The effects of individual components of an electrified wire fence on avoidance behaviour by goats

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Abstract

Two experiments were performed to test the hypothesis that fence posts as well as strands will affect the behaviour of goats that have been conditioned to avoid an electrified wire fence. In the first experiment, the reaction of four does to the fence with an electric strand and posts drawn across the whole width of the paddock (C condition) was compared with their reaction to the fence with an electric strand terminated at half the width of the paddock (L and R conditions). The does did not cross the fence line under either condition. In the second experiment, the avoidance behaviour of four does to two kinds of posts ('familiar wooden post' and 'standard fibre-reinforced plastic (FRP) post') with and without an electric strand was tested. Thus, conditions compared were familiar wooden post only (F), F with an electric strand (W), standard FRP posts only (P) and P with an electric strand (WP). The fence line was crossed in 94, 44, 25, and 6% of trials for F, W, P, and WP, respectively. In conclusion, based on the proportion of crossings the fence line, the standard FRP posts, as with the electric strand, increased the avoidance behaviour.

Key words: Avoidance behaviour, Crossing behaviour, Electric fence, Fence crossing, Goat

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Introduction

Electric fences are often erected around grazing areas of ruminants such as cattle, sheep and goats (e.g. Kilgour & Dalton 1984; McKillop & Sibly 1988; Jaudas & Mobini 2006; Martiskainen et al. 2008; Umstatter 2011; Markus et al. 2014). However, such fences are used with varying success for goats because there are often some individuals that will exit the fence (Jaudas & Mobini 2006). To confine goats in an electric fence, basic knowledge of the fence components that improve the efficacy of the fence in stimulating goat avoidance behaviour is required. Researchers and producers have investigated that the number of strands as well as their spacing affects the efficacy of an electric fence in confining various species of animals (McKillop & Sibly 1988; VerCauteren et al. 2006; Reidy et al. 2008; Goetsch et al. 2012). It is a natural assumption that animals will avoid an electric strand because it administers electric shocks, and that an electric fence will be effective because of the avoidance of the electric wire by animals; however, Goetsch et al. (2012) reported that the efficacy of an electric fence varied considerably according to conditions other than those mentioned above. Effects of various conditions (i.e., experimental designs and training procedures) in efficacy have also been reported specifically in goats (Tsukahara et al. 2013). These results contributed to our interest that goats assess electric fences for components other than strands when avoiding electric fences. We hypothesised that other components besides the strands affect the avoidance behaviour by goats of electric fences. The objective of this study was to investigate the effects of individual components of an electrified wire fence on the avoidance behaviour of goats. In the current study, except for crossing, all responses of goats to an electrified wire fence were considered as avoidance.

Materials and Methods

Study location, animals and conditioning for electric fence avoidance
All of the experiments were carried out at University Farm, Kyushu University (Fukuoka, Kyushu, Japan; 33.62°N lat., 130.46°E long., at 9 m above sea level). The current study complied with the policy of the Guidelines for Ethical Treatment of Animals in Applied Animal Behaviour and Welfare Research (ISAE Ethics Committee 2002) and with that of the Regulations for Animal Experiments at Kyushu University. The goat herd used in the current study comprised four female Japanese native goats (Tokara goat, Capra hircus). Their estimated ages were 3–4 years at the beginning of the study, and the height of their withers ranged from 49 to 52 cm. No animals had previously been exposed to an electric fence.

Consistent with previous studies (Niven & Jordan 1980; McDonald et al. 1981), prior to the first experiment, all the does were conditioned in their resided paddock to become used to an electric fence. The electric fence used in this conditioning comprised two fibre-reinforced plastic (FRP) posts measuring 120 cm in height and 14 mm in diameter (STF-1141; 'standard FRP posts'), one stranded 2 mm diameter poly wire (Getter Cord), two insulators (14 mm Hook) and an energiser (Strobo DC-12B). All equipment used was manufactured by Suematsu Electronics Co., Ltd., Yatsushiro, Japan. Two standard FRP posts were erected 2 m apart, and a strand was drawn between the posts 25 cm above the ground. The voltage applied to the electric strands in our fencing system was maintained at 4.0–5.5 kV. Each conditioning was individually conducted to ensure independent behavioural reactions by the does. Subsequent to introduction to the paddock, each doe made initial contact with the strand and showed a strong avoidance response (e.g., jumping away). This exposure to electric strand was repeated on sunny days between 13 September and 24 September 2010. Each doe was exposed to the fence once or twice a day for 20 minutes each between 12.00 hours and 18.00 hours. Consequently, each doe was subjected to the conditioning exposure 13 times in total until the does avoided the fence completely. We removed the fence each day at the end of the conditioning, so that the does were only exposed to any device relating to electric fence during the conditioning period. In the current study, avoidance behaviour was defined as either an animal did not cross the fence line or took a detour. The fence line was defined as a line of an electric strand and/or between experimental posts placed.

