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Aggression in Domestic Ferrets
(Under the direction of IRWIN BERNSTEIN)

The domestic ferret is an increasingly popular pet. They are usually tame, playful, curious, and quite docile. Fights between ferrets can, however, result in serious injury. This study examined fighting between pairs of ferrets placed together in a pen. While cage mates did not engage in serious fights, almost 60% of newly introduced ferrets engaged in fights that included shaking, dragging, screaming, fleeing, urinating, or defecating. An attempt was made to identify the variables that affect the likelihood of aggression between ferrets and to design a method of introducing ferrets that would reduce fighting. Unfamiliarity was the strongest predictor of fighting behavior. The time of year (spring vs. winter) did not affect fighting behavior. Males and intact (i.e., not neutered or descented) animals were not always more aggressive than females or neutered animals. Intact male/intact male pairings were significantly more likely to result in a fight than intact male/neutered female pairings. Neutered female/neutered female pairings were significantly more likely to result in a fight than intact male/neutered female pairings. For pairs that did fight, a two-week familiarization period, during which pairs of ferrets lived side by side separated by wire mesh and rotated between sides every 24 hours, did not result in less fighting than in the control group. In conclusion, ferrets that are already cage mates are the least likely to fight. When introducing neutered pet ferrets, male/male pairings and male/female pairing are expected to fight less than female/female pairings. Finally, all introductions should be monitored.

INDEX WORDS: Aggression, Domestic ferrets, Familiarity, Fighting, Gender, Introduction, Neutering, *Mustela furo*, Pre-exposure, Season

AGGRESSION IN DOMESTIC FERRETS

by

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TABLE OF CONTENTS

Page

LIST OF TABLES v

INTRODUCTION 1

EXPERIMENT ONE

Materials and methods 10

Results 13

EXPERIMENT TWO

Materials and methods 17

Results 19

DISCUSSION 20

REFERNCES 24

APPENDIX

Literature review 32

References 37

LIST OF TABLES

Page

Table 1. Descriptions of subjects and cage groupings (cages may have included other ferrets not included in the study and therefore not listed here).....27

Table 2. Pairings tested in Experiment 1 (with number of fights in parentheses).....29

Table 3. Numbers of fights/ number of total pairings for first-time meetings between strangers in Experiment 1 30

Table 4. Pairings tested and results for Experiment 2 31

INTRODUCTION

Aggression among animals is not uncommon, and for pet owners, aggression among new pets can be stressful. Scientists and pet owners describe domestic ferrets (*Mustela putorius*), an increasingly popular pet in the United States, as tame, playful, curious, and quite docile (McKay, 1989; Wellstead, 1982; Willis & Barrow, 1971). Still, when strange ferrets are introduced for the first time, fights sometimes occur. The purpose of this study was to investigate the variables that affect the likelihood of aggression between individual domestic ferrets and to design a method of introducing ferrets that would reduce fighting.

Aggression in Ferrets

The level of aggression in an encounter can be measured in several qualitative and quantitative ways. MacLennan and Bailey (1969), in their study of aggression levels in minks, used latency to confrontation as an indirect measure of aggressive level (more aggressive animals had a confrontation sooner). Clapperton, Minot, and Crump (1988) ranked their subjects, New Zealand feral ferrets, as more aggressive if they initiated attacks and engaged in more intense attacks.

Poole (1967, 1973, 1978) studied fights between European polecats (considered to be the closest living relative of the domestic ferret) and polecat x ferret hybrids, and classified fighting into three types: play fighting (which is not considered aggression), ritual (inhibited) fighting, and true (uninhibited) fighting. During a true fight, each animal attempts to bite the back of the opponent's neck with a sustained, immobilizing

hold. Successful bites (when the opponent is unable to break free) are sometimes accompanied by a shaking or dragging of the immobilized ferret. When the attacked ferret is able to break free, it may show evidence of intimidation including screaming, defensive biting, hissing, fleeing, urinating, or defecating. While serious injury from true fighting usually does not occur, the event can be stressful to the owner and the animals.

In true fighting, a winner and loser can be identified. Poole (1974) defined the loser as the animal that first shows defensive behavior. The other animal was the winner. Defensive behavior includes threats (for example, hissing and inhibited biting while retreating) and fearful behavior (screaming, escaping).

Causes of Aggression

There is disagreement in the literature on the function of aggression. Aggression may occur as a displacement activity after failing to obtain food (Baron, Stewart, & Warren, 1957) or aggression may occur to reinforce dominant/subordinate relationships (Johnson, 1989). Parker (1974) argued that competition over resources, such as mates, food, or territory, is the sole reason for fighting. It is possible that ferrets placed in an enclosure together fight over a resource, such as territory. In the wild, however, the European polecat is not likely territorial and home ranges overlap (Norbury, Norbury, & Heyward, 1988). Poole (1973) placed two polecat groups in an arena, one group on each side of a divide, for 5 hours and then opened a door between the two sides. The subjects immediately investigated the new area and fights broke out between strangers. The polecats did not retreat to the familiar side for safety or defend the familiar side against strangers. It therefore seems unlikely that ferrets are territorial.

Placing strangers together in an unfamiliar setting is likely to elicit aggression since "the principal elicitors of aggression in many mammalian species are pain, frustration, direct competition, unfamiliarity, uncertainty, and encroachment on personal space" (Mason & Mendoza, 1993, p. 22). Since ferrets are capable of recognizing familiar animals (Clapperton, Minot, & Crump, 1988) and since true fighting primarily occurs between strangers (Poole, 1967, 1973), it is likely that fighting between ferrets is primarily caused by the presence of strangers.

