Infestation with the sheep body louse (*Bovicola ovis*) in Merino lines divergently selected for maternal multiple rearing ability

S W P Cloete[a], J M Laubscher[a] and J J E Cloete[a]

ABSTRACT

Data were obtained from a population consisting of 160 Merino ewes, as well as 64 male and 75 female progeny of these ewes at the 2-tooth age. The age and sex groups were maintained in separate flocks. The population has been divergently selected from the same base since 1986, either for (high or H line) or against (low or L line) maternal multiple rearing ability. All animals were inspected for sheep lice (*Bovicola ovis*) during September/October 2002 after a wool growth period of at least 4 months. When expressed relative to mean L-line performance, the advantage in lambs weaned per ewe during the lambing season amounted to approximately 110 % in the H line (1.01 *vs* 0.48; $P < 0.01$). The proportion of animals on which 1 or more lice were observed were markedly lower in 2-tooth replacement ewes than in replacement rams and mature breeding ewes (0.053 *vs* 0.625 and 0.531, respectively; $P < 0.01$). One or more lice were observed on a lower proportion of H-line ewes than on those of the L line (0.413 *vs* 0.571, respectively; $P < 0.10$), while a similar tendency was observed in 2-tooth ewe hoggets (0.033 *vs* 0.143, respectively; $P = 0.16$). When the mean number of lice on individuals on which 1 or more lice were observed was compared between lines, the average number of lice observed on H-line young rams was lower than in the L line (4.36 ± 0.85 *vs* 9.71 ± 1.84 lice, respectively; $P < 0.01$). A similar tendency was observed in mature breeding ewes (2.15 ± 0.38 *vs* 3.22 ± 0.42 lice, respectively; $P < 0.20$). The more highly reproductive H-line ewes were not more susceptible to infestation with *B. ovis* than ewes of the L line. In fact, available evidence suggest that H-line animals could be more tolerant of *B. ovis* than those of the L line.

Key words: integrated control, lice management, reproduction, resistance, susceptibility.

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The sheep louse, *Bovicola ovis* (previously *Damalinia ovis*[8]), is regarded as an important ectoparasite by the wool industry. It is an obligate parasite of sheep with no off-host stage[10]. In South Africa, lice were once controlled by compulsory dipping for sheep scab (*Psoroptes communis ovis*). The incidence of sheep scab declined in the early 1980s, but increased towards the end of the decade[5] after compulsory dipping was abolished. The efficacy of chemical control of lice resulted in few alternatives having been considered[9]. Resistance of *B. ovis* to synthetic pyrethroid (SP) backline products was reported as early as 1987[15]. By 1998, in Australia, 90 % of the western Queensland louse population had become resistant to SP compounds (Ward and Armstrong, 1999, as cited by James[9]). The European Union recently passed strict legislation for the control of harmful chemical compounds in primary products[16]. In Australia, the quantity of chemicals used for the control of lice is nearly 3 times that used for blowfly[17]. Lice control therefore markedly contributes to the total chemical load of the Australian wool clip[9]. It is thus imperative that alternative lice control measures be sought to reduce the load of chemical residues in wool.

Marked differences in reproduction rates have been reported for South African Merino lines divergently selected for multiple rearing ability[2,3]. On reproductive Columbia and Polypay ewes the density of lice were found to be higher than on unmated controls, although significance could not be established[13]. It is known that the condition of sheep contributes to tolerance of *B. ovis* infestations[24]. The metabolic demands of reproduction cause a reduction in body reserves[14], suggesting that ewes maintaining a high reproduction rate could well be more susceptible to lice infestations. If so, such ewes would require more frequent treatment, potentially resulting in higher chemical residues. This study therefore focuses on the occurrence of lice on Merino sheep that have been divergently selected for the ability to rear multiple offspring since 1986, using maternal ranking values for lambs reared per joining. Details of the procedure for the selection of replacements have been reported elsewhere[3,4]. Briefly, male and female progeny of ewes that reared more than 1 lamb per joining (*i.e.* reared twins at least once) were preferred as replacements in the High (H) line. Replacements in the Low (L) line were preferably descended from ewes that reared fewer than 1 lamb per joining (*i.e.* barren, or loss of all lambs at least once). Depending on average reproduction rates in the lines, and on replacement needs, progeny of ewes that reared 1 lamb per joining were occasionally selected in either line. Selection decisions were mostly based on ≥3 maternal joinings, especially in the case of rams. Once selected, ewes normally remained in the breeding flock for 5 joinings.

The 2 lines were maintained as a single flock at the Elsenburg experimental farm during this study. The experimental site and general husbandry of the animals have been reported elsewhere[2,3,4]. Joining took place in the summer of 2002, for lambing during winter (June/July).

Individual reproduction records were available for 160 ewes during the lambing season, and included barren ewes. Data were also recorded for 64 ram and 75 ewe 2-tooth replacements in both lines. These animals were born during June/July 2001 and were maintained in flocks separated on sex. During September 2002, all animals exhibited symptoms that included pruritic behaviour, resulting in fleece derangement and an overall 'rubbed' appearance. Such symptoms may be indicative of an infestation with the sheep louse[11,12], and consequently all individuals in the 3 flocks were inspected for the presence of lice, immediately before the replacement flocks were sheared in early October. Unfortunately, all sheep were inspected only once, owing to the deadline imposed by the shearing date. It has been shown that lice are most likely to be found on the sides of long-wool sheep[11,12].