Experiment 1

First, we investigated whether the does were exclusively avoiding the strands when exhibiting avoidance behaviour in response to the presence of an electrified wire fence. If the avoidance of such a fence is solely due to the electric strands, the removal of these strands should mean that the does are no longer confined.
Initially, the reaction of does to the fence under the L condition was compared with their reaction to the fence under the C condition, and subsequently, the reaction of does to the fence under the R condition was compared with their reaction to the fence under the C condition. In both comparisons, the trial was repeated 12 times for each condition, with three replications per individual. To minimize any order effect, two does were observed alternately under the C condition and the treated fence condition (i.e., L and R conditions), whereas the other two were observed alternately in the reverse order. Thus, each doe was subjected to a total of six trials in each comparison, and 12 trials in this experiment. The comparison between L condition and C condition was conducted on four sunny days between 30 September and 21 October 2010. The comparison between R condition and C condition was conducted on four sunny days between 22 October and 9 December 2010. Each doe was tested once or twice a day between 12.00 hours and 18.00 hours.

![Diagram](image)

Figure 1 The conceptual scheme of experimental plots in experiment 1 (left) and in experiment 2 (right). The wavy lines and the black circles indicate experimental fence lines and positions on which standard fibre-reinforced plastic (FRP) posts and/or familiar wooden posts were set up, respectively. The solid lines show either non-electrified wire-mesh fences enclosing the experimental paddock or walls of the experimental pen. In experiment 1, each doe was separately released from the pen to the opposite side of the fence line by temporary removal of the nearest standard FRP post to the pen (dotted line with arrow); all the remaining does were left in the pen. In experiment 2, after being released from the pen through the lockable door, the target doe was introduced into the paddock through the entrance (dotted line with arrow). Except where the target doe goes around the fence line in experiment 2, the doe should cross the fence line to go back to the rest of the herd in both experiments (dashed line with arrow).
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Experiment 1

(C) Control: This fence consisted of the strand at 25 cm above the ground and three standard FRP posts spaced 4 m apart.
(L) Left half, (R) Right half: These were similar to the control fence design except that the strand terminated at the middle of the three posts.
(F) Familiar: This fence consisted of nothing but three familiar wooden posts spaced 2 m apart.
(W) Wire: This fence consisted of three familiar wooden posts and a strand at 25 cm above the ground.
(P) Post: This fence consisted of three familiar wooden posts and three standard FRP posts.
(WP) Wire and post: This fence consisted of three familiar wooden posts, a strand 25 cm above the ground and three standard FRP posts. In combination with the C condition, the L condition and the R condition were used in experiment 1. The other four conditions of fences were used in experiment 2. The wavy lines indicate experimental fence lines, one or both ends of which were terminated to the non-electrified wire-mesh fence surrounding the experimental paddock, as shown in Fig. 1.
Experiment 2

In this experiment, we focused on standard FRP posts as an additional probable factor influencing the avoidance of the electric fence by the does because, like the strand, the posts comprise a fundamental and prominent component of an electrified wire fence. In addition, some modifications were made in experiment 2. The similarities of experimental procedures between the conditioning and experiment 1 may cause the does to avoid crossing the fence line. The fence line was defined across the whole width of the paddock in experiment 1, so that the experimenter had to temporarily remove one of the three posts from the fence line whenever the target doe was moved to the opposite side of the line. From this action, a doe may learn to avoid trying to cross the electric fence and rather wait until the trial is over. To reduce these probable effects, in experiment 2, the target doe was introduced into the paddock through a newly made entrance and was allowed to go around the fence line to get back to the pen, both when it avoided the line and when an observation ceased.

