *M. praelongiceps*. Thus, Darden and Musser (1994) reported that the llama was the only host of *M. mazzai*, initiated by the report by Neumann (1909) in which he described *M. praelongiceps*. He referred to additional specimens of this species which were collected on llamas in Coquimbo, Chile, and which corresponded to *M. mazzai*. Also, some specimens of *M. praelongiceps* referred to by Fahrenholz (1916) also corresponded to *M. mazzai*. Arnau et al. (1949) mentioned an undetermined species of *Microthoracius*, collected from alpacas in Peru, which was included in specimens received from the Department of Puno. Arnau et al. (1951, 1954) identified *M. minor* and *M. praelongiceps* collected on alpacas based on the original description by Werneck (1935a) or on its redescription (Werneck 1935b); the 2nd species in Ferris (1932), *M. praelongiceps*, was erroneously identified from text and illustrations as *M. mazzai*. Apparently the description of *M. mazzai* by Werneck (1932) (see Arnau et al. 1949) was a correction of the true identity of *M. praelongiceps*, with illustrations of both species (Werneck 1933). Ferris (1935) corrected the identification he made (Ferris 1932) as well as the morphological characteristics which unmistakably separated *M. praelongiceps* from *M. minor* and summarized the characteristics of the 4 species in the genus *Microthoracius* Ferris, 1951.

In this same sequence, the classification error was carried on to later papers (Chavez and Guerrero 1960a, b; 1964; 1965). Chavez et al. (1965) described *M. praelongiceps* collected from alpacas in the Department of Puno and from llamas in the Department of Junin (Peru), but the description of the louse on alpacas was confused with either *M. minor* or *M. praelongiceps* and on llamas with *M. minor*. Guerrero (1971), Guerrero and Leguía (1987), and Leguía (1989) continued to include *M. minor* and *M. praelongiceps* as species found on alpacas, but *M. praelongiceps* was actually *M. mazzai*. Guerrero and Leguía (1987) and Leguía (1989) repeated these errors, although Guerrero and Leguía (1987) provided a good microphotograph of an *M. mazzai* female, which they de-

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scribed as being M. praelongiceps. Zaldívar (1991) made a meritorious update of all the lice described on South American camelds but did not personally verify these species, resulting in M. minor and M. praelongiceps being incorrectly identified as parasites of llamas and vicuñas. Unexplainably, M. mazzai was reported as being collected on vicuñas, which was an obviously incorrect identification of M. praelongiceps. He included a correct description of M. minor on alpacas, but classified M. mazzai specimens as M. praelongiceps. More recently, Windsor et al. (1992) and Rojas et al. (1993) identified specimens collected on llamas and alpacas as M. praelongiceps—actually M. mazzai for both camels.

From the previous work, we conclude that M. mazzai has been reported as a parasite of alpacas, both in Peru and Chile, for >40 yr but was never correctly and specifically identified. Thus, we submit the current contribution, wherein M. mazzai is redescribed, including all of the morphological features which are required to differentiate this species from M. minor and M. praelongiceps, and defines alpacas as its host. We also discuss the life cycle, dispersion from animal to animal, clinical lesions, and quantification of losses, along with the efficacy of moxidectin for control.

**Results and Discussion**

Microthoracius mazzai, M. praelongiceps, and M. minor are the 3 Neotropical species which, together with M. camelii (Linneoeus, 1758), the Old World camel, are included in the genus Microthoracius (Fahrenholz 1916). Traditionally, this genus has been included within the Linognathidae following the classification by Ferris (1951). Later it was transferred to the Microthoraciidae created by Kim and Ludwig (1978), within which it is the only species (Figs. 1–26).