[a]Elsenburg Agricultural Centre, Private Bag X1, Elsenburg, 7607 South Africa. E-mail: schalkc@elsenburg.com

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Table 1: **The effect of line on the proportions of sheep with 1 or more lice, and least squares means** (±SE) **for lice numbers recorded.**

Flock and trait	Line		Significance[a]
	H	L	
Mature breeding ewes			
Number of observations	104	56	
Animals with 1 or more lice	43	32	
Proportion	0.413	0.571	*
Mean number of lice observed	2.15 ± 0.38	3.22 ± 0.42	0.20
Ram replacements			
Number of observations	51	13	
Animals with 1 or more lice	33	7	
Proportion	0.647	0.538	ns
Mean number of lice observed	4.36 ± 0.85	9.71 ± 1.84	**
Ewe replacements[b]			
Number of observations	61	14	
Animals with 1 or more lice	2	2	
Proportion	0.033	0.143	0.16

[a]ns, not significant ($P > 0.25$); *significant ($P < 0.10$); **significant ($P < 0.05$); actual significance levels are provided for $0.25 < P > 0.10$.

[b]Mean lice numbers were not computed for replacement ewes owing to a lack of observations.

The fleece of individuals was therefore parted along the side at the shoulder, midrib and britch. Partings were 10 cm in length. Specimens were recovered from individual sheep for identification and examined at ×250 magnification under a stereo-microscope. Lice were identified using standard identification guides[8,19] for biting and sucking lice.

Data expressed as proportions were assessed statistically using Chi-square procedures or Fisher's exact test, depending on the numbers and frequencies involved[22]. In the case of number of lambs weaned per ewe present during the lambing season, the Chi-square method of Brown[1] was used. The numbers of lice per sheep were approximately normally distributed in sheep on which at least 1 louse was observed. These data were assessed by least squares procedures[7] to account for uneven subclasses. Apart from the fixed effects, the random effect of animal was also included, making use of a pedigree file consisting of 4475 individuals and employing the full numerator relationship matrix[7]. Given the relatively small sample sizes, significance was set at $P = 0.10$.

The specimens recovered from individual sheep had filiform antennae with segments of even length. The antennae were exposed on the side of the head capsule, and consisted of 3 segments. The mandibles were adapted to bite vertically. The legs were modified for clasping, with 1 claw on each tarsus. Hardened plates were observed on the pleura. This morphology clearly placed the specimens in the order Trichodectidae (lice of mammals[8]). The lack of a difference in the length of the antennae, the lack of an enlarged 1st antennal segment as well as hardened plates on the pleura, positively identified the lice as *Bovicola ovis*[8].

The flocks differed markedly with regard to the proportion of animals on which at least 1 louse was observed ($\chi^2 = 54.29$, df = 2, $P < 0.01$). The proportion of animals in the flock of maiden ewes on which at least 1 louse was observed was very low (4/75 = 0.053), and lower ($P < 0.01$) than in the other flocks (young rams 40/64 = 0.625; mature breeding ewes 85/160 = 0.531), which did not differ significantly. The biology and population dynamics of *B. ovis* prevents infestation in a flock from spreading rapidly[10]. Lice are mainly spread by contact with infested sheep[10,19,24]. Since the flocks were managed separately for at least 8 months prior to assessment, it is not surprising that the level of infestation differed markedly between flocks.

The number of lambs weaned per ewe present during the lambing season averaged 1.01 for 104 H-line ewes, compared to 0.48 for 56 L-line ewes ($\chi^2 = 29.10$, df = 1, $P < 0.01$). In mature, breeding ewes, 1 or more lice were observed on a lower proportion of H-line ewes than in the L line ($P < 0.10$; Table 1). No significant difference was observed between replacement rams belonging to the two lines ($P > 0.50$). A tendency in favour of the H line relative to the L line was also found for maiden ewes (Fisher's exact probability = 0.16). When individuals on which at least 1 louse was observed were compared between lines, the average number of lice observed on H-line young rams was lower than in the L-line ($P < 0.01$). A similar tendency was observed in mature breeding ewes ($P < 0.25$).

Marked differences in the reproduction rates of the H- and L-line breeding ewes have been reported elsewhere[2,3]. When the occurrence of lice on breeding ewes of the 2 lines was considered, it was evident that the tolerance of H-line animals to *B. ovis* infestation was not compromised. This result was achieved despite the number of lambs weaned per ewe present during the lambing season in the H line being more than double that in the L line. In fact, there were differences ($P < 0.10$) and general tendencies between lines that were in favour of the H line, both in reproductive ewes and in 2-tooth replacements. Owing to the opportunistic nature of this study and relatively small sample sizes, these differences are somewhat inconclusive. However, line or breed differences in susceptibility to *B. ovis* are possible, since it was found that Columbia sheep were less ($P < 0.05$) susceptible to lice infestations than Polypay sheep[13]. Merino wethers of the Bungaree strain also had fewer lice on them at shearing than those of the Collinsville strain, after an equivalent challenge[20]. Moreover, both studies found that lice counts were highly repeatable between years within breeds or strains. In the study of James and Nattrass[13], 62.5 % of the lice were found on the 12.5 % most heavily infested sheep.

In conclusion, it is generally known that selection may be effectively used to obtain resistance against gastrointestinal nematodes[6,23] and blowfly strike[18] of sheep. Resistance to *B. ovis* and other ectoparasites may therefore also be achievable. Knowledge of genetic differences between individual animals and breeds with regard to their susceptibility to *B. ovis* may play an important role in devising an integrated approach to the management of sheep lice. Combined with the strategic treatment of lice with compounds that have a low environmental impact, like spinosad[21], it may be possible to reduce the level of unwanted chemical residues in the national wool clip. Further research is indicated, since the biology of *B. ovis* and host response to the challenge by the parasite are still poorly understood[10].

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