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The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK

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Welfare and mate choice in zebra finches: effect of handling regime and presence of cover

SA Collins*†, JA Archer‡ and CJ Barnard‡

† School of Biology, Portland Square, University of Plymouth, Drake Circus, Plymouth, PL4 8AA, UK
‡ Animal Behaviour & Ecology, School of Biology, University of Nottingham, University Park, Nottingham, NG7 2RD, UK
* Contact for correspondence and requests for reprints: sarah.collins@plymouth.ac.uk

Abstract

Much attention has been focused, quite rightly, on the welfare of laboratory rodents and farm animals but certain other groups have been less well represented in welfare research. Small birds, for example, are often kept as pets and used in a wide variety of behavioural and physiological experiments where 'best' housing conditions are based on advice from experienced keepers as opposed to being tested experimentally. We investigated the effects of two husbandry conditions on the welfare of captive zebra finches: a) optional cover and b) rewarded handling versus random rewards. As a correlate of welfare in the four conditions (cover + reward, cover, reward, nothing), we recorded the time to settle and perform normal behaviours after an experimenter entered the room throughout the study (ie habituation to disturbance). In addition, we measured female preference for males in the four conditions to see whether welfare situation affected attractiveness as a mate. Birds in the two conditions where a reward was provided settled most quickly; and their settling time decreased across the study. Birds provided with cover alone became more disturbed by the entry of the experimenter as the study progressed. However, the birds taking longest on average to settle were those in cages with no cover and no reward. Females preferred males in the reward conditions as mates, either due to the fact that these males settled more quickly or because less-stressed males are more attractive in some other way. Thus, rewarding birds after disturbance is an effective and simple way to improve habituation to handling and human presence. In addition, these birds are more attractive to females, implying that males more habituated to captivity may be preferred as mates. Provision of cover may help under certain circumstances, but appears paradoxically to lead to increased fearfulness over time under the conditions studied here.

Keywords: *animal welfare, cage birds, handling reward, husbandry, mate choice, zebra finch*

Introduction

Housing conditions have long been a major concern in animal welfare (Nicol & Dawkins 1990). Aspects of husbandry affect both the animals' behaviour and physiology (Hurst *et al* 1996; Würbel 2001; Olsen *et al* 2002). The vast majority of work conducted on the welfare effects of husbandry practices has been carried out on poultry (Dawkins 1981; Scott & MacAngus 2004; Sheilds *et al* 2004), other farm animals (Kettlewell & Mitchell 1994; Olsen *et al* 2002; O'Connell *et al* 2004;) and rodents (Hurst *et al* 1996; Nevison *et al* 1999, 2000) However, Home Office records show that at least 9,600 'other birds' (ie not poultry) were used in 2000 (Hawkins *et al* 2001). These included starlings (*Sturnus vulgaris*) and other passerines, waterfowl (various genera) and pigeons (*Columba livia*). This is an underestimate, though, of the true number used in science in the UK as many experiments do not require a Home Office licence and are not included in this number. Of the work on small birds, an estimate from published work suggests that at least 50% are conducted on zebra finches (*Taeniopygia guttata*) (eg Forstmeier *et al* 2004; Naguib *et al* 2004; Rutstein *et al* 2005). Zebra finches are not only one of the most commonly used experimental bird species, but are also kept as pets and, thus, in pet shops, and zoos. It is, therefore, surprising that so little work has been conducted on their welfare, especially given their gregarious lifestyle in the wild (Zann 1996). Husbandry protocols are based on 'best practice' advice provided by aviculturalists and scientists who have worked on the birds for many years (see guidelines in Hawkins *et al* 2001).

Jacobs *et al* (1995) investigated the effects of modest environmental enrichment on zebra finches, such as additional perches, twigs, sand and baths. However, this study was run with a sample size of only two for each condition. More recently, investigation into the welfare of captive starlings indicated that starlings should be kept under conditions with high rather than low frequency fluorescent lights (Greenwood *et al* 2004) and under light containing UV wavelengths (Maddocks *et al* 2002). However, it is clear that further work is needed to provide simple guidelines for those keeping small birds, whether as pets or in the laboratory. Our study addresses two aspects of

husbandry protocol and their effect on welfare; a) handling of birds by an experimenter, and b) the level of cover provided in the home cage.