In his 1967 paper, Poole states that he used only strangers in his dyads because cage mates don't fight. However, in 1973, Poole coined the term "companion fighting" to describe the behavior that occurs between cage mates and that is different from play or uninhibited fighting. Wellstead (1982) agreed that even intact (i.e., non-castrated) male ferrets could be kept together during the breeding season as long as they are introduced during the non-breeding season and not separated for more than 48 hours. When two groups of polecats are placed in the same arena, polecats, like many other species, may attack strangers rather than familiar animals (Poole, 1973). When left in the arena for an extended period, the animals always rested in groups consisting of familiar animals. The difficulty for pet owners is rarely aggression between existing group members, but aggression from or directed toward a newly introduced member.

Other Factors Mediating Aggression Between Strangers

While non-familiarity is perhaps the best predictor of true fighting between ferrets, not all strangers fight. There are other variables that mediate the level of aggression between strangers. The literature indicates that gender and time of year are among the other variables that may affect the likelihood of aggression between strangers.

Gender. Most aggressive encounters described in the literature involve males. When several males and females are placed in an arena together, males attack males and females indiscriminately (Poole, 1973). When attacked, males respond with a counterattack, females scream or respond with defensive behavior. Also, male/male interactions persist; male/female interactions do not. Females show no aggression toward other females. Females are described as aggressive in the literature only when pregnant or nursing (Lloyd, 1999).

It should be noted, though, that the literature includes only data from intact males and females. Moody, Bowman, and Lang (1985) and McKay (1989) suggested that castration of the male might reduce aggression. Ferrets sold as pets in the United States are almost always already neutered. While studies of other species have shown that neutered animals may be less aggressive than intact animals (e.g., dogs; Beaver, 1983, Wright & Nesselrote, 1987), this has not been demonstrated in ferrets.

Time of year. Ferrets are seasonal breeders (Lloyd, 1999). Although males come into season slightly before females, the breeding season is generally in the spring, from about March to July. When in season, the testes of the male descend into the scrotum and the vulva of the female swells.

In Poole's studies (1967), true, uninhibited fighting occurred almost exclusively during the breeding season. The same males paired during the non-breeding season engaged in ritual fighting. When studying the forms of fighting in slow-motion film, Poole (1974) used males in the breeding season because the encounters invariably resulted in fights. Ferreting manuals suggest that males should always be kept separated

during the breeding season, since fights can result in death, but that males can live together when it is not the breeding season (Wellstead, 1982).

Other variables. There are other variables that may affect aggression. Ferrets with adrenal gland tumors, which increase testosterone levels, may be more aggressive (Lloyd, 1999). Tail alopecia is usually the first clinical sign of an adrenal tumor. Ferrets over four years old have a high risk of developing adrenal and other tumors (Lloyd, 1999). Therefore, studies of normal aggression in ferrets should be limited to healthy ferrets under four years old.

Adult ferrets vary in weight from 400 to 2000 grams, with males typically weighing more than females (McKay, 1989). In Parker's (1974) model of assessment strategy, for most species, animals use perceived size as a factor in deciding whether or not to escalate aggression during an encounter. In his studies of male polecats that varied in weight from 790 to 1730 grams, Poole (1973) found no significant correlation between weight and aggression ($r = 0.159$). However, studies of aggression should still control for the possibility that differences in weight between opponents could affect aggression.

Reducing Aggression

Knowing what variables might affect the likelihood of aggression occurring between strangers will allow pet owners to select a new ferret that is less likely to fight with its new cage mates. Since simply being unfamiliar is most likely the strongest predictor of aggression (Marler, 1976), it is likely that even with careful planning, pet owners may still have to deal with a new pet ferret that may engage in true fighting with one or several of its new cohabitants. What is needed, then, is a method for introducing ferrets to each other that is designed to reduce the likelihood of aggression.

Since familiar animals are less likely to fight than non-familiar animals, it would be ideal if potentially aggressive animals could become familiar without having the opportunity to fight. Allowing the animals to have prior sensory contact but not tactile contact may accomplish this. Pairs of ferrets placed together should be less likely to fight if given more extensive prior sensory contact than pairs that are given little to no prior sensory contact.

Allowing some sensory but not tactile contact is a method of introduction that has been used with some success in other species. Pig farmers regularly regroup animals for breeding purposes, and the vigorous fighting that can occur between unfamiliar domestic pigs can create welfare and production problems (Jensen & Yngvesson, 1998). In a study comparing the fighting behavior of newly introduced pigs that had been living in adjacent pens separated by wire to the fighting behavior of pigs that had been living in adjacent pens separated by solid walls, fighting still occurred in both groups, but the total length of contest was significantly shorter for pigs that had been living in pens separated by wire (Jensen & Yngvesson, 1998).

In zoos, keepers also must frequently introduce new animals into small living quarters. For researchers of the endangered kangaroo rat, it was particularly important to find a method of making introductions while reducing aggression in order to improve captive breeding (Thompson, Roberts, & Rall, 1995). Similar to ferrets, kangaroo rats are solitary animals that, in the wild, may become familiar with potential mates through overlapping home ranges. When housed in separate glass cages at the zoo, only visual familiarization before mating was possible. Housing of males and females in adjacent cages separated only by wire mesh screens allowed visual, olfactory, auditory, and some

tactile familiarization, and encounters were about ten times less aggressive than encounters between unfamiliar pairs (Thompson, Roberts, and Rall, 1995).