**Genus Microthoraciidae**

**Diagnosis** (Figs. 1–26). The most relevant features of the Microthoraciidae are the spindle-shaped head, long (in M. mazzai almost as long as the abdomen), with clypeal segment much shorter than antenno-ocular segment (Figs. 3, 5, 9, 10). Eyes well evident, represented by a lens in post-antennal angle (Figs. 3, 11, 12). Antenna generally with 5 segments or, if only 4, the terminal segment has 2 sensilla. In general, setae displaced toward lateral margins (Figs. 3, 11, 12). Head inserted dorsally in thorax, giving these Anoplura a typical angular aspect from side view (Figs. 9, 10). Thorax small, short, with the mesothoracic phragmata connected on the back; ventral apophyseal orifices visible, as well as a scarcely developed sternal plate (Fig. 16). Legs similar in size and shape with claw pointed and tibial thumb poorly developed and provided with a thick apical bristle (Fig. 22). Abdomen devoid of well-defined tergal, paratergal, and sternal plates, densely covered with short, thin setae (Figs. 4, 7, 8); cuticle with a wrinkled aspect (Figs. 4, 8, 23). Spiracles present in segments III–VIII (Figs. 4, 7). External male genitalia with a basal plate moderately developed, thin and relatively short parameres, and pseudopenis well developed, in the shape of a U or a V. Male and female subgenital plate poorly developed (Figs. 25, 26). In females, gonopods corresponding to segment VIII are rounded and those of IX more sharply bordered (Fig. 25).

**Redescription of Microthoracius mazzai**

**Female.** Total 3.32–3.76 mm. General aspect as in Figs. 5 and 6. Head long, approximately same length as abdomen (Fig. 5), clypeal segment arrow-shaped, long and sharp, forming an angle of 25°, frontoclypeal suture subrectal (Fig. 11), postantennal angles well marked, prominent, with 1 pair of well-differentiated eyes (Figs. 11, 12). Prominent haustellum as shown in Figs. 11 and 14, being visible as well through transparency in the haustellar atrium, a series of teethlike formations difficult to delimit, pharyngeal stili 1,200–1,250 μm long, haustellar base covered under a well-defined fold. (It was not possible to homologize the cephalic setae with the nomenclature proposed by Kim and Ludwig (1978) because they were remarkably displaced because of the notable length of the head). Antenna with 5 visible segments, the last one having 2 platelike sensillae and an apical tuft with 13

**Materials and Methods**

Numerous specimens of M. mazzai were collected from unshorn alpacas (10–14 mo old) between May and October 1993. The animals were part of the large alpaca flock in the SAIS Pachuteque Cuyo Production Unit, Hacienda Corpacanche, District of Marcapampa, Province of La Oroya, Department of Junin, Peru, at 4,600 m above sea level in the Andes mountains.

The specimens were fixed in ethanol/acetic/glycerol 1:1:1 (vol:vol:vol) solution, and permanent slides for microscopy were prepared using the methods of Castro and Cicchino (1975). The scanning electron microscope (SEM) was used for detailed observations of external morphological characteristics. For this purpose, the method of Nation (1983) was modified as follows: (1) specimens were kept in 50% ethanol for a minimum of 12 h, then the concentration was increased in successive steps (70, 90, and 100%) for a minimum of 6 h; (2) specimens were transferred to a hermetic container containing hexamethyldilisilazane (HMDS) and refrigerated at 4–5°C for 24 h; (3) transferred to a petri dish containing absorbent paper impregnated with HMDS and left for 7–10 d, during which the HMDS slowly and totally evaporated; (4) mounted on bronze stubs in different positions, using double-faced adhesive tape; (5) spatter-coated with gold in a Joel vacuum; and (6) observed and photographed with a Joel T-100 (SEM).

We followed the anatomical and topographic nomenclature proposed by Kim and Ludwig (1978), although it was not possible to confirm fully the cephalic setae because they had been largely displaced because of the extraordinary length of the head.
Figs. 1–4. *M. mazzai* Werneck, male. (1) Dorsal view. (2) Ventral view. (3) Dorsolateral view of head. (4) Dorsal view of abdomen. III, spiracle, abdominal segment III; VIII, spiracle, abdominal segment VIII; et, thoracic spiracle; ps, pseudopenis; sg, subgenital plate.
hairlike chemoreceptor sensilla of different sizes and rounded ends, with a sensorial seta (Fig. 15). Relatively short thorax, prolonged ventrally toward proximal quarter of head (Figs. 9, 10); prominent spiracle 42–52 μm in diameter, with an ample ostium 34–40 μm in diameter (Fig. 17) whose atrium is provided with phanarae placed in columns, each divided apically into 2–6 sharply pointed fingerlike processes (Figs. 17, 18). Notal orifice well evident, especially when specimen is transparent (often covered by the 1st segment of abdomen, which partially protrudes over thorax). Legs similar in size and format, although 1st pair with tibia and tarsus somewhat thinner and larger than in the other 2 pairs; tarsal claw strongly striated on its internal surface, its length 1/8 greater than the length of the level of the tibial thumb when completely closed (Fig. 21). The abdomen is oval and becomes elliptical when totally engorged (Figs. 5, 6); there are