Previous work has shown that animals can develop a fear response towards humans after repeated interactions (Kettlewell & Mitchell 1994; Hemsworth & Gonyou 1997). Since animals often require catching for husbandry purposes, it is important to reduce the aversive nature of the handling. Allowing animals to habituate to handling may reduce stress. For example, poultry given frequent positive handling from an early age showed improved welfare even compared to those given minimal handling (Gross & Siegel 1979) and, in pigs, early handling reduces the fear response to humans (Cabanac & Briese 1992; Geers *et al* 1995). Another method of reducing the aversive nature of handling may be to provide positive reinforcement after handling disturbance. Hutson (1985) found that sheep given food after an aversive handling procedure were less hesitant to repeat the procedure than the controls.

Provision of cover may be given in an attempt to provide a more naturalistic environment, or a refuge when handlers or observers are visible, so that birds are disturbed less frequently. Red deer (*Cervus elephus*) were less aggressive and reactive when they had access to shelter (Whittington & Chamove 1995). However, the reduction in the level of exposure to humans may make animals less habituated to the presence of humans and more stressed when away from cover, for example when they are to be weighed. Fear of humans can be reduced in domestic chicks (*Gallus gallus domesticus*) simply by regular visual contact with humans (Jones 1997). Thus, cover may have different welfare effects depending upon how often the birds must be disturbed or handled, eg for regular participation in experiments. Provision of cover may make birds less nervous overall, but leave them open to experiencing acute stress when exposed to novel situations or humans. Birds without cover are more likely to habituate to the presence of humans and to find experimental situations less novel and therefore less stressful.

In this study we test the effect of two handling regimes and two cover conditions on the behaviour of male zebra finches. Welfare is measured non-invasively by making behavioural observations after the entry of an observer: time to settle; time to feed and time to sing. These behavioural measures were chosen as they indicate first that the bird has stopped responding to the entry (settling) and, second, that the bird has begun to perform normal behaviours (feeding and singing). In addition, birds were exposed to a novel situation, a mate-choice experiment, and their performance measured. The results of the choice experiment also indicate how welfare state affects attractiveness as a mate. In general we predict that birds experiencing positive welfare will show fewer behavioural problems, settle more quickly after being disturbed, perform elements of their normal (ie undisturbed) behavioural repertoire and be preferred in mate-choice trials.

The aim of this study is to use zebra finches as a model species to suggest simple methods by which the welfare of small, caged birds in an experimental context can be improved.

Materials and methods

Subjects and housing

Thirty-six adult male and eight adult female zebra finches were purchased from a reputable local dealer (Pets at Home Ltd, Nottingham, UK). As it was the aim of the experiment to look into the most typical form of the species all birds were highly domesticated zebra finches showing wild type plumage. All birds were ringed with orange numbered leg rings (supplier AC Hughes, Hampton Hill, Middlesex, UK); a few birds already bore rings from unknown suppliers.

Males were housed, three to a cage (100 × 50 × 50 cm; length × breadth × height), the females in a large aviary (200 × 200 × 150 cm). The cages contained two water and two food dispensers, cuttlefish, millet spray, a birdbath and three doweling perches. Mealworms (*Tenebrio molitor*) and garden cress (*Lepidium sativum*) were provided regularly. Sand and grit were scattered regularly on the floor of the cages and aviary.

Birds were housed and tested in mate choice trials under tropical daylight tubes (which include UV frequencies) in high frequency fluorescent light fittings, (Standard 29580 F58W/54 Daylight tubes, GE Lighting, GEC, USA) and on a 14:10h light-dark cycle (white lights on at 0830h). The temperature was maintained at 28 ± 5°C.

Welfare issues

Birds were observed several times daily for injuries and aggression. Birds showing evidence of injury would have been removed had it proved necessary. Our housing protocols all followed best practice as recommended by Hawkins *et al* (2001), the only ones currently available, and do not differ from normal husbandry procedure.