Connor and Lynds (1977) were less successful when testing the ability of pre-exposure to reduce aggression in house mice. The researchers pre-exposed some males through a wire mesh separation, kept some males entirely separated, and placed some males in the same cage (where fighting did occur). Males separated by wire mesh, when placed together, did not have reduced aggression compared to males that were not pre-exposed. Only males that had been cage mates for 35 days had low levels of aggression during testing. Connor and Lynds (1977) argue that shared substrate and extensive tactile contact allow chemicals from the intruder to be deposited on the subject and that this is necessary to reduce aggression.

If left together, hostile ferrets would likely stop fighting, eventually. Without supervision, though, serious injury could occur. A more common method of integrating ferrets that fight is to allow numerous supervised encounters, breaking up serious fights. This process can take as long as a year. A preferable method may be to allow as much sensory contact as possible between a pair of ferrets without actually allowing them to fight, in order to create familiarity and reduce the likelihood of fighting when they are allowed full contact. In order to allow visual, olfactory, auditory, and limited tactile contact, as in the successful study of kangaroo rats by Thompson, Roberts, and Rall (1995), pairs could be housed in separate halves of a wire cage with a mesh separation or in wire cages placed side by side. In order to allow as much contact with the chemicals of the opposing ferret as possible, as recommended by Connor and Lynds (1977), animals

could be rotated between sides of the cage so that they shared bedding materials and defecation sites.

Predictions

The most reliable predictor of aggression between any pair of ferrets, regardless of gender, neutering, or time of year, should be familiarity. When a pair of cage mates is placed together in an unfamiliar arena, there is no indication, in the literature, that they should fight. All true fighting should occur between strangers.

Testosterone. Not all strangers fight. The literature indicates that there are several factors that increase the likelihood of fighting between strangers. Males are more aggressive than females and are more aggressive during the breeding season than the non-breeding season. It seems likely that this is because of higher testosterone levels. A clinical sign of an adrenal tumor, which increases testosterone levels, is an unusually high level of aggression. Since neutering reduces testosterone levels, the likelihood of aggression in neutered, domesticated ferrets should be low, even during the spring. Neutered males and females should show similarly low levels of aggression. Intact males and females should show behavior patterns similar to those described by Poole and others. Intact males should be most aggressive during the spring, attacking males and females, neutered or intact, indiscriminately.

Familiarity. While testosterone levels may influence aggression levels between strangers, the fact that cage mates are unlikely to fight regardless of gender, neutering, or time of year indicates that enabling familiarity to develop should reduce aggression. Ferrets given visual, olfactory, chemical, auditory, and some tactile contact pre-exposure

should be less aggressive than pairs that have had minimal pre-exposure and are, therefore, less familiar.

EXPERIMENT 1

Materials and Methods

Subjects

Domestic ferrets in households and rescue shelters in New Jersey, Pennsylvania, and Georgia were used for this study. The study included 55 ferrets living in social cages (at least two animals per home cage for at least three months prior to testing): 24 neutered, descented males; 19 neutered, descented females; 8 intact males (not neutered or descented); and 5 intact females. The compositions of the groups are given in Table 1. All subjects were adults (between 9 months and 4 years of age) with no known health problems. Subjects from different sites had different diets and daily routines and no changes were made to these for the study.

Pairings

Subjects were tested in pairs, looking at four variables: familiarity (cage mates vs. strangers), time of year (spring vs. winter), gender-based pairs (male/male, male/female, and female/female), and neutering (intact/intact, neutered/intact, and neutered/neutered). This could be a 2 x 2 x 3 x 3 factorial design with 36 possible conditions; however, not all conditions could be tested. For example, a pair of intact male cage mates was not available until the last data collection session in the spring (2001) and so intact male cage mates were never tested in the winter. Most of the intact females had nursing young during the winter and were not tested. A full summary of the

numbers of pairs tested in each condition (and the number of pairs that fought) is presented in Table 2.

In order to achieve the greatest number of pairings possible during the limited data collection sessions, the animals participated in multiple pairings but they did not participate in more than one trial in a 24-hour period. Animals were tested in as many of the conditions as possible, but no subject was scored for the same condition twice. All variables were between-subject variables, with unique pairings for each condition, with the exception of time of year, which was a repeated measures variable (pairs were tested both during the spring and the winter).

Apparatus

Pairings occurred in a portable arena made from 5 particleboards (61cm tall x 122 cm wide) connected with hinges. Since the arena had to fit into different locations, the hinges allowed it to fit into different shaped spaces. The arena was formed into the closest approximate of an equal-angled pentagon as possible. A piece of transparent dryer hose (10.2 cm in diameter, 3 meters long) was placed in the center of the arena and a white, heavy-duty shower curtain lined the floor. All surfaces were cleaned with Fantastik® brand household cleaner between trials to eliminate scents from previous subjects. Trials were videotaped, and scored at a later time.

Procedure

Data were collected in the spring, from May through July (2000 and 2001), which corresponds with the breeding season according to the literature and in the winter, during December and January (2000 to 2001). For each trial, a pair of animals was simultaneously placed in the arena and their interactions were videotaped for 10 minutes.

