CREATURE COMFORTS: METHODS TO MAXIMIZE CAPTIVE SILVER FOX PRODUCTIVITY BY THOUGHTFUL MANAGEMENT PRACTICES

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Abstract ZOOL 795: Independent Investigation

The degree of interest in the silver fox (*Vulpes vulpes*) as a model for biological and ethological study has increased greatly since the development of a domesticated line at the Institute of Cytology and Genetics in Novosibirsk, Siberia. This research has produced impressive amounts of data in varied studies involving many scientific realms. Much of this research focuses on the welfare of these captive animals, which remain a profitable source of income for fur farmers. This review discusses some of the management practices that have proven beneficial to the welfare of captive silver foxes. It then addresses the potential outcomes of the application of these techniques, i.e. how they may be beneficial to both the researcher and businessman.

1. Introduction

Before the welfare of captive animals can be quantitatively measured, the definition of welfare must be understood within a biological context. A report by the European Scientific Committee on Animal Health and Welfare defines welfare as "the state of an animal as regards its attempt to cope with its environment." The state to be measured remains at the discretion of the reader, but options that should be considered include the physical, behavioral and mental state of the animals.

The primary question facing the success of a species in a captive environment is their ability to adapt to a restricted environment. Species that show high versatility and flexibility will be more likely to adapt to this new environment. However, dramatic changes are expected to coincide with this removal from their natural niche and

introduction into a much more restrictive environment. These changes occur primarily at the behavioral and physiological level. At the behavioral level, the characteristics of captivity may reduce or eliminate an animal's ability to express certain species specific behaviors. This can subsequently cause changes at the physiological level, often expressed as a non-specific neuroendocrine response known as the stress response. Often it is the physical changes generated by these restrictions that are used to gauge animal welfare (The Welfare, 2001). Researchers use behavioral and physiological tests to measure these physical changes, the data is often then used to infer the mental state of the animal to express the final assumed welfare of the animal. Fear has been defined as a negative feeling associated with stress (Rekila, 1997). Applying quantitative data to internal states or feelings such as fear or confidence is not scientifically ideal. However it is a useful way to summarize the general motivational state of captive animals.

Extensive scientific research has been conducted on silver foxes. Many of these studies were funded wholly or in part by fur farming associations (Ahola, 2002; Bakken, 1993; Moe, 1995; Pedersen, 1990) directly or indirectly interested in profit maximization. These studies show that simple management techniques can greatly increase the welfare of captive silver foxes by providing a captive environment that is based on an understanding of the biology of the species.

2. Management Considerations

a. Group Size and Space Allocation

Perhaps the most obvious difference between the natural and captive world of the silver fox is the amount of space available to an individual. Although realistic environments may exist for some species (in large breeding parks, for example), farm foxes are primarily kept in cages, with space reduced for convenience and economic reasons. For the same reasons, caretakers may also alter group sizes. This is also a useful method to limit disease spread or to preclude or promote mating (Price, 1999). Unfortunately, these changes are likely to cause harmful consequences in the subjects involved.

In a comprehensive study, Leena Ahola varied group size and space allocation in 98 captive silver fox cubs while measuring a number of behavioral, physiological and production-related effects. Upon weaning, the foxes were divided into five different housing systems comprised of one, two or four member groups and space allocations of $1.2m^2$ or $0.6m^2$ available per individual. The multiple parameters measured indicated that space allocation had only a limited effect on the welfare parameters measured in the study. However, varying social conditions (group size) was shown to have an effect on the behavior and fur quality of the foxes.

Video-recordings analyzed by Aloha and her team were used to assess the behavior of the captive foxes in the varying housing situations. In the examination of locomotor stereotyped behavior, a significant difference was found between singly

housed cubs and cubs housed in pairs or in quartets (Figure 1). Ahola states that "the occurrence of stereotyped behavior in group L1 suggests that some cubs housed singly… may have had poorer welfare, e.g. they were frustrated because did not have any cage mates." This use of emotion (frustration) as a gauge of welfare is non-scientific, but is meant to indicate that the cubs are far removed from the social and environmental stimulants of the wild.

