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### Investigation and treatment of ovine psoroptic otoacariasis

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1 **Abstract**

2 **Background-** Psoroptic otoacariasis has been described world-wide and is caused  
3 by a mite morphologically indistinguishable from the sheep scab mite *Psoroptes ovis*.  
4 A single treatment of affected sheep with 200 µg/kg of injectable ivermectin is  
5 reported to be curative.

6 **Case report-** *Psoroptes* mites were isolated following treatment with ivermectin but  
7 treatment with moxidectin at 1mg/kg caused complete cessation of clinical signs.  
8 Affected animals were seropositive to Pso o2 antigen ELISA, and had serum  
9 haptoglobin concentrations that overlapped with those described for field infections  
10 of classical sheep scab.

11 **Conclusions and clinical importance-** Psoroptic otoacariasis is not controlled by  
12 single treatments of injectable ivermectin but resolves after a single treatment with  
13 injectable moxidectin. Pso o 2 ELISA can detect infection with *Psoroptes* spp. mites  
14 but cannot distinguish between sheep scab and psoroptic otoacariasis.

15 **Background**

16 Psoroptic otoacariasis has been described in domestic sheep (*Ovis aries*) in the UK,  
17 France, Germany, Brazil and Israel.<sup>1,2,3</sup> It is also a widespread problem among  
18 Bighorn sheep (*Ovis canadensis*).<sup>4,5</sup> Opinions differ whether the causative mite  
19 should be classified as a strain of *Psoroptes ovis* (the sheep scab mite) or of  
20 *Psoroptes cuniculi* (the rabbit ear mite) or whether these are homospecific.<sup>6</sup>

21 Clinical signs of psoroptic otoacariasis include brown crusts in the external auditory  
22 meatus (EAM), aural pruritus and subsequent secondary changes.<sup>1,3</sup> The majority  
23 of the mites are found close to the tympanic membrane.<sup>7</sup> Diagnosis is by isolation of  
24 mites. There are no licensed products for the treatment of psoroptic otoacariasis.  
25 Unlike sheep scab, it does not respond to plunge-dipping in organophosphates but is  
26 reported to be cured by single injections of ivermectin at 200 µg/kg compared with  
27 sheep scab for which two injections at a seven-ten day interval are required<sup>1,8,9</sup>.

28 **Case report**

29 The owner of a small pedigree Wensleydale flock requested investigation of aural  
30 pruritus and hair loss affecting the majority of the flock in October 2013. Psoroptic  
31 mange (sheep scab) had not been diagnosed previously in the flock or in any  
32 neighbouring holdings; only two animals had been introduced during the previous 5  
33 years. The owner reported two previous outbreaks of similar disease in 1992 and  
34 2002. On both occasions injectable moxidectin treatment was reportedly successful.

35 The flock was first visited on 14th October 2013 and all of the sheep were examined.  
36 This confirmed the presence of lesions of the pinnae and EAM consistent with  
37 psoroptic otoacariasis. The yellow scabs typically associated with sheep scab were  
38 not seen. Affected EAM were swabbed as previously described; a sterile, cotton-  
39 tipped, bacteriology swab was gently inserted into the EAM, rotated and then  
40 withdrawn, with any loose debris in the EAM also collected.<sup>1</sup> All sheep were blood  
41 sampled using plain vacutainers. The swabs and any debris recovered were  
42 examined microscopically. The serum samples were analysed for anti-Pso o 2

43 antibody by ELISA as previously described and for haptoglobin using a commercial  
44 colorimetric assay (Tridelta PHASE Haptoglobin Assay; Tridelta Development Ltd,  
45 Maynooth, Co.Kildare, Republic of Ireland).<sup>10</sup> Haptoglobin is an acute phase protein  
46 and as such is a non-specific marker of inflammation. Levels are known to be  
47 elevated in sheep with active sheep scab infection and drop rapidly after successful  
48 treatment. <sup>11</sup> All sheep were treated with subcutaneous injection of ivermectin at 200  
49 µg/kg (Panomec Injection for Cattle, Sheep & Pigs, Merial Animal Health Ltd,  
50 Harlow, Essex, UK).