If a fight was in progress at the end of the trial, the trial was continued until that interaction ended so that a winner could be determined. When similar coloring of subjects made identification difficult, animals were marked with colored mascara. Trials were terminated early if an interaction escalated to a fight that might result in serious injury (for example, uninhibited bites were directed to body areas other than the neck). Also, the ferret owners had the right to end a trial at any time.

Scoring

For each trial the interaction was scored in order to determine if a true fight occurred using the following operational definition. For an encounter to be recorded as a fight for these studies, either: (a) the attacking ferret's bite made contact with the opponent (i.e., bites were not inhibited) and the opponent was unable to escape; the attacker sustained the bite for at least two seconds and may have shaken or dragged the immobilized ferret, or (b) the attacking ferret's bite made contact but did not immobilize the opponent; the attacked ferret screamed, urinated or defecated while fleeing. When fights occurred, the latency to the first fight and the identity of the initiator and winner were all scored. The opponent not using defensive behavior when the fight ended was deemed to be the winner.

Analysis

Since the primary dependent variable was a dichotomous one (fight/non-fight), non-parametric statistics were used to analyze the results. Proportions tests (chi square and the Fisher exact test) were used to determine if the fights were significantly more frequent for some pairings than for others (for example, strangers or cagemates).

Wilcoxon signed ranks test was used to determine if fights were more likely to occur during the spring or the winter for pairs tested in both seasons. An independent t test was used to determine if the latency to fight was affected by time of year.

For pairings that resulted in a fight, binomial statistics were used to determine if the initiator of the fight was male (as opposed to female) or intact (not neutered) more often than chance predicts. Binomial statistics were also used to determine if the winner of a fight was more likely to be male, intact, or the initiator of the fight.

Results

Familiarity

None of the 31 pairs of cage mates (including a pair of intact males) fought. Pairings of strangers, on the other hand, resulted in a fight in 49 of 82 pairings. The difference in proportions of fights and non-fights between strangers and cage mates was significant (χ^2 (1, N = 113) = 32.71, p < .0001).

Time of Year

Twenty-seven pairs of ferrets were tested twice, once during the spring and once during the winter. Use of Wilcoxon signed ranks test to analyze a change in behavior measured with a dichotomous variable (fight/no fight) failed to find a significant effect of time of year on fighting behavior (T = 22, N = 27, p > .05). Six pairs fought during the spring, but not the winter. Four pairs fought during the spring but not the winter. Ten pairs fought in both seasons and seven pairs did not fight in either season. To assess further possible effects of time of year, the Wilcoxon signed ranks test was run again using the 11 pairs that included an intact animal, and there was still no significant effect of time of year (T = 7.50, N = 11, p >.05). Three pairs fought in the spring, but not in the

winter. One pair fought in the winter but not in the spring. Four pairs fought in both seasons and three pairs didn't fight in either season. When the latency to fight (seconds) was compared between fights that occurred during the spring (N = 33, M = 149.58s, SD = 144.42s) and fights that occurred during the winter (N = 16, M = 158.69s, SD = 143.75s), there was no significant difference in the time elapsed before the first fight occurred between the two seasons ($t = 0.207$ (47), $p > .05$).

Gender and Neutering

Since no effect for time of year was found, the remaining analyses were run on the first encounter only between a pair, regardless of season. This results in 55 pairs used for analyses, as shown in Table 3. The Fisher's exact test was used to compare the proportions of fights and non-fights because of small sample sizes (Agresti & Finlay, 1997).

The proportion of intact male/intact male pairings that fought (all three pairs fought) was not significantly greater than the proportion of neutered male/neutered male pairings (5 out of 9 pairings fought, $p > .05$) or neutered male/intact male pairings (4 out of 7, $p > .05$). Neutered male/neutered male pairings were not significantly different from neutered male/intact male pairings ($p > .05$). The pairs of intact males did not have a significantly greater proportion of fights than pairings of an intact male/intact female (3 out of 5, $p > .05$). There were no pairings of intact female with intact female strangers.

Pairings of a neutered female with a neutered female fought in all seven pairings. This was not a significantly higher proportion of fights than in neutered male/neutered male pairings (5 out of 9, $p > .05$) or neutered male/neutered female pairings (9 out of 13, $p > .05$). There was not a significant difference between the neutered male/neutered male

pairings and the neutered male/ neutered female pairings ($p > .05$). The neutered female/neutered female pairings did not have a significantly higher proportion of fights than neutered female/intact female pairings (1 out of 3, $p > .05$).

When looking at a neutered subject paired with an intact subject, gender did not have an effect and there is no significant difference between male/male pairings (4 out of 7) and male/female pairings (2 out of 8, $p > .05$), male/male pairings and female/female pairings (1 out of 3, $p > .05$), or male/female pairings and female/female pairings ($p > .05$).

When looking at a pairing of a male with a female, the neutered/neutered pairings (9 out of 13) did not have a higher proportion of fights than the neutered/intact pairings (2 out of 8, $p > .05$). There was no significant difference between neutered/neutered pairings and intact/intact pairings (3 out of 5, $p > .05$) or between intact/neutered pairings and intact/intact pairings ($p > .05$).

Since, for these comparisons, intact male/neutered female pairings were not distinct from intact female/neutered male pairings, an analysis for this difference was done separately. Pairings between an intact male and a neutered female (0 fights out of 5 pairings) were not significantly less likely to result in a fight than pairings between an intact female and a neutered male (2 out of 3, $p > .05$). Intact males paired with neutered females were significantly less likely to fight than two intact males together, which fought in all 3 pairings, ($p = .018$) or two neutered females together, which fought in all 7 pairings, ($p = .001$).