Experimental plot and fence in experiment 2

The animals and experimental plot in this experiment were the same as in experiment 1. However, instead of the lockable door, the pen and the paddock were connected by a top-hinged, one-way swinging door which allowed the does to enter the pen but not exit from it. As shown in Fig. 1, a lockable door located at the opposite side (back) of the pen was used to remove the target doe from the pen. An entrance to the paddock was constructed at the most remote corner from the pen (Fig. 1). A 4 m long fence line (half the width of the paddock) was defined midway between the new entrance to the paddock and the pen, one end of which terminated at the wire-mesh fence surrounding the paddock (Fig. 1). Given that the does behaved in a way similar to that in experiment 1, they could not avoid encountering this fence line at about 4 m from the position at which the line had been in the previous experiment. The does could not avoid crossing the next line to the fence line to return to their herd, both when they avoided the line and when the observation ceased (Fig. 1).

To determine the effects of the strand alone and the effects of the standard FRP posts, we constructed wooden posts with a diameter of 12 mm (similar to the standard FRP posts), which were 30 cm in height. These posts had been in position in the resided paddock for a month. Consequently, by the beginning of experiment 2, it appeared as though all the does had become familiar with these posts (hereinafter, referred to as 'familiar wooden posts'). In this experiment, four conditions were established using three of these familiar wooden posts, which were set up on the fence line (Fig. 2). To enhance the presence of posts, the intervals between adjacent posts were shortened to 2 m, which were half of those in experiment 1. Under the familiar condition (F condition), only the familiar wooden posts were set on the fence line. In addition to three familiar wooden posts, the experimental fences composed of a strand of wire under the wire condition (W condition), three standard FRP posts under the post condition (P condition) and a strand and three standard FRP posts under the wire and post condition (WP condition) were set. In the W and WP conditions, the strand was drawn across all of the familiar wooden posts at 25 cm above the ground, and in the P and WP conditions, the standard FRP posts were erected in proximity to the familiar wooden posts. Ideally, the F condition should act as the negative control, with the proportion of observations in which the does crossed the line approaching 100%. In contrast, the WP condition should ideally act as the positive control, where the proportion of observations in which the does crossed the line approaching 0%. The proportions of observations in which the does crossed the line under the W condition and the P condition would depend on the effect of the presence of the strand and the standard FRP posts. These proportions would be not lower than that under the WP condition, and not higher than that under the F condition. The energiser, poly wire, standard FRP posts, and the insulators were the same as those used in the conditioning.

Procedure in experiment 2

Each trial involved two steps. Initially, the does were exposed to the same experimental setup as in the F condition to train them to cross the fence line and consequently to reduce the effect of the previous trial (Step 1), and subsequently, their reactions to any one of the four different fence conditions were observed (Step 2). Step 1 was performed in the following sequence. A target doe was released from the pen through the lockable door and introduced into the paddock with the F condition through the entrance at the far side of the paddock, and then the experimenter shut the entrance and remained out of view of the doe at the greatest extent. This step ceased when the doe returned to the pen through the one-way door (Fig. 1).

Step 2 was the observation step and performed in the following sequence. Before the release of the target doe from the pen, one of the conditions of the fence was set up on the fence line. In the same way as in the first step, the target doe was introduced into the paddock, with the experimenter staying out of view of the doe. The behaviour of the target doe, which would be constantly trying to return to its herd, was recorded with a digital video camera (DCR-SR300, Sony Corporation). This observation ceased either when the doe went back to the pen through the one-way door or when 10 minutes had passed. In the latter case, the doe was brought back to the pen through the opening next to the fence line.

This trial was repeated 16 times for each condition, with four replications per individual. To minimize any order effect, the order of conditions was randomly
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determined for each doe by means of a lottery. Thus, each doe was subjected to a total of 16 trials in this experiment. This experiment was conducted on thirteen sunny days between 1 April 2011 and 13 May 2012. Each doe was tested once or twice a day between 12.00 hours and 18.00 hours.

Data analyses
All data were collected from the video recordings. All trials in experiment 1 were classified according to whether the target doe crossed the fence line. Furthermore, it was determined in each trial whether the doe approached the half of the fence line without strands. Taking the visual acuity (Hughes & Whitteridge 1973) and the body size of the does into account, it was estimated that the does were able to perceive the strand when their front hooves were located less than 2 m from the fence line. Therefore, when the doe had approached close enough to the fence so that the right and left front hooves were placed within 2 m of the line segment, this was counted as the doe having 'approached' the fence.