Experimental conditions

The 12 cages containing three males were randomly assigned to one of four conditions such that they were distributed around the bird room to control for any location effects (eg being nearer the door). The two husbandry regime variations were as follows: a) cover versus no cover: an opaque green cloth was placed over the left third of the cage in cages in the cover condition; b) reward versus no reward: every day one bird in each cage was caught. This entailed moving all three birds into a small section of the cage using a wooden divider, catching one bird and moving him to the other side of the divider, then removing the divider (a record was kept of which individual was caught to ensure that one individual was not caught repeatedly. Subjects in the reward condition received lettuce (a preferred food) immediately after the procedure; those in the no reward condition were given the same amount at a random time but not immediately after handling, to ensure that dietary factors did not influence the results (Rashotte *et al* 2001).

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On each day of the experiment, 12 randomly chosen cages, six in the morning and six in the afternoon, were observed after the experimenter entered the room. Three behavioural measures were taken from the birds in each cage: a) the time to settle (stop flying around); b) the time to start feeding (on their usual seed — lettuce reward was given at a different time) and c) the time to start singing. The time taken in each case was for the first bird within that cage to perform the behaviour (ie cage was the unit). If none of the birds performed the above activities within 20 minutes, a time of 1,200 s was recorded. The above data were collected for 12 days.

In addition, all cages were observed randomly for 10 minutes on alternate days and the number of aggressive interactions recorded. All birds were weighed at the beginning of the experiment and at the time of the mate choice trials.

Mate choice test

When birds had been housed in the above conditions for two weeks, we conducted a series of mate choice trials using a pair-wise choice chamber (following the design of Collins & Luddem 2002). This consisted of a large central chamber (80 × 40 × 40 cm; length × breadth × height) with a mesh front and sides; two mesh-fronted wooden stimulus cages could be placed at the ends of the central chamber. All three were equipped with perches, food and water. Extra lighting was provided above the choice chamber (containing UV frequencies — see earlier).

A female was placed in the central chamber and one male in each of the two stimuli cages. Birds were allowed to settle for five minutes with an opaque barrier between the female and each of the two males (A and B) before starting the choice trial which lasted 15 minutes. In each trial the amount of time each male spent singing and the time the female spent in front of and facing each male was recorded using stopwatches. These scores were used to calculate the % female preference for each male and the % time each male spent displaying: (100 × time A/[time A + time B] in each case). The stimuli cages were swapped over half-way though the trial. In each trial males were selected from two different housing conditions, but were chosen to be comparable in size, colouring and leg band colour to control for likely potential confounding factors (Burley & Coopersmith 1987; Burley *et al* 1996).

Six tests were conducted per day in the birds' active period (between 0900 and 1400h), and no individual was tested more than once in any given day.

After completion of the first set of mate choice trials, males were assigned to new cages and conditions and the above procedure was repeated, including a second set of mate choice trials. This gave a total of six replicates for each condition. Over all choice trials, each of the eight females was tested with all possible combinations of pairings from the four conditions in the mate choice trials. Each individual male was seen from 1–4 times (mean 2.8) across the duration of the experiment.

Statistical analysis

Female choice and male display percentages were normally distributed, and male behavioural measures were square-root transformed to correct for non-normality.

Behavioural analysis

We conducted a mixed model ANOVA on the behavioural data. The model was structured as follows: cage as 'subject' — a random factor; reward and cover conditions, and cover × reward interaction, as between 'subject' fixed factors; and day of observation (1–12) as a Repeated Measure fixed factor (see: McCulloch & Searle 2000; Verbeke & Molenberghs 2000).

For the above tests the denominator degrees of freedom will not be integers, because these statistics do not have exact *F*-distributions, the denominator dfs are obtained by a Satterthwaite approximation (SPSS Technical Report 2002).

The dependent variable was time for the first bird to settle, feed, or sing in any cage (ie cage is the unit not individual). There were very few aggressive interactions so these were not analysed.

Mate choice analysis

For each male, we calculated the average percentage time females spent making their choice and the average percentage time he spent displaying for the choice trials in which he participated within a particular condition. Therefore, for each male there was a mean display and choice percentage for the first and second condition to which he was exposed.