Weight

To determine whether differences in fighting behavior might be attributed to differences in weight between opponents, weights were taken for 19 animals: 12 males (M = 1229g, SD = 268g) and 7 females (M = 877g, SD = 268g). Weights ranged from 570g to 1700g. Twenty-one pairings where the weights of both animals were known were analyzed. The difference in weight between opponents ranged from 0 to 795g. The difference in weights between pairs that fought (N = 14, M = 234g, SD = 215g) and pairs that did not fight (N = 7, M = 452g, SD = 108g) was not significant (t = 1.971(19), p > .05).

Initiators and Winners

Male/female pairings were analyzed to determine if males or females were more likely to initiate a fight. In 14 pairings that resulted in a fight, six of them were initiated by the male and eight of them were initiated by the female. This difference was not significant (binomial, p > .05). In intact/neutered pairings, there were seven fights, one initiated by the neutered animal and six initiated by the intact animal. This difference was also not significant (binomial, p > .05).

The initiator of the fight was significantly more likely to be the winner of the fight: 20 initiators won out of the 27 fights where a winner could be clearly determined (binomial, p = .01). Males were not significantly more likely to win than females (males won in 8 of 11 male/female pairings, binomial, p > .05). Intact animals were significantly more likely to win than neutered animals in intact/neutered pairings (the intact animal won in 7 out of 7 pairings with a clear winner, binomial p = .0078).

EXPERIMENT 2

Materials and Methods

Subjects

Seventeen pairs of ferrets that fought during their trial in Experiment 1 were tested in the pretest for Experiment 2. The composition of these pairings and their data may be seen in Table 4.

Pairings

Of the seventeen pairs pre-tested, ten pairs engaged in true fighting during the pretest. These ten pairs that fought during the pretest were randomly assigned to the experimental condition (maximum pre-exposure) or the control condition (minimum pre-exposure). Groups were created with similar proportions of gender and neutering variables, when possible. For example, since there were two pairs of intact males, one was randomly assigned to the experimental group and the other was assigned to the control group.

Apparatus

Trials occurred using the same portable test arena and video equipment described in Experiment 1. In addition, for the experimental condition, ferrets were housed in wire cages of various sizes, either modified by a wire mesh divider to house two ferrets side by side or in smaller cages clipped side by side. Ferrets from the control group remained in their separate home cages, which also varied in size. For both conditions, animals paired together came from separate rooms of the rescue shelter or even from separate

homes, when possible. Pairs that did live in the same room did not live in adjacent cages and likely had minimal sensory information that could establish familiarity.

Procedure

Data were collected during the spring (May and June). Each of the 10 pairs (5 pairs in the control group, 5 pairs in the experimental group) was placed in the test arena (described in experiment one) and videotaped for 10 minutes as a pretest, then assigned to the control group or the experimental group as described above. The 5 pairs in the experimental group were housed in the divided or side-by-side cages and rotated between sides every 24 hours for two weeks. Since ferrets at the rescue shelters were let out of their cages at least one hour a day for play and exercise, subjects in the experimental group were returned to their normal social group each day during this period. Since in any one room, ferrets from multiple cages were not let out simultaneously, playtime did not result in unintended pre-exposure. The 5 pairs in the control group continued to get play and exercise time with their cage mates as well.

After two weeks (during which the experimental pairs lived side-by-side) each pair was again tested in the portable test arena. Fighting behavior was scored as in Experiment 1. A Fisher's exact test was used to determine if the control group was more or less likely to fight than the experimental group after the two weeks of different pre-exposure conditions. A two-way ANOVA, one-factor between and one-factor within, was used to analyze differences in the latency to fight as functions of condition (experimental vs. control) and test (pre-test vs. second test).

Results

One pair from the control group and one pair from the experimental group did not fight during the second test, although this may have been because of successful avoidance of the aggressor. The other four pairs in the control group and the other four pairs in the experimental group still fought. Therefore there was no difference between the control group and the experimental group in fighting behavior two weeks after the pre-test (Fisher's exact test, $p > .05$).

Latency to fight was again used as a measure of aggression for the control group ($N = 5$, pre-test, $M = 215.2$, $SD = 203.9$; second test, $M = 317.6$, $SD = 239.5$) and the experimental group ($N = 5$, pre-test, $M = 181.6$, $SD = 130.7$; second test, $M = 214.6$, $SD = 230.9$). An ANOVA did not indicate a significant interaction for condition x test ($F = .246$ (1,8), $p > .05$). There were also no significant main effects for the between-subject variable, condition ($F = .388$ (1,8), $p > .05$) or the repeated measures variable, test ($F = .935$ (1,8), $p > .05$).

DISCUSSION

As predicted, cage mates didn't fight. However, more than half the strangers placed together did fight, so it is definitely an issue that a pet owner is likely to face when introducing new ferrets. The fights often involved sustained bites and even shaking of the immobilized ferret that might result in injury. The attacked ferret usually screamed and sometimes urinated and defecated while attempting to flee. Such behavior is likely to adversely affect both pet and owner, and the behavior should be avoided if possible. At the rescue shelters where most of the data were collected, new animals were brought in on a regular basis. Because of space and time constraints, it would be more efficient to be able to introduce these new ferrets into already established groups.