All trials in experiment 2 were classified according to whether the target doe crossed the fence line. The trials in which the doe did not cross the fence line were subdivided according to whether the doe detoured around the line to get back immediately to the pen or the doe did not go back to the pen until the trial ceased, both of which were considered as avoidance behaviour. The number of trials in which the doe crossed the fence line under each condition was counted for each doe. The proportion of trials in which the fence line was crossed was calculated by dividing the crossing count by the number of trials required under each condition.

In experiment 2, the data were analysed using the glmer function of the lme4 package version 1.1-7 (Bates et al. 2014) in the R statistical package version 3.10.0 (R Core Team 2014). To examine whether the existence of the strand and/or the standard FRP posts decreased the probability of the fence line being crossed, we fitted a generalized linear mixed model (GLMM) with a binomial distribution and a logit link function. The presence or absence of the strand and the standard FRP posts and their interaction were incorporated into our model as a fixed effect, and each doe was fitted into the model as a random effect because individuals were repeatedly measured. The full model is given by

\[ \text{logit}(q) = \beta_0 + \beta_1W + \beta_2P + \beta_3WP + r \]

where q is the probability that a doe crosses the fence line; W, P and WP are variables indicating the presence or absence of the strand, the presence or absence of the standard FRP posts and their interaction, respectively (presence = 1; absence = 0); \( \beta_0 \) is the intercept; \( \beta_1 \), \( \beta_2 \) and \( \beta_3 \) are the coefficients of W, P and WP, respectively; and r is the random effect.

In general, the fit of any model can be improved by increasing the number of parameters; however, the ideal model would be appropriately simple, based on concepts of parsimony (Burnham & Anderson 2002). In addition, when there are many candidate models, model selection in a context of null hypothesis testing is inappropriate because of the multiple-testing problem. For these reasons, the best model was selected on the basis of minimum Akaike information criterion (AIC), a smaller value of which indicates a better fit and a more parsimonious model. In addition, using the lsmeans function of the lsmeans package version 2.14 (Lenth & Hervé 2015), we calculated least squares (LS) means for each treatment and determined the significant differences between these LS means. Then, the values of LS means on the logit scale were back transformed to the original (probability) scale.

Results

Experiment 1
In the comparison between L condition and C condition, none of the does came within 2 m of the right half of the fence line (where the strand was absent) or passed across the fence line under either the L condition or the C condition. In the comparison between R condition and C condition, two does came within 2 m of the left half of the fence line (where the strand was absent) in two and one of three trials, respectively, under the C condition. Similarly, two does approached the fence line in two trials and the other two did in one trial under the R condition. However, no crossing was observed under any condition in the comparison R condition and C condition, as was observed in the comparison L condition and C condition.

Experiment 2
In most of the trials, the does ran towards the pen immediately after their introduction into the paddock. During the trials under the W condition, the does sometimes tried crossing the fence line and clearly stumbled over the strand. The behavioural responses of the does in experiment 2 were classified into three categories, as shown in Table 1. In all except one trial, the does crossed the fence line under the F condition. Under the W condition, three does crossed the fence line in two of four trials, and the remaining doe crossed only in one trial. Under the P condition, one doe crossed the line in two of four trials, two does did so in one trial and the remaining doe one did not cross the line in four trials. Only one crossing of the fence line was observed under the WP condition. However, the doe that crossed the line in this trial appeared to attempt to stop right in front of the line but the momentum carried it over the strand as was seen in some trials under the W condition. In descending order in terms of condition, does passed across the fence line in 94%, 44%, 25% and 6% of the trials under the F, W, P and WP conditions, respectively (Table 1).
Table 1. Behavioural responses of does to experimental fence lines in experiment 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>F</th>
<th>W</th>
<th>P</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Goat1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Goat2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Goat3</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Goat4</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Proportion of crossing (%)
- Goat1: 94
- Goat2: 44
- Goat3: 25
- Goat4: 6

The plus symbol (+) indicates that the doe crossed the fence line; the minus symbol (-) indicates that the doe did not go back to the pen until the trial ceased; the ‘D’ symbol indicates that the doe detoured to go back immediately to the pen.