Another interesting analysis performed by Ahola included professional fur graders evaluating pelt quality at the conclusion of the study. The 10-point scale used to evaluate each pelt showed quality decreased with increasing group size and with decreasing space allocation. The poorest quality furs were found within a four-cub group housed in a small space allocation. Females living in small cages also showed a significantly higher number of bite wounds than females given more space. These crowded females seemed to be less able to avoid aggressive encounters with cage mates (Ahola, 2002).

b. Conspecifics

In the study by Ahola, crowded female foxes produced the lowest quality furs. This reduction in fur quality is one important economic consideration for fur farmers, but it is not the only parameter affecting profits. Because female individuals play a central role in fox farms, their reproductive success is often directly related to the success of the farm. However, it is not uncommon for some vixens to display poor reproduction, including barren individuals, or cub loss due to fetal reabsorption, abortion, negligence,

or infanticide (Bakken, 1993). One study has found evidence that these behaviors may be a result of the gender and proximity of conspecifics within the fox farm.

Cub-killing has long been assumed by fur farmers to be a maladaptive behavior as a consequence of environmental stressors (Bakken, 1993). This "environmental disturbance" hypothesis was challenged by an intriguing study by M. Bakken who initiated a study of female farm foxes in an effort to predict the causes of barren females and cub-killing. Bakken hypothesized that these seemingly maladaptive reproductive behaviors were actually adaptive and controlled by social factors. This social control hypothesis proposed that the captive females were influenced by social factors identical to those experienced in wild fox populations. In the wild, only dominant females in the group usually rear cubs (Bakken, 1993). Thus, in fox farms, high-density populations are a suboptimal condition for high reproductive output.

Bakken used 16 two-year old vixens that had killed or harmed all of their cubs in their first breeding year to test his hypothesis. These vixens, which had been formerly housed using standard farming practices, were placed in single sheds before the onset of their second breeding season. The vixens were visually and spatially isolated, yet could to some extent hear and smell other vixens. The reproductive performance of the first and second breeding season were then compared. Figure 2 shows the number of cubs born (means + SE, open column), and the number of cubs weaned unharmed (means + SE, hatched column). Although the average number of cubs birthed from the vixens remains the same in both the first (A) and second (B) season, the vixens raised some cubs

unharmed only in the second season. This data suggests that animal density may have some effect on the regulation of maternal behavior in captive silver fox females. However, the vixens still harmed and killed some cubs in the second breeding season, and the isolation effects only accounted for 19 percent of the overall variation in the number of cubs weaned unharmed.

c. Handling

In the wild, animals will generally avoid close encounters with man. Yet captivity brings these two species into extremely close proximity, with variable results. Over a period of time, a captive species may come to experience humans as a positive social object or companion, as is common in dogs. To a lesser degree, humans may act as secondary reinforcers as they become associated with primary reinforcers such as food (Price, 1999). Experience plays a large role in the individual animal's reaction to humans, and early handling may provide a particularly strong effect on this behavior in captive animals.

V. Pedersen and L.L. Jeppesen developed a study to assess the effects of cub handling during the early weeks of development. 32 cubs were assigned to an experimental group that were fondled and talked to for one hour every week from 2 to 8 weeks of age. The sensitive primary socialization period of the silver fox has been estimated at 60-65 days in domestic breeds, therefore handling ended approximately with the closure of that period (i.e. the onset of the fear response) (Plyusnina, 1991). 46 control cubs born of different mothers were not exposed to human touch. Beginning on

the 12th week, and then again in the 15th, 18th, and 20th week, all cubs were tested using three behavioral tests. In the human test, the experimenter approached the cage, established eye contact, and recorded the behavior of the fox – aggressive, fearful, inquisitive, or passive. In the strike test, the experimenter raised a hand, waited till the fox looked at it, and then moved the hand quickly towards the cage without striking it. The ensuing agonistic reaction was rated on an index, from 1 (offensive attack) to 6 (escape). In the glove test, a rubber glove on a stick was put into the cage; the behavior of the fox was noted as a response to this as in the human test.