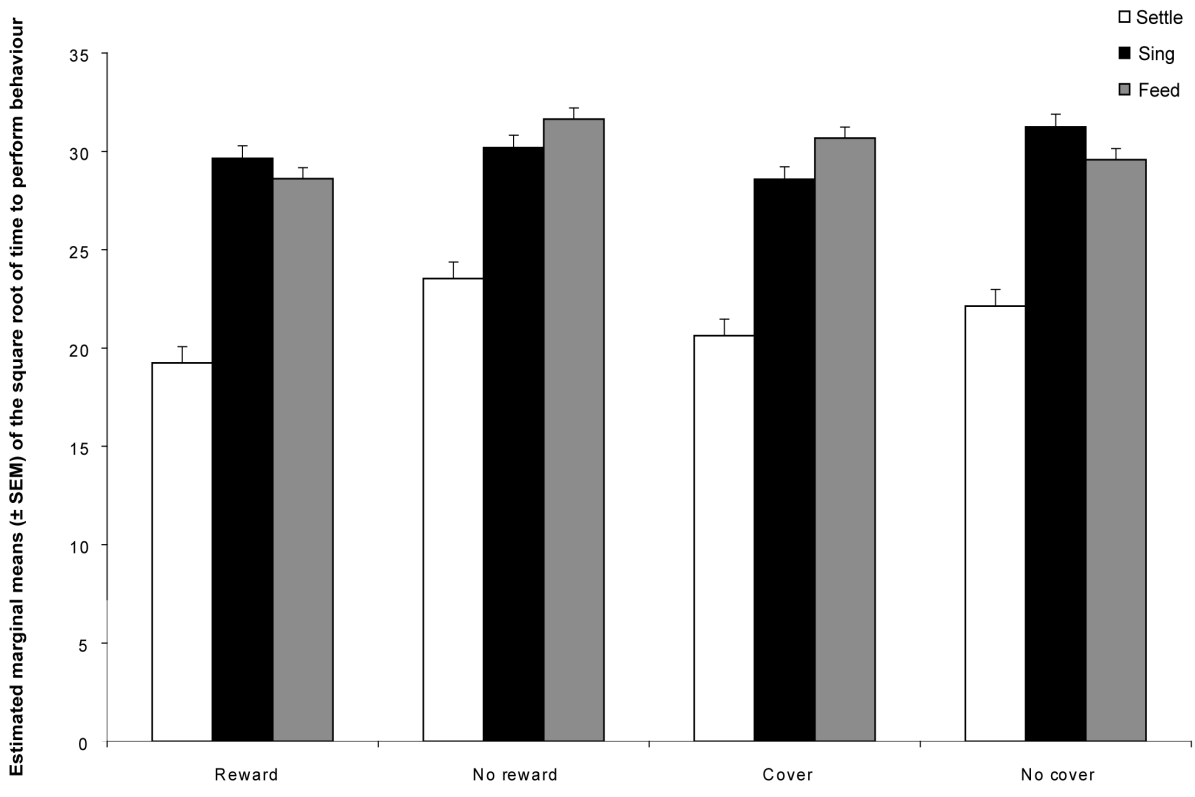
We tested for differences in female preferences between conditions using ANOVA with reward and cover condition as fixed factors; male ID was entered as a random factor to control for the two measurements on certain individuals. In addition, male display% was entered as a covariate as a number of studies have suggested there are individual differences in male display and that this is an important determinant of female preference (Houtman 1992; Collins 1994). All statistics were conducted using SPSS version 14.0.2.

Results

Behaviour

Males in the reward condition settled faster than those in the no reward condition ($F_{1,258.2} = 12.81$, $P < 0.001$; Figure 1). There was no effect of cover. Males in the cover condition began to sing more quickly than males in no cover ($F_{1,232.53} = 8.52$, $P = 0.004$; Figure 1). There was no effect of reward. Males in the reward condition started to feed more quickly than those in no reward ($F_{1,208.24} = 14.51$, $P < 0.001$; Figure 1). There was also an interaction between reward and cover conditions ($F_{1,208.24} = 6.79$, $P = 0.01$). For males provided with cover, there was a greater difference between reward and no reward conditions compared to the no cover condition.

Figure 1



Estimated marginal means (± SEM) of the square root of the time taken to settle, sing and feed.

There was no effect of condition on weight or weight change over the experiment. There was too little aggression between the males to perform an analysis.

Mate choice trials

There was a significant effect of reward ($F_{1,27}$ = 6.71, P = 0.015) and display percentage ($F_{1,27}$ = 40.52, $P < 0.001$) on female preference. Reward males were preferred over no reward males (Figure 2) when controlling for male display level. There was no effect of cover or male ID, and no interaction.