The principal question posed by this study was, which variables predict the likelihood of a fight between a pair of strange ferrets? Time of year did not seem to have an effect, even on intact animals that are most likely to have seasonal changes in hormone levels. This is probably because the animals are kept in artificial lighting that does not mimic the lengthening days that trigger the breeding season in ferrets. Both rescue shelter owners said that the intact males tend to stay in season longer (testes are descended) than the literature indicates for a normal breeding season. When they do come out of season, it does not seem to coincide with the seasons as described in the literature. Females come into heat once or twice a year, but also not congruent with the seasons as described in the literature.

Based on the literature, it was predicted that intact males would be highly aggressive, attacking any ferret that they were placed with (Poole, 1973). Pairings of two intact male strangers did result in a fight every time. Such fights were not more intense than those produced by pairing an intact male with an intact female. Aggression was low, though, when intact males were paired with neutered females. As predicted, intact males are not indiscriminately aggressive.

Females were not, in general, less aggressive. In fact, there was a fight every time a neutered female was paired with another neutered female for the first time. Neutered females were not indiscriminately aggressive, however, as neutered females were not as aggressive when paired with an intact male.

Aggression in neutered ferrets had not been previously studied, but based on findings in other species it was predicted that neutered animals would be less aggressive than intact animals. The data, however, indicated that pairs of neutered males were not less aggressive than pairs of intact males. Pairs of intact females were not tested. When a male and female were paired, two neutered animals were actually more aggressive than an intact animal with a neutered animal. The least aggressive pairings, with no fighting in any of the encounters, were intact males with neutered females.

These findings indicate that individual variables, such as gender or neutering, cannot predict aggression. For example, intact males were not always aggressive. Instead, it is important to examine the interaction of variables between the two individuals being introduced. An intact male placed with another intact male was highly aggressive and a neutered female placed with another neutered female was highly

aggressive, but an intact male placed with a neutered female was not likely to be aggressive.

In a survey of behavior problems in dogs, Wright and Nesselrote (1987) found that intact males had the highest frequency of aggression problems with other dogs and neutered females had the second highest levels of aggression. While in dogs the solution may be to neuter males and leave females intact, this solution would not be appropriate with ferrets. Neutered male ferrets make excellent pets, but intact female ferrets do not. A female ferret will remain in heat for three to nine months if she is not mated (Lloyd, 1999). During this time she will eat less and sleep less, lose hair, and become quite sick. Breeders must put intact females with a vasectomised male, or give their intact females hormone treatments (either human chorionic gonadotropin or proligestone, according to Lloyd, 1999), to induce ovulation if they are not going to be bred. Fortunately, pet stores sell male and female ferrets that have already been descented and neutered. It should also be noted that the tests for gender and neutering effects were on small samples that required a conservative statistical test, the Fisher's exact test. Additional gender and neutering effects may be present, but not detected in this study.

In Experiment 2, familiarity, as manipulated here, did not reduce fighting. In fact, owners reported that some aggressive behavior occurred across the wire divide between pairs in the experimental group. In some monkey species, gradual introductions may actually increase aggression between strangers, as conflict resolution is not possible (Bernstein, 1991).

Other methods of introduction have been tried in other species that may be effective in ferrets. For example, two groups of cage mates may be introduced at once.

While this did not result in more or less aggressive encounters than individual introductions in Rhesus monkeys (*Macaca mulatta*, Fairbanks, et al., 1978), it may be more effective with ferrets. Other methods of introduction focus on the characteristics of the introduction area. Increasing the number of hiding spaces in the introduction area has had mixed results in reducing aggression in several monkey species (Fairbanks, et al.,1978). The familiarity of each animal with the introduction area has been found to affect aggression in many species, including European rabbits (Mykytowycz & Hesterman, 1975).

In summary, unfamiliar ferrets are more likely to engage in aggressive behavior than familiar animals. The best advice, then, would be to buy or adopt ferrets in pairs, not singly, if multiple ferrets are desired. Mixed pairings of a male and a female or two males are the least likely to result in aggression when a new neutered pet ferret is introduced. All introductions should be monitored carefully to break up fights that could result in injury.

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Table 1. Descriptions of subjects and cage groupings (cages may have included other ferrets not included in the study and therefore not listed here)

Name	Sex	Descented	Neutered	Weight (grams)
Last Chance Ferret Rescue				
Cage1				
Willow	F	Yes	Yes	
Dreamer	M	No	No	1590
Cage 2				
Squirt	M	No	No	1475
Hobbs	M	Yes	Yes	1020
Suzie	F	Yes	Yes	910
Juice	M	Yes	Yes	1020
Casper	M	Yes	Yes	1250
Unnamed #1	F	Yes	Yes	910
Unnamed #2	F	Yes	Yes	795
Unnamed #4	F	Yes	Yes	910
Gulliver (U#5)	M	Yes	Yes	910
Bandit (U#6)	M	Yes	Yes	1020
Cage 3				
Austin	M	Yes	Yes	1700
Hazel-Ra	M	Yes	Yes	1360
Babycakes	F	Yes	Yes	570
Cage 4				
Snowy	M	Yes	Yes	910
Bear	M	Yes	Yes	1360
Cage 5				
Lucky	F	Yes	Yes	910
Harley	M	Yes	Yes	
Cage 6				
Frankie	F	Yes	Yes	1135
Fred	M	Yes	Yes	1135
Cage 7				
Buffy	F	No	No	
Jasmine	F	No	No	
Cage 8				
Coatie	M	Yes	Yes	
Scottie	M	Yes	Yes	
Ariana	F	Yes	Yes	
Halley	F	Yes	Yes	
Cage 9				
Jasper	M	Yes	Yes	
Rascal	F	Yes	Yes	
Gun	M	Yes	Yes	