Pedersens tests were designed to help determine the overall fear response of the foxes towards humans, and determine if early handling could alter these responses. The in-cage behavioral tests returned significant results, showing that "handled subjects, irrespective of age, were less fearful and more inquisitive or alert compared with control subjects ($P<0.01$, χ^2 test, two-tailed) [Pedersen, 1990]. The figures 3, 4, and 5 below display the results of the human, strike, and glove test, respectively. Figures 3 and 5 show a dramatic increase in inquisitive behavior, as well as a reduction in fearful responses between the handled animals (H) and the control animals (C). In figure 4, the reactions to the strike test indicate that the handled animals were much less fearful of the human experimenter, i.e. were more alert but less likely to show escape behaviors. Another important factor in this study is that the behavior of the handled foxes seems to stay relatively constant over each of the trials. This suggests permanence in the observed behavior changes. Pedersen and Jeppesen theorize that this altered reactivity to the behavioral tests indicates reduced stress sensitivity in the handled animals. Additional

testing suggests that this stress-reducing effect changes not only the response to humans, but fear levels and exploratory behavior in open-field tests (Pedersen, 1990).

d. Data Gathering

With many captive silver foxes being used for research, there is often considerable sampling being done on the population. This may include invasive procedures such as blood analysis and body temperature tests, as well as simple procedures like counting the number of cubs born to a vixen. In an effort to minimize stress to the subjects, some researchers have developed less invasive ways to gather data.

As seen throughout this discussion, much of the research on promoting welfare in captive silver foxes involves ethophysiological data. Randi Oppermann Moe et al noted this trend and the fact that the testing procedures involved, including the mere presence of humans, were often severe stress factors in farm foxes (Moe, 1993). In response, Moe initiated a study in which radio transmitters were surgically implanted into 18 silver fox vixens. These devices were able to monitor heart rate, core temperature, and locomotor activity, all which are parameters prone to change during stressful events. Moe et al hypothesized that this technology could be used to gather behavioral and physiological measurements in captive furbearers while minimizing intrusiveness and the stress response.

Overall, the implantation surgery was well tolerated by the foxes, although one individual was euthanized 3 months after surgery due to complications that may have due

to the presence of the transmitter within the abdomen. Hematological comparisons between the day prior to surgery and 13 days post-op revealed a return to standard WBC and neutrophil count, but a decrease in eosionphil count following surgery (Figure 6). Eosinophils have been previously used as a stress indicator in the silver fox, which can drop due to physiological stress (Moe, 1995). The monitors, transmitters, and receivers showed a high success rate in their functioning. This is partly due to a change in implantation methods over successive trials. The final method, including a during-pregnancy surgery and secure ECG leads showed a 100% success rate 10 days after surgery of all data- ECG, temperature, and activity (Figure 7).

This research indicates that advanced technology can provide vital data while causing minimal stress, although the types of data available through this particular method remain limited. Moe et al close with suggestions for the future use of this method, including the theory that struggling during handling caused a retraction of the ECG leads, which may have caused the reduced success in earlier trials. For further review of this method, see Bakken, 1993 [Radio telemetry: a method of evaluating stress and learning ability in the silver fox (*Vulpes vulpes*)].