Figs. 9–14. *M. mazzai* Werneck. (9) Female, lateral view, showing typical angular silhouette. (10) Head, thorax, and 1st abdominal segment. (11) Head of female, dorsoventral view. (12) Same, ventral view. (13) Female haustellum viewed dorsally. (14) Male haustellum viewed ventrally. et, thoracic spiracle; cf, frontoclypeal suture; h, haustellum; o, eye; c, head; a, abdomen.
no defined tergal, paratergal, or sternal segments, but the sternal and tergal areas corresponding to each segment are delimited by conspicuous transverse grooves (Figs. 5, 8) (which are somewhat lost in conventional microscopical slides because of pressure of cover slip). Abdominal setae short and thin, poorly defined in irregular rows, setae of tergal and sternal segments II-VIII formed by a central set and 2 lateral groups close to corresponding spiracles, separated by a space without setae (Figs. 7, 8). In area corresponding to tergite IX, through transparency, a narrow, well-pigmented, arc-shaped sclerotization clearly visible. Gonapophysis of segment VIII rounded, each with 5–6 strong setae and 3 + 3 setae situated close to vulval margin; gonapophysis of segment IX strongly pointed and facing inward (Fig. 25). Abdominal spiracles with external diameter between 39 and 41 μm, maximum diameter of ostium between 13 and 15 μm (Fig. 19). Atrium provided with phanarae similar to those found on thorax (Fig. 20).

Male. Total length of the body 2.49–3.01 mm (although Ferris [1932] mentioned measuring a speci-
men of only 2 mm). General aspect as in Figs. 1 and 2. Features of head, thorax, and abdomen similar to those of female, differentiation based upon the smaller size, longer and narrower abdomen, pigmentation of tergite IX being barely noticeable, and terminal portion of abdomen being different (compare Figs. 24 and 25). When resting, external genitals protrude from abdomen and end of pseudopenis visible, U-shaped, with its appendix extended in a pointed process and terminating in an aedeagus with rounded border (Fig. 24).

Life Cycle. The life cycle has not been determined specifically for any species of Microthoracius. However, in incomplete studies, Guerrero (1971) and Guerrero and Leguia (1987) suggested that eggs hatch in ~10 d and that the nymphs mature to adults 2–3 wk after hatching. It appears that egg development takes place in 10 d, when ecdysis commences. The females of this progeny commence egg-laying 14–21 d later; therefore, 2 d of preoviposition period are subtracted. Each of the three instars require 4–6 d; therefore, the life
cycle of *M. mazzai* from egg to egg would vary between 14 and 31 d.

Prevalence and Dispersion. We found that 40% of adult alpacas ≥3 yr old and ~20% of younger animals 10–14 mo old were infested by *M. mazzai*. The numbers of lice on infested animals was high, especially in the younger age group. It is evident that the most frequent manner of spreading infestation is repeated close contact when lactating, before weaning, and between working animals of the same or similar age groups confined temporarily together at night. In general, our data are coincident with reports by Rojas et al. (1993) who, working with what they reported as being *M. praelongiceps* in the Chilean Andes, described an 11% prevalence in 2-mo-old alpacas, attaining 38% in animals ≥3 yr old.

Clinical Signs of Louse Infestation. Known in vernacular Spanish as “piojera,” high lice burdens cause stress in alpacas because of itching and irritation when the lice feed or move over the skin surface. The animals show signs of uneasiness and their normal feeding and sleeping schedules are affected. Younger animals diligently nibble, bite, and often kick their skin, and many rub against posts, shrubs, and fences to the point of self-inflicting serious wounds. These signs are well documented in existing literature (Chavez and Guerrero 1964, 1965; Guerrero 1971; Leguiña 1989) and in general do not vary greatly from lice infestation in cattle or in sheep.