51 Clinical signs reappeared and worsened within 1 month. The flock was visited again  
52 and deep skin scrapings were taken from the hyperkeratotic areas of affected  
53 animals. One animal had died and three had been sold between the first and second  
54 visits. Both ears of all sheep with visible lesions were flushed following a previously  
55 described method; in brief a length of flexible rubber tubing was gently inserted into  
56 the EAM and 60 ml of sterile saline was instilled using a syringe, overflow from the  
57 ear was captured and negative pressure applied to withdraw as much of the flushing  
58 fluid as possible, which was then pooled with the overflow fluid.<sup>2</sup> Repeat blood  
59 samples were collected from all animals with visible lesions. All sheep in the flock  
60 were treated with 1 mg/kg moxidectin (Cydectin 20 mg/ml LA Solution for Injection  
61 for Sheep, Zoetis UK Ltd, London, UK). Ears were scored at both visits. An arbitrary  
62 0-3 score was given to each ear using the following criteria: 0- no visible lesion; 1 -  
63 alopecia and crusting at the ear base; 2 - more extensive alopecia and crusting and  
64 the presence of dark brown scabs; 3 - fibrosis and thickening of the pinna, complete  
65 occlusion of the external auditory meatus and the presence of several dark brown  
66 scabs. Individuals were assigned a score by summing their ear scores. Sheep were  
67 classified as lesions present/absent and as lamb (<1 year old) or adult (> 1 year old).  
68 Statistical analysis was performed using Minitab 16 (Minitab Inc., State College, PA,  
69 USA). Proportions of affected sheep were compared by 2-proportions test,  
70 haptoglobin concentration and ELISA titre variation between animals were analysed  
71 by 2-sample t-test, and within animals over time by paired t-test; correlation between  
72 these variables was analysed by a Pearson test. Comparison to previously published  
73 results was performed using a 1-sample t-test.

74 At the first visit 11/23 animals had visible lesions; at the second visit 14/19. A  
75 statistically significantly higher fraction of adult sheep than lambs had score 3 lesions  
76 on both dates ( $p=0.043$  and  $p=0.012$  respectively).

77 No mites were isolated from the swabs or skin scrapes. 3 mites were isolated from 2  
78 animals by flushing. These were morphologically consistent with *Psoroptes ovis*  
79 tritonymphs.

80 Pso o 2 titres which exceeded twice the optical density of the negative control (0.21)  
81 sample were considered sero-positive. At the first sampling, 6/18 samples were  
82 sero-positive, whilst 7/12 were positive at the second sampling. Not all Pso o 2 or  
83 haptoglobin results could be assigned to specific individuals due to mismatches  
84 between sheep ear tag numbers and label numbers. There was no statistically  
85 significant difference between the two sets of Pso o2 ELISA titres ( $p=0.209$ ), or when  
86 the identified samples were compared ( $p=0.591$ ).

87 The mean haptoglobin concentration was 0.47 mg/ml at first sampling and 0.24  
88 mg/ml at second sampling, the haptoglobin concentrations were statistically

89 significantly different ( $p=0.019$ ). There was no difference between the haptoglobin  
90 concentrations at first sampling and the pre-infestation mean (0.30mg/ml) previously  
91 described ( $p=0.072$ ), though some results were higher than those described for field-  
92 acquired sheep scab.<sup>11</sup> There was no correlation between Pso o2 titre and  
93 haptoglobin concentration at either date ( $p=0.402$ ,  $p=0.759$  respectively). The  
94 presence of ear lesions and the age of the animal did not appear to have a  
95 significant effect on the likelihood of a positive Pso o 2 ELISA result or the serum  
96 haptoglobin concentration.

97 After ivermectin treatment a temporary reduction of the degree of pruritus was  
98 observed but clinical signs resumed within 1 month. After moxidectin treatment the  
99 owner reported a cessation of signs in all sheep. To date (an 18 month period) none  
100 have shown further signs of aural pruritus.

## 101 Discussion

102 The appearance and age distribution of clinical signs were similar to those described  
103 previously.<sup>1</sup> The lack of lesions or history of sheep scab suggests the mites isolated  
104 are a fully ear-adapted strain.