Table 2. Estimated parameters of the generalized linear mixed model for the proportions of trials in which does crossed the fence line in experiment 2

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimate (Std. error)</th>
<th>Deviance</th>
<th>Residual d.f.</th>
<th>AIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>β₀ + β₁ W + β₂ P + β₃ W : P + r</td>
<td>2.71 (1.03) -2.96 (1.15) -3.81 (1.18) 1.35 (1.65)</td>
<td>26.69</td>
<td>11</td>
<td>36.69</td>
</tr>
<tr>
<td>β₀ + β₁ W + β₃ P + r</td>
<td>2.29 (0.76) -2.42 (0.83) -3.24 (0.85)</td>
<td>27.34</td>
<td>12</td>
<td>35.34</td>
</tr>
<tr>
<td>β₀ + β₁ W + r</td>
<td>0.38 (0.36) -1.48 (0.54)</td>
<td>51.02</td>
<td>13</td>
<td>57.02</td>
</tr>
<tr>
<td>β₀ + β₂ P + r</td>
<td>0.79 (0.38) -2.47 (0.62)</td>
<td>39.29</td>
<td>13</td>
<td>45.29</td>
</tr>
<tr>
<td>β₀ + r</td>
<td>-0.32 (0.25)</td>
<td>58.96</td>
<td>14</td>
<td>62.96</td>
</tr>
</tbody>
</table>

†: Counts of crossing range from a minimum of 0 (a doe did not cross in any of the trials) to a maximum of 4 (a doe crossed in all trials).

W, the existence of the strand (presence = 1; absence = 0); P, the existence of the standard FRP posts (presence = 1; absence = 0); β₀, intercept; β₁−β₃, the parameters of the fixed effects; r, the random effect for individuals.

As shown in Table 2, the GLMM with the lowest AIC (the best model) included the variables for the presence or absence of the strand (W) and the standard FRP posts (P). In this model, the intercept and the coefficients for the variables W and P were estimated to be 2.29, -2.42 and -3.24 with a standard error of 0.76, 0.83 and 0.85, respectively. The deviance was 27.34 on 12 degrees of freedom. The LS means were significantly different for the strand treatment (0.67 with a standard error of 0.50 for the absence of the strand versus -1.75 with a standard error of 0.57 for the presence; t = 2.91, P < 0.05) and for the post treatment (1.08 with a standard error of 0.48 for the absence of the posts versus -2.16 with a standard error of 0.60 for the presence; t = 3.83, P < 0.05). The values of LS means on the original (probability) scale were estimated at 0.66 (68% confidence interval (CI) 0.54 - 0.76) and 0.15 (68% CI 0.09 - 0.23) for the absence and presence of the strand, and 0.75 (68% CI 0.65 - 0.83) and 0.10 (68% CI 0.06 - 0.17) for the absence and presence of the posts, respectively.
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Discussion

In the current study, two experiments were performed to test our hypothesis that when goats avoid an electrified wire fence, posts of the fence have an effect on their avoidance in addition to the strand. First, in experiment 1, we investigated whether the avoidance of such a fence is solely due to the strand. In the comparison between L condition and C condition, none of the does passed across the fence line under either the L or the C condition. This result may indicate that the doe avoided something other than the strand. However, it may just have been that the does had not discerned the disappearance of the strand from the experimental fence. This is because, in all of the trials under the L condition, they did not come within 2 m of the right half of the line where there was no strand. In the comparison between R condition and C condition, all four of the does approached the line segment at least once, indicating that they would have had an opportunity to perceive the absence of the strand. Nevertheless, the does did not cross the fence line under any condition in the comparison between R condition and C condition. The absence of crossing of the fence line in experiment 1 may support the expectation based on our hypothesis. On the other hand, in addition, the results may suggest that the does could have been refusing to cross the fence line regardless of the condition in any of these comparisons, simply because the experimental procedures in experiment 1 were similar to that in the conditioning. In experiment 1, each doe was taken to the paddock through the same lockable door as used in the conditioning. Another possibility is that after the first trial, they had learned to wait until the trial was over.

Experiment 2 was designed to avoid the aforementioned uncertainties, as well as to determine the components of the electrified wire fence that trigger avoidance by the does. To prevent the does from simply waiting for the trial to end, they were allowed to travel only in one direction (to the pen), and to make a detour around the fence line to the pen. Thus, the doe had a choice of crossing or going around the fence line on every trial; when the does did not do so after a 10-minute period of observation, an experimenter then brought the doe back to the pen through the opening next to the fence line. If the does had waited for the trial to end or had made a detour around the fence line regardless of the condition, the proportion of trials in which the does had crossed the line would have uniformly approached 0% under any condition. In fact, this proportion varied with the conditions, which is supported by the best model that included the presence or absence of the strand and presence or absence of the standard FRP posts. Additionally, the proportion of crossings the line was very high under F condition and it was very low under the WP condition, as we expected. These results clearly indicate that the does passed across the fence line when they were able to cross the line without difficulty and not when they experienced difficulty in doing so.

