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The electric-shock trial (Trial 11) replicated as closely as possible the method of training that staff at DOC's Hauraki Area Office have been using. This involved taking a dog from its home cage, fitting it with the electronic collar, presenting it with an opportunity to touch either a stuffed kiwi or a frozen carcass of a kiwi (placed adjacent to one another) while being off a leash, and then delivering to the dog an electric shock through its collar the moment it was judged to have touched either bait. Three personnel were used: a handler, a trainer, and a time keeper. The trainer placed the stuffed kiwi and the kiwi carcass close together in a pre-determined position, and then took up a position inside the enclosure that provided a clear view of the dog and kiwi baits (see Fig. 4). (No attempt was made to hide the trainer from the dog's view). The handler opened the door to the enclosure, pushed the dog through the gap, and then closed the door. The handler remained outside the enclosure. The time keeper, also outside the enclosure, started recording elapsed time the moment the door was closed. The trainer then observed the dog and delivered a shock using the remote control the moment she judged that the dog had touched either of the kiwi baits. The electric shock was delivered for around 0.5 s. The time keeper stopped timing as soon as he heard the tone produced by the collar, and the handler simultaneously opened the door to allow the dog to escape, or to enter and retrieve the dog. (Most dogs returned to the door immediately after receiving the shock.)

Figures 4 and 6 show the two training sites used in Trial 11. Initially, all 12 dogs were put through a corrugated-iron door and into a large enclosure. The trainer was located at the position indicated by T1 and the kiwi baits were located at K1. One dog (Bruiser) failed to touch either bait after being in the enclosure for

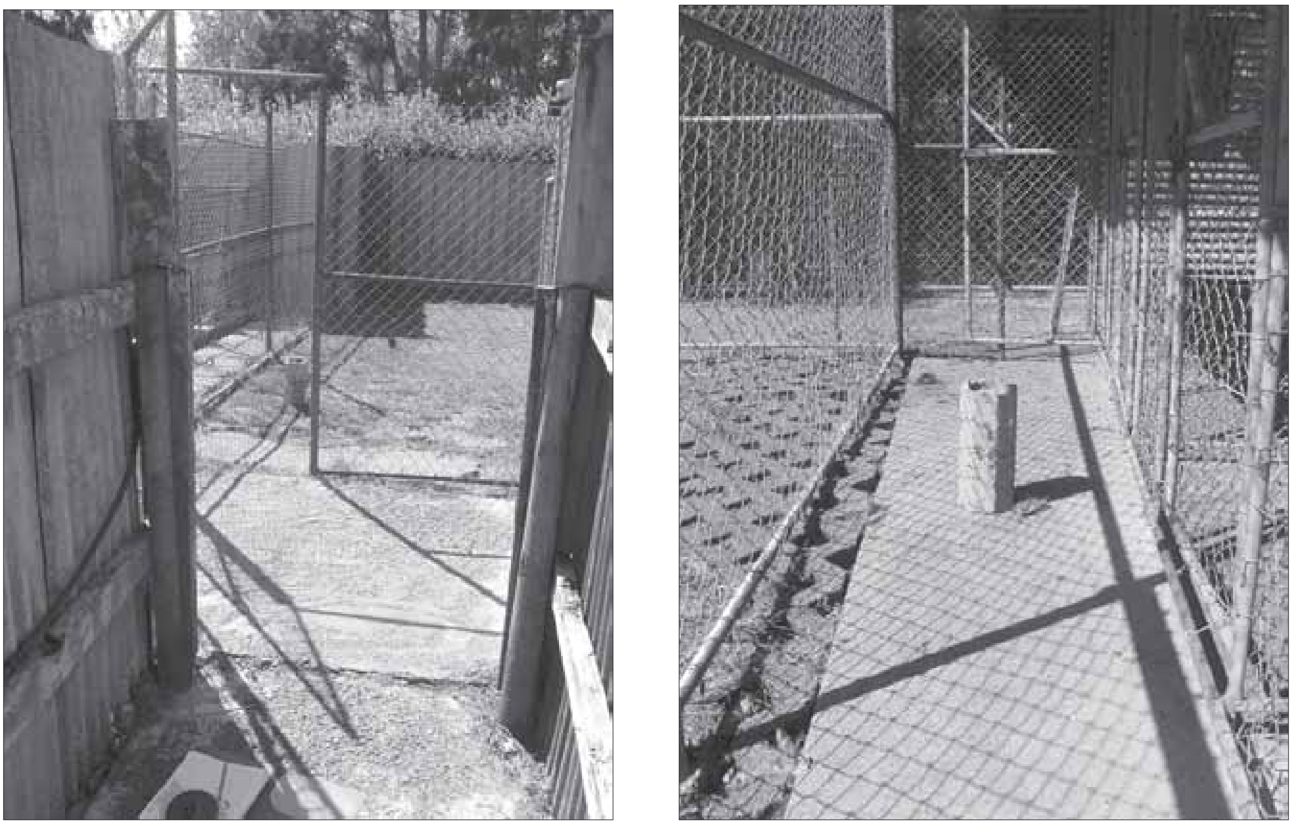

Figure 6. Training Site 1 (left panel) and Training Site 2 (right panel). The pipe standing on end in each photograph indicates the position of the kiwi baits. The trainer's position is out of view but is shown in Fig. 4.

13 min 32 s. Consequently, this trial was terminated and another training trial was conducted using positions T2 and K2 in an enclosure that was considerably smaller. Training in this second site was more successful but still not entirely satisfactory (see below for more details).

2.4.4 Post-training testing

This testing was identical to the pre-training testing except that four observers were employed behind the hide when the kiwi baits were presented, and four dogs (Axel, Patch, Puppy and Shep) received an additional two trials. The trials in this phase were numbered 13 to 18. For those dogs receiving additional trials, Trial 19 involved food at the burrow and Trial 20 involved re-presenting the kiwi baits at the burrow. (The reasons for conducting these additional trials will become clear in the Results section.)