Economic Losses. Lice infestations cause losses mainly from lowered weight gains directly related to a decrease in daily feed intake as a consequence of stress, as well as producing, through frequent nibbling, biting, rubbing, and kicking, mechanical damage to the fleece and in its quality. However, these losses have been poorly registered or quantified, and the little existing information is controversial, consisting mostly of separate case reports. This is evident as losses from lice have not been correctly separated from those caused by other concomitant ectoparasites, especially sarcoptic mange. For example, Guerrero and Alva (1986) considered that lice were mainly a cause of worry and uneasiness, but that 95% of the losses were caused by *Sarcoptes scabiei* and the remaining 5% by psoroptosis and phthirioses in general. Guerrero and Leguiña (1987) reported that 25% of the total losses in alpacas from ectoparasites were caused by sarcoptic mange and lice infestation, but added that only 10% of these were actually attributable to lice. Contrary to these evaluations, Windsor et al. (1992) stated that damage is directly proportional to the prevalence and intensity of the clinical signs of the parasitic disease described in this article. This farm, because of its management and size, represents the overall picture of organized alpaca breeding in the higher valleys of the Andes. The losses from lice infestation (80–85%) were far more important than those caused by mange or liver fluke; this evaluation was coincident with the opinion of farm management and their technical assistants.

Parasite Infestation and Treatment. On the Hacienda Copancancha alpacas, when visited by the authors and attending veterinarians, a combination of mange mites and lice was found, especially in young animals which were weak because of a diagnosed acute *Pneumocystis carinii* infection. The highest level of phthirioses was clearly visible in these younger animals, and parasite burdens were lower and tended to be less generalized in older alpacas. The reason for our original visit was a report received that in previous single-dose treatments with moxidectin or ivermectin, reinfection of *M. mazzai* was found 30–40 d after treatment, at that time considered to be possible because of the special husbandry practices on these farms which involved confined herding, especially in winter.

First-hand information from veterinarians working in the area attributed excellent control of phthiriosis when the flocks were treated for *Sarcoptes scabiei* according to A.L. (unpublished data) applying 2 subcutaneous injections of moxidectin (Cydectin, American Cyanamid) (200 mcg moxidectin/kg b.w.) with a 7–10 d interval between injections. This treatment was then recommended to be under close surveillance; favorable results were obtained. It appeared to be the best program in the area for the control of lice, especially when integrated into improved husbandry practices, which mainly included separating age groups and isolating treated flocks to minimize reinfection. This treatment also would cover the needs of the control program for mange (both psoroptosis and sarcoptosis). Liver fluke infection, on the other hand, involves a confirmed diagnosis and a separate propylaxis program. There is some controversy as to the pathogenicity of *F. hepatica* for cameldids. Czarnecki et al. (1996) reported no overt clinical effects in llamas, despite heavy parasite burdens, in a recent study made in northwestern Argentina. Previously, Leguiña (1991) had described high mortality in alpacas with acute liver fluke infection in a study in Peru.

From a parasitic point of view, the life cycle of *M. mazzai* on Hacienda Copancancha alpacas becomes interesting and, for treatment schedules, extremely important. In alpacas bred at 4,600 m, above sea level, the life cycle could vary considerably in length. For comparison, the life cycle under more temperate and less limiting climactic conditions has been only partially described (Guerrero 1971, Guerrero and Leguiña 1987). It is possible that in the high Andes with extreme low temperatures, *M. mazzai* could suffer a change in the length of the period from oviposition to eclosion by as much as 7 d, but under normal climactic (they are mainly winter parasites) and host conditions, it tends to shorten to 4–9 d (Prieto et al. 1991). Further observations on cattle lice in Argentina in field studies comparing the life cycle of a single species in 2 areas with markedly different climates, important variability was identified in the length of this period (A.C.G., unpublished data). This would technically explain the poor control on that farm obtained with a unique treatment of either of the macrocyclic lactones, moxidectin or ivermectin (Ivomec, MSD AgVet) because they are used globally with excellent results to control sucking lice and the need for the repeat treatment to control the immediate generation of lice as they hatch. In this case, and in future work,
an interval of 10–12 d (rather than 7–10 d), would offer still better control and yet cover the need for mange control.

Nevertheless, and despite the described practical and valid solution to a specific efficacy–treatment problem, it is suggested that further studies be made on the pharmacokinetoe and pharmacodynamic processes of the macrolide lactones when used in camelpids, which, added to any changes in the life cycle of these lice under special climatic conditions, also could influence treatment programs and their efficiency.

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