Name	Sex	Descented	Neutered	Weight (grams)
Last Chance Ferret Rescue (cont'd)				
Cage 10				
A	M	Yes	Yes	
B	M	Yes	Yes	
C	M	Yes	Yes	
D	F	Yes	Yes	
Cage 11				
Diesel	M	No	No	
Frankie	M	No	No	
Cage 12				
Dexter	M	Yes	Yes	
It's Raining Ferrets				
Cage 1				
Chewie	M	Yes	Yes	
Cassandra	F	Yes	Yes	
Cage 2				
Hanky-Pank	M	No	No	
Cage 3				
Miranda	F	Yes	Yes	
Cage 4				
Elijah	M	Yes	Yes	
Brawny	M	Yes	Yes	
Max	M	Yes	Yes	
Nippers	M	Yes	Yes	
Cage 5				
Flyers	F	No	No	
Cage 6				
Cinnabar	M	No	No	
Cage 7				
Caleb	M	No	No	
Cage 8				
Yentl	F	No	No	
Cage 9				
Rachael	F	No	No	
Cage 10				
Abner	M	No	No	
Household #1				
Cage 1				
Jingle	F	Yes	Yes	
Maudie	F	Yes	Yes	
Cage 2				
Casey	F	Yes	Yes	
Sugar	F	Yes	Yes	

Table 2. Pairings tested in Experiment 1 (with number of fights in parentheses)

Strangers

Spring

	Male/male	Male/female	Female/female	
Neutered/neutered	8 (5)	11 (8)	8 (7)	
Neutered/intact	7 (4)	8 (2)	3 (1)	
Intact/intact	3 (3)	5 (3)	0 (0)	
				Total = 53 (33)

Winter

	Male/male	Male/female	Female/female	
Neutered/neutered	6 (1)	8 (4)	4 (4)	
Neutered/intact	5 (3)	3 (1)	0 (0)	
Intact/intact	2 (2)	1 (1)	0 (0)	
				Total = 29 (16)

Cage mates

Spring

	Male/male	Male/female	Female/female	
Neutered/neutered	5 (0)	9 (0)	3 (0)	
Neutered/intact	0 (0)	3 (0)	0 (0)	
Intact/intact	1 (0)	0 (0)	0 (0)	
				Total = 21 (0)

Winter

	Male/male	Male/female	Female/female	
Neutered/neutered	4 (0)	4 (0)	2 (0)	
Neutered/intact	0 (0)	0 (0)	0 (0)	
Intact/intact	0 (0)	0 (0)	0 (0)	
				Total = 10 (0)
				Grand total = 113 (49)

Table 3. Numbers of fights/ number of total pairings for first-time meetings between strangers in Experiment 1

	Male/male	Male/female	Female/female
Neutered/neutered	5 fights/9 pairings (55.6%)	9/13 (69.2%)	7/7 (100%)
Neutered/intact	4/7 (57.1%)	2/8 (25%)	1/3 (33.3%)
Intact/intact	3/3 (100%)	3/5 (60%)	0/0

Table 4. Pairings tested and results for Experiment 2

Animal 1	Animal 2	Pre-test	Condition	2nd Test
Neut. male	Neut. male	No fight		
Intact male	Intact male	Fight	Exper.	Fight
Neut. fem.	Neut. fem.	No fight		
Neut. fem.	Neut. fem.	Fight	Exper.	Fight
Neut. fem.	Neut. fem.	Fight	Control	No fight
Neut. male	Intact fem.	Fight	Control	Fight
Neut. fem.	Neut. fem.	No fight		
Intact male	Neut. fem.	No fight		
Neut. male	Neut. fem.	No fight		
Neut. male	Neut. fem.	Fight	Control	Fight
Intact fem.	Neut. male	Fight	Exper.	Fight
Neut. fem.	Neut. male	Fight	Exper.	Fight
Intact male	Intact male	Fight	Control	Fight
Neut. fem.	Neut. fem.	Fight	Exper.	No fight
Neut. male	Neut. fem.	No fight		
Neut. male	Neut. fem.	No fight		
Neut. male	Neut. male	Fight	Contol	Fight

APPENDIX

Literature Review

The Domestic Ferret

The most commonly used Latin name given for the domestic ferret is *Mustela putorius*, meaning "smelly weasel" (Lloyd, 1999). This is also the scientific name used for the European polecat, from which the domesticated ferret is most likely derived (Lloyd, 1999; Chivers & Einon, 1981; Moody, Bowman & Lang, 1985; McKay, 1989; Zeunner, 1963). European polecats and domesticated ferrets can interbreed and their offspring are fertile (Poole, 1967). Other scientific names for the domestic ferret are used, distinguishing it as a separate genus, species, or sub-species from the European polecat. These include *M. furo* (Chivers & Einon, 1981), *M. putorius furo* (Moody, Bowman, & Lang, 1985), and *Putorius putorius furo* (Zeuner, 1963).