3. Results

Formal analyses were conducted of each dog's behaviour on only those trials involving the ML and video camera[4] (see Table 2). However, before these analyses are described, general observations of behaviour on all test trials, and the trial where a dog received a shock for touching the kiwi (Trial 11), are presented.

In about half of the test trials, the dog approached the burrow as soon as it was released. Most approaches seemed to be elicited by movement cues when the stuffed animal or food bowl was driven from the burrow. Some dogs, however, consistently turned away from the burrow upon being released and oriented toward the handler walking toward the hide. The time a dog spent oriented toward the hide varied across dogs, but most turned and approached the burrow within 5 s of the handler being out of sight. Whenever a dog was deemed to have touched one of the animal baits on test trials, they usually put their nose within 3 cm of the carcass rather than the stuffed animal, although several dogs touched the baits by way of seizing the rabbit and/or possum carcass in their mouths. In most of the trials that terminated when a bait was touched, dogs did not try to increase their distance from the burrow before touching the bait.

In Trial 11 (the electric shock trial), 11 of the 12 dogs touched the kiwi carcass within 3 s to 10 s of being released into the enclosure of Training Site 1. Bruiser was the exception. Thirteen minutes and 32 s elapsed in Training Site 1 without this dog touching either bait. Consequently, this trial was terminated and another was attempted in Training Site 2; an enclosure that was significantly smaller than that defining Training Site 1. However, Bruiser behaved similarly on this trial;

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[4] Data obtained on trials involving the UL (at least three on Day 1, one on Day 2, two on Day 3 and one on Day 4), and on the training trial, were not formally analysed because behaviour on the UL was not strictly comparable to behaviour on the ML, and only trials involving the ML were recorded by the video camera. However, the latencies recorded by a stop watch on trials involving the UL were not systematically different from those on trials recorded by the video camera.

immediately sitting upon being released through the door, and not approaching the kiwi baits any closer than about 45 cm. After 7 min 12 s, the trainer decided to terminate this trial also. The trainer left her position, picked up the stuffed kiwi and carcass (the carcass in her left hand and the stuffed kiwi under her right arm), and began walking toward the enclosure door. Bruiser immediately followed. Upon seeing Bruiser following, the trainer paused momentarily and Bruiser reached forward and contacted the kiwi carcass. The trainer immediately delivered the shock using the remote control in her right hand.

Each dog's behaviour on pre- and post-training trials involving the ML was analysed in terms of three dependent variables:

- Whether or not the dog touched the bait at the burrow.
- The time between being released by a handler and touching the bait (response latency).
- The dog's path around the Testing Site on selected trials.

Response latencies were calculated using the video records of each trial where video evidence of release by the handler marked the start time and audio evidence of the reward clicker marked the end time.

Figures 5, 7 and 8 present response latencies for each dog on each of the test trials they received. Figure 5 presents data obtained for Ocean—the dog that avoided the kiwi prior to the training phase. Figure 7 shows data for those dogs that received 18 trials, while Fig. 8 presents data for those dogs that received 20 trials. Bar shading indicates whether or not a dog touched the bait at the burrow, with grey bars indicating that the bait was touched and black bars indicating that it was not touched. In 12 of the 13 trials where the bait was not touched (two in Fig. 5, two in Fig. 7 and nine in Fig. 8), the trial was timed-out because 7 min had elapsed since the dog was released. (In the one remaining case, a dog—Shep—did not touch the kiwi on Trial 18 because it slipped out of its collar and escaped from the testing site after 2 min 45 s.) Dog behaviour in these 12 trials therefore satisfied our operational definition of bait avoidance.

The results shown in Figs 5, 7 and 8 can be summarised as follows: in the pre-training phase, only one of 13 dogs (Ocean, Fig. 5) avoided baits, and most dogs took similar times to touch the baits. Twelve dogs, therefore, showed no evidence of bait avoidance prior to training. In the post-training phase, six dogs (50% of those tested) touched all the baits including the kiwi in Trial 18. These dogs took, on average, no longer to touch the kiwi in post-training testing than they did in pre-training testing (Trial 9); four took longer and two took less time (see Fig. 7). Of the six dogs that avoided the kiwi in post-training testing, one avoided for less than 7 min (Shep, Fig. 8), and two also avoided the possum on Trial 17 (Axel and Puppy, Fig. 8). Only three dogs (Dumas, Patch and Snoopy), therefore, showed the ideal data profile for evidence of a learned avoidance of kiwi.

Shep received an additional two trials in the post-training phase (Trial 19 involving food and Trial 20 involving kiwi) because, as noted above, she did not avoid the kiwi in Trial 18 for the full 7 min. Figure 8 shows that, in Trial 19, she quickly approached the burrow and ate food there. In Trial 20, she also quickly approached and touched the kiwi. Axel, Puppy and Patch received the same additional two trials in post-training testing because Axel and Puppy had