105 Swabbing failed to detect any mites, flushing isolated mites from two animals. This is  
106 similar to a previous report of psoroptic otoacariasis in Brazilian sheep.<sup>2</sup> Only sheep  
107 with visible lesions were swabbed or flushed, as this investigation began as an  
108 investigation of the cause of the clinical signs. This is likely to have missed infected  
109 sheep as ear mites have been isolated from sheep showing no clinical signs of  
110 otoacariasis.<sup>1</sup> Animals with lesions may be those which are hypersensitive and thus  
111 responding strongly to a relatively small number of mites. Mites were recovered from  
112 10.5% (2/19) animals, which is lower than previously reported (46%-83%).<sup>2</sup> This, and  
113 the fact that only immature stages were isolated, is consistent with ivermectin  
114 treatment eradicating the adult mites which were then replaced by newly hatched  
115 mites.

116 Previously, cessation of pruritus and elimination of living mites from the ear canal  
117 following a single injection of ivermectin (200  $\mu\text{g}/\text{kg}$  bw), has been reported for ovine  
118 psoroptic otoacariasis.<sup>1</sup> This is in contrast to the situation with sheep scab.  
119 Injectable moxidectin, both in the 1% and 2% formulation, is widely used for the  
120 treatment and control of sheep scab.<sup>12, 13, 14</sup> Similarly, a sustained release ivermectin  
121 implant has been successfully used to treat psoroptic otoacariasis in Bighorn sheep.  
122<sup>15</sup> The period of persistent activity of 1% moxidectin against infection by *P.ovis* is 35  
123 days; this is longer than the incubation period of *P. ovis* eggs and the maximum  
124 survival period of the mite away from the host.<sup>12,13,16,17, 18</sup>

125 Several animals at each sampling were seropositive for anti-Pso o 2 antibodies in a  
126 flock with no clinical history of sheep scab. These results suggest that positive Pso  
127 o2 ELISA results indicate either sheep scab or psoroptic otoacariasis, as has  
128 previously been described for crude *Psoroptes* antigen ELISAs in both domestic and  
129 Bighorn sheep.<sup>19, 20, 21</sup> Anti-*P. ovis* antibody ELISAs have been proposed for the  
130 detection of asymptomatic sheep scab infections; these results suggest that such a  
131 test cannot distinguish between these two *Psoroptes* spp. infections.<sup>10,22</sup>

132 Haptoglobin concentrations in sheep artificially infected with sheep scab increased to  
133 above 3 mg/ml, well above that of any sheep in this investigation.<sup>11</sup> However the

134 range of concentrations seen at the first sampling did overlap that described for  
135 naturally acquired sheep scab infection, as would be expected from an active  
136 infection.<sup>11</sup>

137 There was no difference in the proportion of animals with positive Pso o 2 ELISA  
138 titres at the first and second sampling. This is unsurprising given the first treatment  
139 was unsuccessful in eliminating infection and that circulating anti-*Psoroptes* antibody  
140 levels drop over a period of weeks to months after successful treatment in cases of  
141 sheep scab and Bighorn otoacariasis.<sup>20, 22, 23</sup> Haptoglobin levels fell between first  
142 and second sampling; this would be consistent with ivermectin killing the adult mites  
143 and so temporarily reducing the antigenic stimulation.

#### 144 **Conclusions and clinical importance**

145 Psoroptic otoacariasis is an uncommon parasitic infection of sheep causing clinical  
146 signs related to aural pruritus. Mites may be most successfully isolated ante-mortem  
147 by flushing of the external auditory meatus. Treatment with ivermectin was  
148 unsuccessful in this case; moxidectin treatment resulted in the resolution of clinical  
149 signs. Ear mite infection resulted in positive titres using the recombinant Pso o2  
150 ELISA test.

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209 **Figure captions**

210 Figure 1.

211 This figure shows the range of lesions associated with psoroptic otoacariasis in this  
212 case. Top: A score 1 lesion- alopecia and crusting at the ear base. Middle: A score 2  
213 lesion with more extensive alopecia and crusting and the presence of dark brown  
214 scabs. Bottom: A score 3 lesion with fibrosis and thickening of the pinna, complete  
215 occlusion of the external auditory meatus and the presence of several dark brown  
216 scabs. Ears without any visible lesions received a score of 0.

217 Table 1.

218 This table shows the total ear lesion score, age of affected sheep and Pso o2 ELISA  
219 titres and haptoglobin concentrations where these could be ascribed to individual  
220 animals. The negative control OD was 0.21, the positive control OD was 2.0. Pso o2  
221 values which were considered to be positive are in **bold**. Sheep which were absent  
222 from the flock in December (dead or sold) are denoted by N/A in the applicable cells.