There was a trend for males in the reward condition to display less than those in no reward ($F_{1,27}$ = 3.82, P = 0.06) when controlling for female preference.

Discussion

The results for the behavioural analysis show that birds receiving rewards habituated best to entry of the experimenter, whereas birds with no reward, or with/without cover, remained disturbed over the course of the observations. Birds with cover started singing before those with no cover. Birds in the reward condition began feeding before those given no reward, and this effect was seen more strongly when cover was also present. The results from the choice experiments show that there was an effect of husbandry condition on mate preference and that birds from the reward condition were most preferred, relative to their display level, though they displayed much less than the males not given a reward.

The results from the behavioural observations suggest that providing a reward increases habituation of birds to entry by a human observer. The most likely explanation is that capture is associated with human presence and a reward makes capture, and thus the presence of a human, a less negative experience (Hutson 1985). Birds that were provided with cover did not habituate any better to the entry of humans than those with no cover. It may be that the experience of being caught in this situation is sometimes negative ie the birds took cover but were handled anyway — their refuge is not actually safe (Whittington & Chamove 1995; Buchwalder & Wechsler 1997), therefore no overall effect of cover on settling is observed. Depending upon the purpose for which birds are kept, and therefore how often they are disturbed, the provision of cover may improve, or reduce, welfare.

The results for singing and feeding are particularly interesting. Individuals provided with cover begin singing sooner than those without, after they have settled. However, birds in the reward condition begin feeding sooner than those with no reward. Thus, both reward and cover lead to an earlier expression of a natural behaviour, but the particular behaviour being expressed, differed. The reason for this is unclear. One possibility is that the provision of cover

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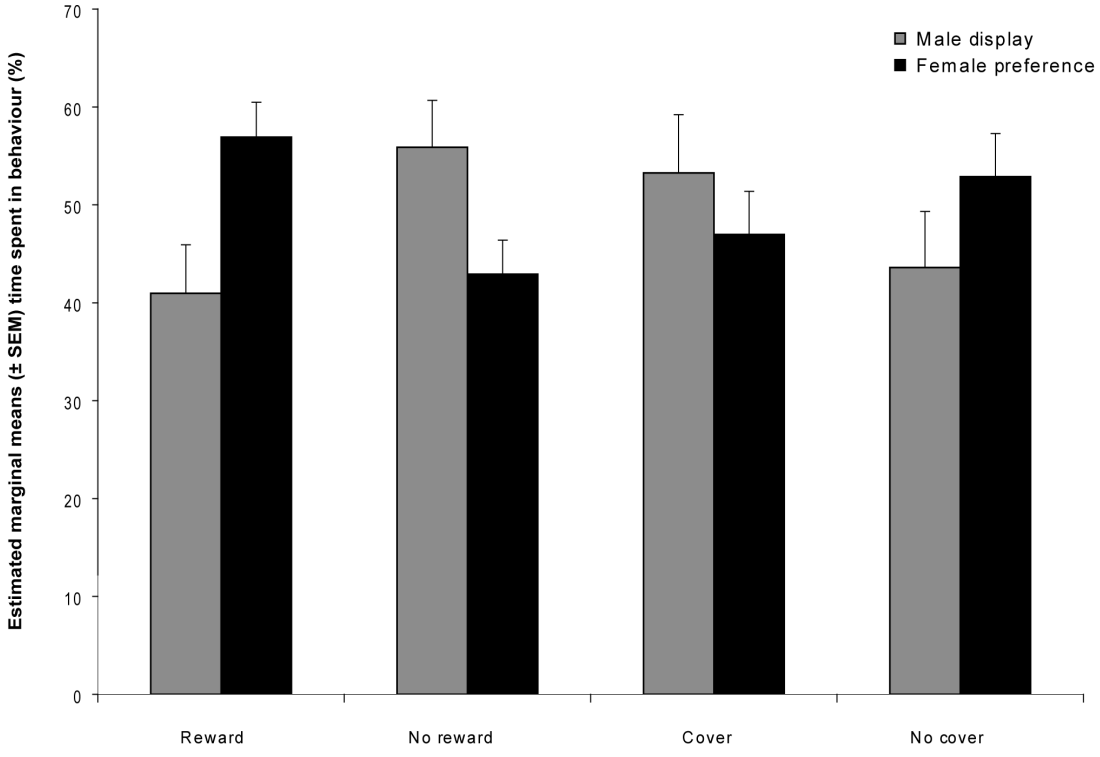
Figure 2