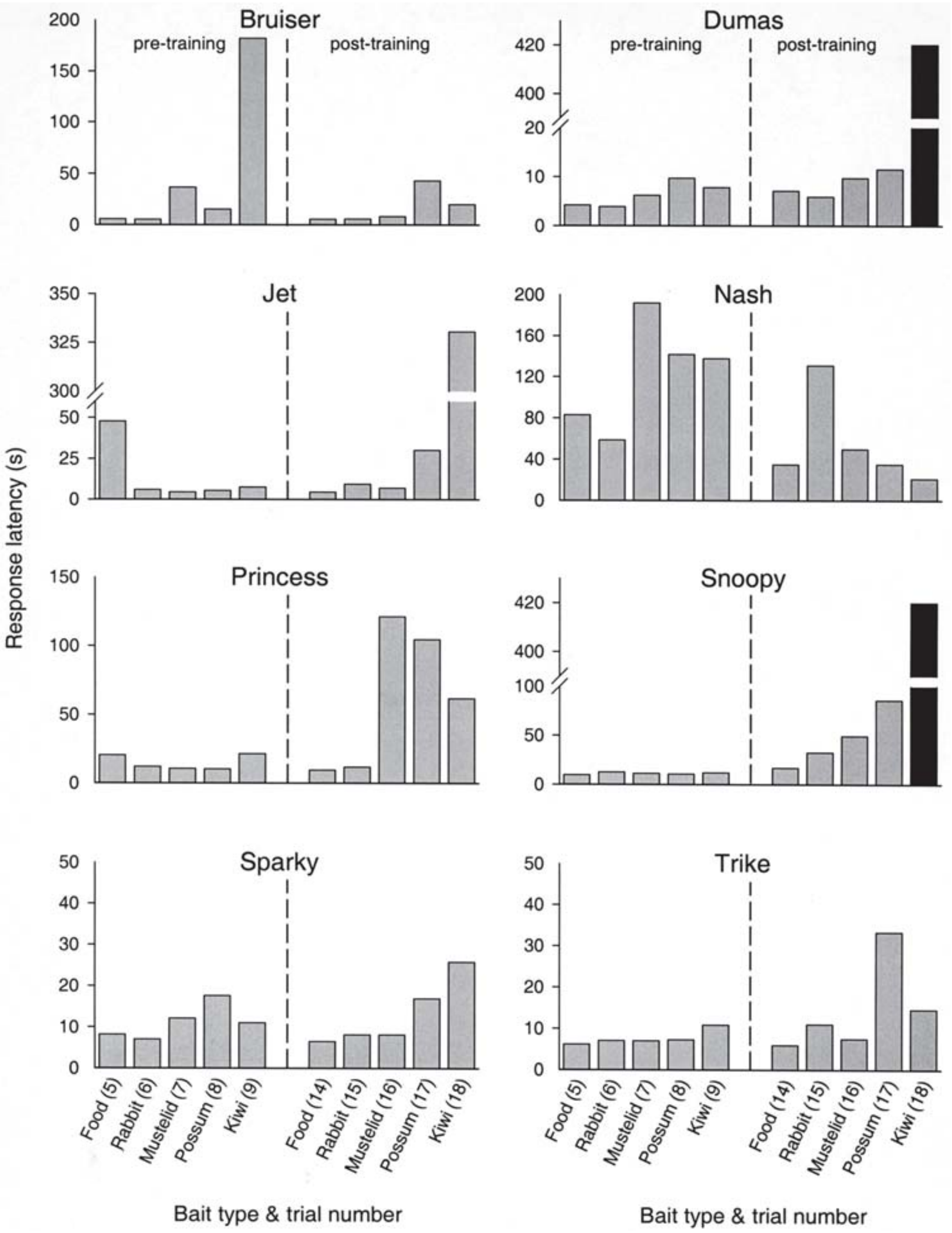


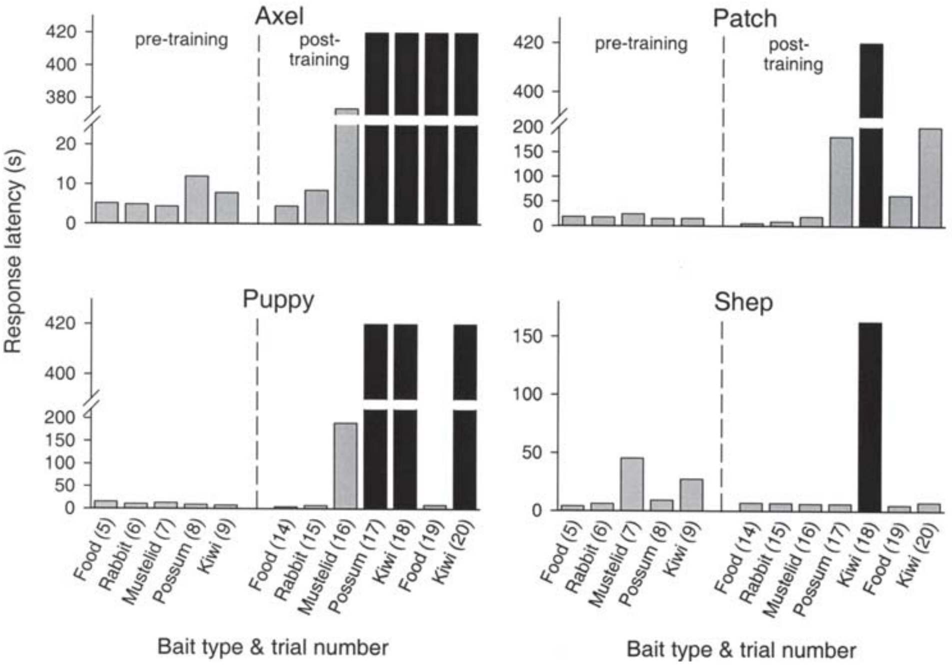
Figure 7. The time taken (in seconds) for each of eight dogs to touch the bait at the burrow before and after the aversion-training trial (Trial 11). Shaded bars represent trials where the bait was touched; solid bars represent trials where the bait was **not** touched. Note that for all solid bars, the response latency is assigned a value of 420 s (7 min) because a trial was halted if the dog had not touched the bait by this time.

avoided the possum as well as the kiwi in this phase, and all three dogs had shown a consistent increase in latencies across trials in this phase. (This increase in latencies implies that the avoidance seen in Trial 18 may have just been a continuation of increasing times to approach the baits rather than evidence of these dogs discriminating kiwi from other baits.) Patch and Puppy approached the burrow and ate the food there in Trial 19, but Axel did not. Patch touched the kiwi when it was presented again in Trial 20, but the other two again avoided the kiwi.

Figure 7 shows that Snoopy also exhibited a consistent increase in latencies across post-training trials. This dog was not given additional trials in response to this trend because, as will be described below, he was deemed to have contacted the kiwi after 7 min had elapsed in Trial 18.

Study of the paths dogs took around the testing site allows greater analysis of a dog's behaviour on selected test trials. Figure 9 shows these paths on pre- and post-training trials involving the kiwi (Trials 9 and 18 in the left and right columns

Figure 8. The time taken (in seconds) for each of four dogs to touch the bait at the burrow before and after the aversion-training trial (Trial 11). Unlike the dogs in Fig. 7, each of these four dogs received a total of 20 trials. Shaded bars represent trials where the bait was touched; solid bars represent trials where the bait was **not** touched. Note that for all solid bars except that for Trial 18 (kiwi) for Shep, the response latency is assigned a value of 420 s (7 min) because trials were halted if the dog had not touched the bait by this time.