Regardless of the nomenclature used, the domestic ferret is a small, furry carnivore averaging 400 to 2000 grams as an adult, 35 to 60 cm in length, with a lifespan of 8 to 12 years (McKay, 1989). Ferrets are in the same family, Mustelidae, as marine otters (*Lutra felina*), minks (*Mustela vison*), skunks (*Mephitis mephitis*), and the endangered North American black-footed ferret (*Mustela nigripes*). The ferret was likely domesticated from the European polecat for rabbit hunting, possibly as early as 450 B.C. The first undisputed reference to the domestic ferret is by Strabo in Geographica, in 63 B.C. (McKay, 1989). Both wild-caught European polecats and domestic ferrets are still used for hunting rabbits in Great Britain and other countries (Wellstead, 1982). There are small differences in skull measurements between domestic ferrets and polecats, and polecats are also described as more vigilant and more agile (Wellstead, 1982).

Aggression in Ferrets

Poole (1967, 1972, 1973, 1974, 1978) created a detailed ethogram of behavior occurring during fights in polecat and ferret x polecat hybrids. Behavior was classified as aggressive and defensive, and each animal was given an aggression score based on its behavior during an encounter. Poole (1973) also classified animals as dominant (shows no fear, initiates fights, and does not vocalize when fighting), subordinate type A (shows defensive behavior to some but not all individuals), subordinate type B (shows fear to all opponents, even on first meeting), or an intermediate type (does not initiate aggression but fights if attacked, breaks off a fight after winning, appears not to be intimidated, and seems to have low motivation for fighting or fleeing). Subordinate animals show restricted movement around dominant animals and defensive behavior when attacked, including hissing and screaming.

Play Fighting in Ferrets

Play fighting is described only among juveniles in polecats (Poole, 1978). Play is distinguished by its jerky, bouncy movements and inhibited attacks. Chasing and flight are more common in play (23% of the time) than in true fighting (10%). Unlike many species, polecats do not alternate roles of attacker and defender during play fighting. Behavior that Poole describes as meta-communicatory is common during play and absent during serious fighting. In play, a fleeing animal often turns its back to show "open mouth" to an opponent, which may be an invitation to chase. The bouncy movements of locomotion in play may also serve as an invitation to play. These signals make up 58% of behavior during play bouts. They are often repeated, occurring in 96% of 10-second intervals (Poole, 1978).

Ritual Fighting in Ferrets

Adult aggression, for many species, has been described as ritual fighting, marked by displaying and by inhibited attacks more than by actual physical encounters that may result in injury. Poole (1967) describes the fighting that occurs between strange males during the non-breeding season as ritual fighting. Bites are inhibited (they do not make contact or are immediately released on contact) and opponents do not show fearful behavior such as screaming or fleeing. A similar form of inhibited fighting is described for cage mates, but Poole (1973) refers to this behavior as companion fighting. Like ritual fighting, companion fighting involves inhibited biting with no evidence of intimidation. Unlike play, companion fighting and ritualized fighting are sustained and the typical exaggerated movements of play are absent.

In some species, including the polecat, uninhibited fighting also occurs, and this is the type of fighting that ferret owners would prefer to avoid if possible. Ferrets and polecats have tough skin on the back of the neck where 83% of the bites in a fight are directed (Poole, 1974). A thick layer of fat under the skin prevents severe injury from bite wounds that puncture the skin. Finally, strong neck muscles protect the vertebrae when ferrets are shaken during a bite.

Factors that affect aggression

This dissertation considered the effects of familiarity, season, gender, neutering, and method of introduction on aggressive behavior in domestic ferrets. There are other factors that may affect aggression that were not included in this study.

Scent. Ferrets that are sold as pets in the United States usually have had their anal sacs removed during the neutering procedure. While this reduces their odor, some musky

scent remains from the sebaceous and apocrine glands (Moody, Bowman, & Lang, 1985). Scent reduction surgery is much less common in Great Britain, where ferrets are often kept for hunting and the procedure is considered unethical by some (McKay, 1989). In fact, in the U.S. the population of ferrets that has been neutered but not descented is quite small, originating mostly from private breeders. Since animals that have not been neutered still have intact anal sacs, it would be difficult to determine if differences in behavior between intact animals and neutered animals were associated with neutering or with the lack of scent glands.

Ferrets with anal sacs intact may release a strong odor if hurt or aroused (Willis & Barrow, 1971). Ferrets may also use the anal sacs for scent-marking behavior (Clapperton, 1989). Clapperton, Minot, and Crump (1988) found that ferrets were less aggressive when in the presence of an opponent's scent than when in the presence of their own or an unfamiliar scent. Therefore it is possible that opponents of ferrets with intact scent glands may be less likely to initiate a fight. Since this study focused on intact ferrets and typical pet ferrets (neutered and descented), the effects of scent and scent gland removal on aggression between strangers were not tested.

Social isolation. European polecats are usually solitary animals (Norbury, Norbury, and Heyward, 1988). In only two of 41 dens excavated were two ferrets found denning together. In labs and in households, however, polecats and ferrets are typically housed in pairs or larger groups. Even when given individual nest boxes, a large group of 24 ferrets invariably slept piled in two or three of those boxes (Poole, 1973).

MacLennan and Bailey (1969) found that in minks, as in many other species, solitary animals were more aggressive than socially living animals, except during the

breeding season, when both groups were equally aggressive. It was not possible in this study to test the hypothesis that domestic ferrets are also more aggressive when kept in social isolation, since the only animals living in single cages were usually put in separate cages because they were more aggressive to others.

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