Other researchers have used a variety of mechanisms to reduce or eliminate sampling stress. To test for the concentration of urinary cortisol as an indicator of stress, M Harri (2003) collected urine using a funnel constructed below the cages. In the same study, Harri used a specific method to conduct a field test with a minimum amount of stressful variables. After being removed from their cage, the foxes were carried to the

testing area inside of an opaque box. The open field arena itself was purposefully created using opaque walls to reduce the chance of a deviant stress response. It was not until after the experimenter left the area (and the fox had 60 seconds to calm down), that the fox was released into the arena and testing began. This was facilitated by a remotely controlled sliding door (Harri, 2003). Other researchers have utilized similar methods during the field test, such as ensuring that no humans were visible (Pedersen, 1990). However not all researchers go to the extent of Harri, as in the Pedersen study of stress responses the foxes were dropped into the field arena directly by human operated neck tongs, and response evaluation began immediately.

3. Benefits

Cooperation between fur farmers and research scientists is a necessary component for mutual success. Access to different fox farms allows researchers an enormous opportunity to study captive fox behavior and physiology, as well as the effects of domestication. If the research results in a better understanding of captive silver fox welfare, fur farmers will have the opportunity to apply this knowledge to their business. The studies mentioned in this review have certainly suggested a variety of management techniques that can be used to improve captive silver fox welfare. The benefits to the fur breeding industry from the implementation of these procedures will now be discussed.

Research has shown that a singly caged fox is more likely to exhibit stereotyped behaviors (Ahola, 2002). This is an obvious decrease in the welfare of the fox. Housing

foxes with other members of their species until their natural dispersal time will increase the welfare of the fox (Ahola, 2002). A potential benefit of this is to reduce idle time, which can lead to destructive behaviors (Price, 1999) that may directly (chafing) or indirectly (stress response) reduce fur quality. The Ahola study also indicated that crowded animals have a reduced fur quality, especially for females who became more aggressive in high densities.

The data gathered can also be used to make some assumptions. It can be assumed that crowded females are under higher levels of stress. If these females are later used for breeding, fetal development may be influenced by this chronic stress response. Alternatively, females provided with appropriate space and cage mates may be generally healthier. Thus, the environment provided by the keepers can affect the welfare of both the mother and unborn cubs.

Similar research by Bakken (1993) showed that female proximity has a significant effect on the reproductive success of female silver foxes. In the study, females in standard housing conditions harmed many of their cubs their first breeding year, but the numbers reduced significantly when isolated the next season. It can be assumed that the unharmed cubs have a higher welfare, and will develop under less stressful conditions than their harmed counterparts. Additionally, infanticide reduced when the females were isolated. This is obviously an important factor, as cub death causes a loss of not only that cub's future fur, but in females, any offspring they would have birthed.

The research by Pedersen and Jeppesen investigating different handling procedures on later behavior of fox cubs showed strongly that handled cubs were less fearful of humans as adults. Additionally, they showed less escape behaviors during the previously discussed strike test. The proposed explanation for this altered behavior is a reduced stress sensitivity, which contributes to the welfare of the foxes. Individuals with lower stress levels can be expected to adapt better to the captive environment, including more normal behavior and physiology. This increase in the health of the animal will very likely affect the quality of the animal's body, including their fur. It also has obvious implications concerning the ease with which workers can mange the foxes.

Thoughtful data gathering methods are an important aspect of fox farms. When fox breeders allow researchers to use their animals as subjects in experiments, they expect their animals to be returned intact. As it becomes apparent that some sampling techniques can affect the welfare of the foxes, it is important for researchers to try to implement techniques that will not cause negative consequences.

4. Conclusions

By applying scientific knowledge to fox farm management, business owners may see a rise in profits due to higher reproductive success, higher fur quality, and animals that are easier to manage. For these reasons it is expected that many fur farmers will be interested in the application of some or all of these techniques. In fact, many have already shown their support for the research and techniques, as seen by the high funding

levels in the various studies. Yet profit maximization is not the only benefit of an increased welfare of farm foxes. Scandinavian fur breeders have experienced pressure from animal rights groups, insisting on the use of foxes that can live without stress in captivity (Trut, 1999). Other breeders may choose to use these methods to increase fox welfare not due to any outside pressures, but because of moral considerations for the foxes themselves.

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