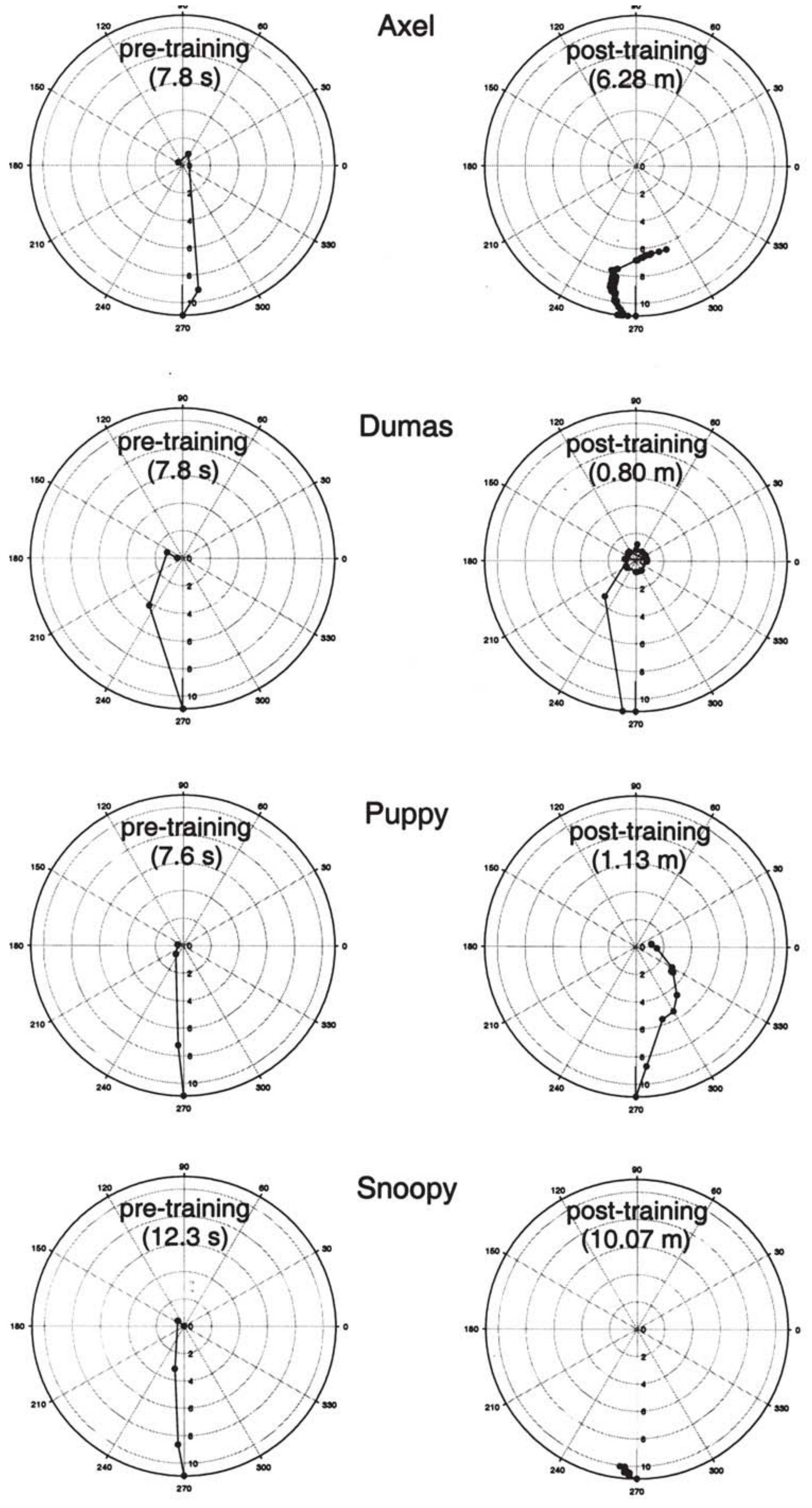


respectively). This analysis has been conducted for the four dogs that avoided the kiwi on all their post-training trials (i.e. Axel, Dumas, Puppy, and Snoopy). Response latencies are given for the pre-training trial and the minimum distances between the dog and the pole are given for the post-training trial. Paths were constructed as follows: a method of observation known as momentary-time sampling was used to calculate repeated measures of a dog's position at 3-s intervals throughout the trial. Position was coded in terms of angle and radius. The angle of a position was estimated by comparing an imaginary line between that position and the pole at the burrow, with an imaginary line from the release point to the pole. This was achieved by identifying physical features around the testing site in the background of selected frames of the video record. The radius of a position was calculated by inspecting a visual representation of the audio track and counting the number of clicks recorded in each of 140 3-s intervals. Adding up the number of clicks in each interval gave the distance that was traveled toward the pole in that interval and estimates of the minimum distance of a dog from the pole at given moments in time.

The time that a dog spent at various positions in the testing site is not easily seen in Fig. 9 because data points often fall on top of one another. Consequently, Fig. 10 was produced to supplement Fig. 9 and present graphically a dog's rate of approaching the burrow on those trials featured in Fig. 9. The data plotted in Fig. 10 are cumulative records of distances traveled over the trial as a function of time in the trial, where the distance traveled in each 3-s interval was calculated as above. A flat line for a period on these records indicates no movement toward the burrow in that period, whereas a steeply falling line indicates a very rapid approach.