In experiment 2, if the avoidance of an electrified wire fence by does had been solely due to the presence of a strand, the proportion of trials in which they crossed the fence line under the W condition should have been nearly the same as that under the WP condition, which was the positive control. However, the proportion of crossings under the W condition (44%) was much higher than that under the WP condition (6%). This result indicates that the strand is not the only factor affecting the avoidance behaviour of does. If the standard FRP posts had no effect on the avoidance of an electrified wire fence by does, the proportion of crossings under the P condition should have been nearly the same as that under the F condition, which was the negative control. However, the proportion of crossings under the P condition (25%) was much lower than that under the F condition (94%). This result indicates that, like the strand, the standard FRP posts also have an effect on the avoidance behaviour of does. The GLMM analysis also confirmed that the presence of standard FRP posts is a factor affecting the avoidance, in addition to the strands. The best model included the variables for the presence or absence of the strand and the standard FRP posts but not their interaction. The negative coefficients for these variables in this model indicate that the probability of the does crossing the fence line is decreased by the presence of the strand and the standard FRP posts, independently of each other.

As described in the introduction, an electric fence appears to work effectively by means of the avoidance of the strand by animals. In fact, at least during the early stage after initial conditioning to an electric fence, the avoidance behaviour is only partly due to the strand as shown in experiment 2. Posts, which are as fundamental and prominent components of the fence as the strand, also have an effect on the avoidance of the fence by the goats, even though they fail to administer an electric shock. These results imply that the does focus on possible shocks given by both electric strands and posts. Lee et al. (2007) reported that cattle could be conditioned to associate an aversive stimulus (electric shocks given by shock collar) with a trough. Similarly, Schilder and Van del Borg (2004) inferred that a dog trained using a shock collar would expect an aversive event (electric shocks) to occur whenever its handler was around. Although there are differences between species and kinds of electric shock device used, in our experiments, the does also expected an aversive event to occur whenever there were standard FRP posts on the fence line. Adding posts or a similar component, such as battens, to an electrified wire fence could increase the avoidance behaviour to the fence, as well as improve the physical strength of the fence. Although only strands and posts were investigated in this study, other components, such as insulator and energiser could be investigated. Therefore, without
increasing the number of strands or their spacing, the efficacy of such a fence could be improved by adding some prominent components associated with electric shocks by animals even if those components fail to administer an electric shock.

Conclusions

We concluded that when goats avoid an electrified wire fence, their avoidance is not solely due to the electrified strands. Posts, at least among the components of such a fence, also have some effect on the avoidance behaviour.

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ワイヤー方式の電気牧柵の構成要素がヤギの忌避行動に及ぼす影響

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要 約

ヤギがワイヤー方式の電気牧柵に対する忌避学習をする際に、架線に加えて支柱が彼らの忌避に影響を及ぼしているという仮説を検証するため、2つの実験を行った。まず始めに、ヤギの電気牧柵に対する忌避が架線のみに起因するかどうかを確認するために、パドックの両側柵を結んで立てた全ての支柱に一本の架線を取り付けた牧柵に対するヤギの反応（C区）を全長の半分にのみ架線を取り付け、架線を避けて通過できるようにした牧柵に対するそれを比較した（L区およびR区）。しかし、いずれの処理区においてもヤギは牧柵を通ることができなかった。次に、ヤギがワイヤー方式の電気牧柵のどの構成要素を忌避しているかを特定するために、ヤギが警戒を示さなくなった支柱（馴致支柱）および結線された支柱（電牧支柱）、架線を組み合わせて4つの処理区を設け、それらに対するヤギの反応を比較した。それぞれの処理区の牧柵は、騒訟支柱のみ（F区）、騒訟支柱および架線（W区）、騒訟支柱および電牧支柱（P区）、騒訟支柱および架線・電牧支柱（WP区）を用いて作成した。その結果、各処理区の全観察のうち、ヤギはF区では94％、W区では44％、P区では25％、WP区では6％の頻度合で牧柵を通ることができた。この結果は、架線と同様に、電牧支柱もヤギのワイヤー方式の電気牧柵に対する忌避学習に影響を及ぼしていることを示している。

キーワード：脱柵、電気牧柵、忌避行動、ヤギ

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