Mean (± SEM) female preference for males in the different conditions corrected for male display rate. Mean (± SEM) male display rate corrected for female preference.

promotes singing because the male can remain close to safety whilst attracting attention (Dunn & Zann 1996a). Another possibility is that a cage with cover resembles a breeding habitat and so males sing more to attract a female to this suitable site (Dunn & Zann 1996b). In unmated zebra finches the function of undirected song appears to be to influence female preference (Dunn & Zann 1996a, b). The provision of a reward may have enhanced food-seeking behaviour on entry of a human observer, due to the association between the person and reward. The interaction shows that where birds have no cover and are given a reward they are even quicker to feed, presumably because birds with cover are sometimes singing rather than feeding.

Given the results for the behavioural observations we would make the following predictions for the mate choice trials. Males in the reward conditions would be most preferred in the mate choice trials, due to their higher welfare. However, the results from our experiment were more complex, due to the fact that the display rate was so variable between conditions. In general, there is a relationship between male display rate and female preference in zebra finches (see Collins & ten Cate 1996), both because males tend to display when the female is present and because the female is present when the male displays (Collins 1994). Our results show that, for a given level of male display, females spent more time in front of males from the reward conditions. Therefore, males from the reward condition were, in effect, singing less for the same level of female preference than those in no reward, implying something other than their display rate was attracting the females. However, why should males in the reward condition display so much less than males in no reward? There are three possible explanations for this. First, males in the two reward conditions may be more choosy (perhaps due to being of higher quality), so do not display intensively (ten Cate & Mug 1984). Second, given that males in reward were still preferred by the females, even though they displayed less, it is possible that they were perceived to be of a high quality, due to the lower levels of stress they experienced during the study. Their quality might be apparent to the females through particular song characteristics (Spencer *et al* 2003), or physical characteristics such as differences in beak colour (Burley & Coopersmith 1987). Zahavi (1987) proposed that muscle tightening (a sign of stress) could change the pitch of the song which could signal to the female that the male has experienced recent stressors. A third possibility is that as males given a reward had habituated more strongly to handling, it may have allowed them to settle more quickly in the choice chamber thereby beginning to sing sooner than males in the other conditions. Previous work (Collins 1994)

has shown that the male that begins singing first in a mat choice experiment is most likely to be preferred. Males in the no reward condition which were initially ignored by the female, may have sung more in order to gain her attention, albeit unsuccessfully. This is the first time that a direct effect of welfare, and/or husbandry practices, on mate choice has been suggested, and it shows how likely it is that females prefer males that are the most habituated to captivity rather than those of the highest quality, which has implications for the maintenance of healthy breeding populations and genetic diversity.

Animal welfare implications

Several implications for husbandry practices are suggested by these results. First, the provision of a favoured food as a reward after a negative experience associated with humans may reduce the level of fear expressed by birds towards the appearance of a human. Rewarding disturbance may reduce the stress to which caged birds are subject and thus improve their welfare. As a side-effect, it appears that birds may also become more attractive to the opposite sex.

Second, the provision of cover may increase welfare but probably only if this remains safe and birds are not caught near their refuge. The provision of cover may have certain positive welfare aspects, but the results we found for this aspect of changing husbandry practices were less clear. Therefore, we suggest that the provision of cover is beneficial in certain circumstances; cover may help when keeping birds as pets or in zoos, but in situations where birds must be caught regularly it may be better to leave cages open.

In conclusion, we recommend that rewards are provided to small finches in all situations whenever they are disturbed by a human ie in the laboratory, the zoo and at home. Both husbandry practices we investigated are simple and easy to provide. Although this experiment was conducted on male zebra finches we would expect similar results for a number of species.

We hope this paper stimulates further work on how the welfare of birds in captivity can be improved and how different species, eg open feeding versus scrub feeding, or wild caught versus domestic, might respond to the same husbandry measures.

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