The dogs reported in Figs 9 and 10 behaved similarly in the pre-training trial (Trial 9): each dog approached the burrow and touched the kiwi. They had a short latency (Fig. 10), and took a relatively direct path to the kiwi (Fig. 9). (Three dogs did, however, run slightly past the kiwi before approaching it from

Figure 9. Momentary (3-s) time samples of the paths each of four dogs took around the testing site when the kiwi baits were presented before the aversion training (Trial 9, left column) and when they were first presented after aversion training (Trial 18, right column). The times given for the pre-training trials represent latencies from release until a dog touched the kiwi baits. The distances given for the post-training trials represent the minimum distance remaining between the dog and the burrow at trial end. Data are presented for only those dogs that satisfied the definition of avoidance in Trial 18. See text for further explanation.



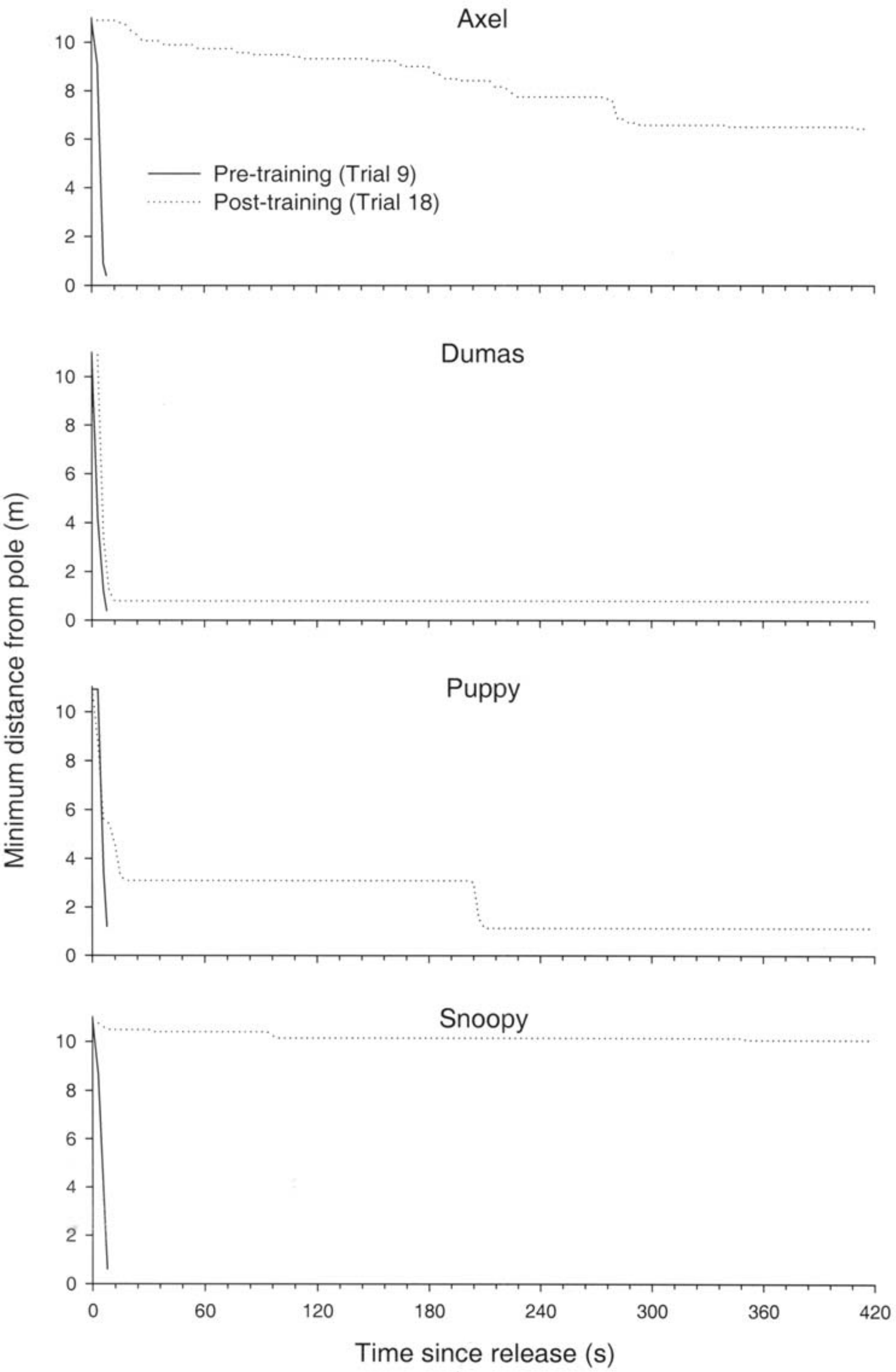


Figure 10. Momentary (3-s) time samples of the distance remaining between a dog and the burrow when the kiwi baits were presented before the aversion training (Trial 9, dotted line) and when they were first presented after aversion training (Trial 18, solid line). These distances were estimated by first calculating the cumulative distance traveled per successive 3-s intervals, and then subtracting these cumulative differences from 10.9 m; the distance between a dog and the burrow when it was released on the extended lead at the start of a trial. Data are presented for only those dogs that satisfied the definition of avoidance in Trial 18. See text for further explanation.

a down-wind position; see Fig. 9.) Furthermore, in this trial, the dogs never attempted to increase their distance from the pole once they had begun their approach. In contrast, Figs 9 and 10 show that the behaviour of these dogs in the post-training trial (Trial 18) differed markedly. Comments regarding each dog's behaviour in this trial follow.

Figures 9 and 10 show that Snoopy's movement around the testing site in the post-training trial was extremely limited; he traveled only 83 cm toward the burrow over the 7 min of the trial. Once the trial ended, however, this dog followed the researcher into the burrow and contacted the kiwi. This contact, although not satisfying our definition of ‘touching’, was considered sufficient evidence of Snoopy not having learned an aversion to kiwi. The following text describes what happened. As noted above, Snoopy often (13 of 17 trials) climbed into the burrow before or after touching the bait placed immediately outside. Early in testing, we speculated that he was entering the burrow for shade from the sun because each day had been warm (between 25ºC and 30ºC) and with little cloud cover, and the burrow offered the only shade within his reach on the testing site. Trial 18 was conducted late in the afternoon (5:52 p.m.) and when, for the first time in testing, trees on the north-western corner of the site were casting long shadows across it. One of these shadows just reached the point where Snoopy was released by the handler (Point D on Fig. 2). Once released, Snoopy immediately turned 90º, lay down in the shade, and stayed there for 7 min, giving up clicks only when he turned his head toward the burrow momentarily on two occasions. A researcher entered the testing site after 7 min and began walking toward the burrow to turn off the camera. Snoopy stood and began following the researcher to the burrow shortly after the researcher walked past him. Upon hearing the clicks, the researcher stopped approx. 5 m from the burrow, turned, and then walked back to behind the hide. Snoopy, unable to retreat back to his shady position, continued walking toward the burrow and proceeded to climb into it, contacting the stuffed kiwi with his shoulder on the way.

Figures 9 and 10 show that Dumas behaved quite differently from Snoopy on the post-training trial (Trial 18). Dumas hesitated for about 4 s after being released, but then ran to the burrow at a speed similar to that in the pre-training trial (Trial 9). Once all the lead had been retracted and he was 0.8 m from the baits, he slowly approached the kiwi carcass and got to about 30 cm from it, at which point he turned and attempted to run from the burrow, stretching the rubber cord to about 1.2 m as he did so. He made eight attempts to run from the burrow within the first 2 min, and then sat in a position that maximised his distance from the kiwi for the remaining 5 min.

Axel can be seen in Fig. 9 to have traveled 4.62 m toward the burrow on the post-training trial (Trial 18), and so was 6.28 m from the pole at trial end. Figure 10 shows that his rate of approach on this trial was quite constant over the 7 min and much less rapid than on Trial 9. Video records of Trial 18 showed that he was oriented toward the hide (i.e. away from the baits at the burrow) for all except 43 s of the 7 min, and that he traveled most of the 4.62 m while walking backwards. This dog, therefore, seemed to be looking for his handler over the entire trial. Also noteworthy is that he never attempted to increase substantially his distance from the burrow and so exerted little force against the rubber cord.

Puppy’s behaviour in Trial 18 was similar to Axel’s, but very different from Dumas’. Figure 10 shows that upon release in Trial 18, Puppy initially ran to the burrow at a speed similar to that in the pre-training trial (Trial 9), but then paused for around 3 min at 3.09 m from the pole. He then approached to 1.13 m from the pole before pausing again for the remaining 3.5 min. Like Axel, Puppy never attempted to increase his distance from the pole and was oriented to the hide for most of the 7 min.

4. Discussion

This paper reports the first empirical assessment of the training protocol designed, and used, by DOC staff and contractors in an attempt to train dogs to avoid kiwi. That training generally involves a single trial where dogs are presented with an opportunity to touch either a kiwi carcass or a stuffed kiwi (the training stimuli), and electric shock is delivered through a dog's collar the moment it contacts either bait. This encounter is presumed to involve the dog sensing, and later avoiding, visual and/or odour features of the training stimuli. A practical avoidance of live kiwi in natural encounters is expected to develop to the extent that a live kiwi looks like the stuffed kiwi, or a live kiwi smells like the kiwi carcass, used in training.

The experiment reported here measured a dog's tendency to approach various stuffed animals and carcases of those animals (including kiwi) before and after a replication of the DOC method of training. Thirteen dogs were attached individually to an extended retractable lead and presented with up to 20 opportunities to run toward a burrow where either food or one of four different dead and stuffed animals had been placed. In addition, these test trials were conducted in a site that clearly differed from that in which the training trial was conducted. One dog (Ocean) avoided the kiwi on two pre-training trials and so was not given the training (Fig. 5). All other dogs touched all of the animal baits and so were trained using the DOC method. After training, 8 of 12 dogs touched the kiwi again on at least one of its two re-presentations. These dogs (67%) clearly failed to learn any useful (or practical) degree of avoidance. Of the remaining four dogs, three presented patterns of avoiding other baits after training (Figs 7 and 8), and behavioural differences within the kiwi trials (Figs 9 and 10), that suggested alternative explanations for their having not touched the kiwi in the post-training trial (Trial 18). One of these three dogs (Snoopy) contacted the kiwi after trial end and after having sat in the shade at the release point for the entire trial. This behaviour suggested that the dog had approached the burrow because of the shade it offered and that any kiwi avoidance was not strong. The second dog (Axel) avoided multiple baits after training: the possum (Trial 17), the kiwi (Trial 18), the food (Trial 19), and then the kiwi again (Trial 20). Just as this dog's avoidance of the possum and food suggest that he was not responding to kiwi cues on Trial 18, his behaviour within Trial 18 (Figs. 9 and 10) suggests that he never sensed the kiwi at the burrow. The third dog (Puppy) avoided the possum (Trial 17) and then avoided the kiwi twice (Trials 18 and 20) after training. This dog also showed increasing latencies across trials, and no evidence of attempts to escape on the kiwi trials.

The behaviour of Axel and Puppy across and within trials suggested that only food had served to reinforce burrow approaches, and that burrow approaches had begun to extinguish (cease occurring) after Trial 14 as a result of repeated failures to find food there. Although further experimentation would be necessary to verify this explanation, it is at least a viable alternative to these dogs having learned an aversion of kiwi and so should detract from their provision of affirmative evidence. The number of dogs in the sample showing the desired effect of DOC's training is, therefore, between one and four (8% to

33%) with the lower number offering the more conservative estimate.[5] It should also be noted that the dog providing the strongest evidence of a learned avoidance (Dumas) showed a weak degree of avoidance in that he approached the kiwi carcass to approx. 30 cm before attempting to escape.

The extent to which this experiment was a preliminary and conservative assessment of DOC's training should be highlighted. This experiment investigated dogs' motivation to touch only the bait for which they had previously received a shock for touching (the kiwi carcass or the stuffed kiwi). That is, we did not assess the dogs' behaviour when presented with a live kiwi in a more natural encounter on the grounds that failure to show avoidance of the training stimuli precludes any possibility of an avoidance generalising to live kiwi in their natural habitats. There can be little doubt that live kiwi would present more movement cues (and therefore visual stimuli) than our stuffed kiwi, and that the odour of live kiwi differs from (and perhaps exceeds) the odour of our frozen carcass. Furthermore, dogs roaming in natural kiwi habitats are likely to be more actively sampling odours, and more responsive to movement cues provided by a kiwi, than were the dogs on our Testing Site. These factors probably limit the degree to which an avoidance of the training stimulus demonstrated in our controlled tests generalises to practical avoidance in the field. It is entirely possible, therefore, that the one dog showing kiwi avoidance in our study (Dumas) might fail a more ecologically valid test of avoidance.

Although any adopted method of avoidance training cannot be expected to prove effective with all dogs, the present experiment found DOC's typical method to be effective for such a small percentage of dogs that it seems unjustifiable. Notwithstanding the poor outcome with this method, a number of published studies have reported that pairing electric shock with potential prey can, under some conditions, establish prey avoidance in canid species (e.g. Linhart et al. 1976; Andelt et al. 1999; Christiansen et al. 2001). However, the training methods reported in these studies differ substantially from the method used by DOC and assessed here. The nature of these differences makes it even less likely that dogs showing kiwi avoidance in the present procedure would also show avoidance in natural encounters.

Most of those studies investigating avoidance learning in canids have been conducted by conservation biologists searching for non-lethal techniques to control depredation of domestic animals by non-domestic canids such as coyotes (*Canis latrans*), foxes (*Vulpus vulpus*), wolves (*Canis lupus*), and feral dogs (*Canis familiaris*). For example, Andelt et al. (1999) assessed the use of shock collars to deter coyotes from attacking domestic sheep. They presented captive coyotes with live and free-roaming lambs expected to elicit chasing, capture and consumption in the coyotes. (This behaviour pattern is instinctive, but that does not imply that animals cannot learn to discriminate when, and when not, to emit it.) Those five coyotes that killed and partially consumed lambs in a pre-training test were worked with individually in repeated sessions. In each session, a coyote was kept for an hour in an enclosure that contained a

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[5] Stronger evidence for Dumas having learned kiwi avoidance could have been provided if further trials had been conducted. These trials could have involved presenting the possum again (Trial 19), the kiwi (Trial 20), food (Trial 21), and the kiwi (Trial 22). The more often he approached the non-kiwi baits but avoided the kiwi, the stronger the evidence for a learned avoidance of kiwi.

free-roaming lamb. Rather than delivering shocks whenever the coyote contacted the lamb, they were delivered each time a coyote appeared to pursue the lamb and was within 2 m (but occasionally 5 m) of it. The number of times a coyote pursued the lamb and, therefore, received the shock varied from two to five across coyotes. Some pursuits were separated by as little as 10 s, while others were separated by as much as two months. Andelt et al. reported that shocks averted all pursuits, reduced the probability of further pursuits, and caused coyotes to retreat from lambs for more than four months.

Other studies by Linhart et al. (1976) and Christiansen et al. (2001) corroborate the need for multiple training trials where predatory behaviour is elicited by live prey. Linhart et al. attempted to train coyotes to discriminate between black and white rabbits. Four coyotes were each given daily 1-hour sessions where a black rabbit was tethered to one corner of an enclosure and a white rabbit was tethered to another. The coyotes were permitted to kill and eat the white rabbit, but they received an electric shock immediately they pursued the black rabbit. Three of the four coyotes learned to avoid black rabbits after three to five shocks and, when repeatedly retested at intervals between four and eight weeks, did not begin attacking them again until three to nine months later. Similarly, Christiansen et al., working with 17 domestic dogs attacking live sheep, reported that an average of 2.59 shocks per dog was required to train avoidance.

The results of these studies suggest that the DOC method of delivering one shock when a dog touches either a static stuffed kiwi or a kiwi carcass may well have been inadequate to train an avoidance of live kiwi.[6] These procedural differences do not, however, seem able to explain why dogs in the present study failed to avoid the very stimuli that had previously been associated with shock (i.e. the training stimuli). Instead, other explanations for this failure to learn avoidance seem necessary. Laboratory (basic) and field (applied) research investigating a phenomenon known as taste aversion conditioning (or conditioned taste aversion) may well offer such explanations.

Taste aversion conditioning (TAC) describes the learning that has occurred when animals avoid ingesting substances with specific flavours (or odours) because of some prior association between that flavour (or odour) and illness. Research into this type of learning grew rapidly in the 1960s. Garcia et al. (1966) and Garcia & Koelling (1966) reported that the avoidance of illness-associated flavours seemed to be learned differently from the avoidance of other aversive stimuli, and the association of stimulus events generally. In particular, Garcia et al. (1966) showed that avoidance of a flavour can be learned after just one pairing of the flavour with illness, and when there are long delays between ingestion of the flavoured substance and subsequent illness. In contrast, learning to avoid other aversive stimuli such as electric shock generally requires repeated pairings of a stimulus with shock where the two stimuli occur close together in time. Furthermore, they found that animals consistently avoid the flavour (or odour) of an ingested substance that has been followed by illness and seem to learn little about visual properties of the substance.

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[6] Professional animal trainers using shock collars with sheep-worrying dogs also present live sheep in a variety of settings so as to reduce the likelihood that dogs learn to avoid sheep only in the training site (M. Vette and M. Ward, Animals on Q, pers. comm. 2005). Christiansen et al. (2001) also acknowledge that the sheep avoidance observed in their dogs may not generalise to other settings.

This latter phenomenon was initially demonstrated by Garcia & Koelling (1966). In their study, two groups of rats were given flavoured water to drink, and whenever they drank, lights would begin flashing and a clicking noise would start. After drinking the water, the rats in one group were made sick by the injection of an emetic (lithium chloride—LiCl), whereas rats in the other group received electric shocks to their feet whenever they drank. Thus, the water's flavour, the flashing lights and the clicking sound were all associated with an aversive stimulus, but this stimulus was illness for one group and shock for the other. Garcia & Koelling (1966) then tested the amount of water that rats in both groups drank under different conditions. They found that those that were made sick subsequently avoided the taste (or odour) of the water but drank near-normal amounts in the presence of flashing lights and a clicking noise. Those that had received electric shock, on the other hand, avoided drinking in the presence of flashing lights and a clicking noise but did not learn an aversion to the taste and/or odour of the water. Similar results were obtained by Gustavson & Gustavson (1982). They paired electric shock, ammonia, mustard, quinine and illness (induced by LiCl) with eating Oreo® cookies when rats were in three different environments. Only illness suppressed cookie eating in all environments.

The differential effects of shock and illness described above have been taken to imply that animals are biologically (innately) prepared to learn an avoidance of stimuli in specific sensory modalities depending on the nature of the aversive stimulus (e.g. Seligman 1970). With respect to the present experiment, these results suggest that if those dogs who failed to avoid the kiwi after training learned anything from that training, then they may have learned an aversion of the site where the shock was experienced. Dogs having learned site avoidance could not, however, result in their avoiding kiwi (or burrows) in the present experiment because training and testing sessions were conducted in very different sites. That site avoidance was learned here is consistent with, and so could be predicted from, reports from animal trainers stressing the need to render the training site an irrelevant feature of the to-be-avoided stimulus by training in a range of sites. (See footnote 6). It is also consistent with the results of preliminary investigations into the feasibility of the assessment protocol arranged in the present experiment. (In those investigations and unlike the present procedure, dogs received the shock when they touched the kiwi baits on their first presentation in the pre-training testing phase. This attempt to train a kiwi aversion while dogs were on the ML and in the testing site resulted in approx. 95% of dogs avoiding the burrow when all baits, including food, were presented there. Most dogs simply sat where they were released by a handler and remained there for the 7 min of the trial.) Finally, that associating shock with the kiwi baits resulted in site avoidance could explain in part why DOC's method has been judged effective in informal field tests. That is, dogs might have stayed close to their handlers and avoided approaching any visual or scented feature in a post-training setting if that setting (perhaps including the people present) resembled that in which they previously received a shock[7].

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[7] The conditions under which dogs avoided the burrow in the preliminary investigations described above (i.e. different site and disguised burrow and equipment) suggest that relatively subtle features of settings may acquire aversive properties after association with shock.

Gustavson et al. (1974) recognised that the features of TAC described above seemed to make it an ideal method for modifying the behaviour of predators toward their prey. These researchers subsequently demonstrated that captive coyotes that had been fed a sheep-flavoured meal and then made ill by an injection of LiCl not only later refused to eat sheep-flavoured meals but also ceased killing sheep. Since that publication, TAC has proven to be an effective method of controlling depredation involving a range of animal species and a range of prey in their natural habitats (see Gustavson & Nicolaus 1987, for a review of these studies). In fact, the majority of studies investigating behaviour modification techniques for altering predator-prey interactions have attempted some sort of application of TAC.

Although TAC sometimes reduces the consumption of a particular prey animal without eliminating the killing of that prey (e.g. Conover & Kessler 1994), this form of aversion training seems likely to be more effective than using shock when attempting to train kiwi avoidance in dogs. There are several reasons for this. First, it is widely believed that live kiwi emit a strong and distinctive odour, and that a dog hunting a kiwi will locate it by following its odour trail. TAC research suggests that training dogs to escape from that odour as soon as they detect it will be easier when illness has been paired with the odour (so the dog is avoiding being ill) than when shock has been paired with the odour. Second, kiwi in their natural habitats will likely present few visual cues that could elicit the predatory behaviour in dogs. This is because kiwi usually react to predators on the ground by 'freezing' rather than by fleeing (McLennan et al. 1996), and non-moving kiwi are reasonably well camouflaged. This limits the utility of training an avoidance of visual features of kiwi and so, according to the research, limits the utility of using shock (even repeatedly and in different settings) as the aversive stimulus. It also offers another reason for attempting to train an odour avoidance, because once a dog is off the odour trail, it is unlikely to see a kiwi and so be presented with visual stimuli that could elicit seizing and killing. Put another way, TAC should result in dogs learning to escape from kiwi odour to avoid illness, but in the process, they will have avoided encountering kiwi at close proximity and, therefore, attacking them[8]. Together, these arguments constitute reasonable grounds for research into the effectiveness of using TAC to protect kiwi from dogs.

5. Conclusions

In conclusion, the present experiment found little evidence for the effectiveness of using one administration of electric shock in the presence of a stuffed kiwi and a kiwi carcass to train an avoidance of kiwi in dogs (the widely-used DOC method). Although we assessed dogs' avoidance of only the training

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[8] This TAC need not involve feeding dead kiwi laced with an emetic to dogs. Instead, a method of capturing the natural odours of rats (e.g. Byrom et al. 2001) could possibly be adapted for kiwi so that kiwi odour could be sprayed onto food containing an emetic, or perhaps even combined with the emetic in pill form.

stimuli in a controlled (and, therefore, contrived) environment, a failure to avoid these stimuli logically precludes any generalisation to avoidance of live kiwi in natural encounters. It is likely, therefore, that this training has been producing the desired behaviour change in only a small percentage of dogs using kiwi habitats. Differences between the DOC method and those reported in the literature as being successful imply that repeated presentations of a moving kiwi in a range of different settings, and the opportunity for repeated pairings of shock with kiwi, would likely prove more effective. However, features of another type of learning (TAC) suggest that training an avoidance of kiwi in dogs might be better achieved by inducing illness in dogs after they ingest food that had a strong kiwi flavour and odour. The basic research investigating TAC also predicts a likely problem with aversion training that involves electric shock: unless careful planning and skilled trainers are involved, dogs will probably learn to avoid the site where the shock was received or, at best, the visual features of a kiwi in that site. Further research, informed by the literature on conservation biology and using methods adopted in Applied Behaviour Analysis, should be undertaken to investigate these possibilities. Until such research identifies the essential features of an effective training protocol, modifying the behaviour of dogs by way of training techniques remains only an ideal (and perhaps unachievable) solution to their predation of kiwi, and alternative strategies should be employed.

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