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Behavioural and morphological variation between captive populations of red junglefowl (*Gallus gallus*) – possible implications for conservation

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Abstract

The escalating threats to ecosystems worldwide have lead to a need for efficient methods to breed animals in captivity and to prepare captive-born animals for release back to the wild. However, life in captivity may lead to modifications in the animal's behaviour mainly by genetic changes, including behavioural adaptations such as reduced predator responses. Such modifications may seriously affect survival after a reintroduction. The present study was a first screening of behavioural and morphological variation between different captive populations in standardized test situations using red junglefowl as a model species. The birds were tested in three different test situations in order to measure anti-predatory behaviour, social behaviour and exploratory behaviour. The results of this study clearly show that there are behavioural differences between the captive populations which potentially can be crucial for the animals in a reintroduction situation. However, the extent to which these differences are due to genetic changes caused by small breeding populations or adaptations to the different captive environments is not yet known, although morphological differences found suggest that genetic variation may cause some of the behavioural differences as well. The differences found imply that life in captivity can affect an animal's behaviour and even though the red junglefowl is merely used as a model here, this suggests that these aspects may be important to consider also in other species where reintroduction is a more central motive for keeping the animals in captivity.

Keywords: Behaviour; Conservation; Captive breeding; Red junglefowl; *Gallus gallus*

1. Introduction

As threats to ecosystems increase worldwide, conservation of species has become a central concern. Along with the increasing numbers of endangered species, there is a need for efficient methods to breed animals in captivity and to prepare captive-born animals for release to the wild (Wallace, 2000). Today, conservation of threatened species is to a large extent carried out by zoos, where animals are kept in small populations under protected conditions. One major goal is to eventually reintroduce them into their natural habitats or an acceptable similar environment, in order to re-establish free-living populations to a previous range or to support the breeding in a declining population (Price, 1984; Campbell, 1980). However, captive environments differ significantly from wild ones and evolution does not stop just because animals are placed in enclosures (Kohane and Parsons, 1988; Carlstead, 1996; Spurway, 1955). Life in protected captivity affects the animals by genetic changes due to small breeding populations and this may lead to behavioural adaptations to the captive situation (Snyder et al., 1996; Price, 1984; Gosling and Sutherland, 2000; Allendorf, 1993). Genetic changes in small populations has for example been demonstrated experimentally

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in houseflies (*Musca domestica*) (Bryant et al., 1986) and in species released into a wild habitat, for example the common mynah (*Acridotheres tristis*) (Baker and Moeed, 1987), but its effect on behaviour has not yet been elucidated.

Maintaining genetic diversity in captive populations has often been emphasized as being the most critical element for the success of captive breeding programs but the true obstacles are usually behavioural, such as mate choice, social structure, predator avoidance behaviour and domestication (Snyder et al., 1996; Curio, 1996). An animal's behaviour is the outcome of interactions between the environment and the genotype and failure to produce an environment that is at least functionally equal to that of the wild is likely to result in modifications of frequencies and intensities of natural behavioural patterns (Shepherdson, 1994; Price and King, 1968; Hale, 1962). Therefore, the breeding and rearing of animals in a captive environment can result in changes that could reduce their ability to survive and reproduce in nature, partly as a result of natural selection in captivity. Consequently, the success of conservation programs will essentially depend on a comprehensive understanding of the role of the captive environment in the development of behaviour (Price, 1984).

Animals resulting from several generations of captive breeding are less likely to be successful after reintroduction into a wild environment than animals that are translocated or first generation captive-bred animals (Campbell, 1980). Causes of failure or problems in reintroduction of captive-bred animals vary from case to case but a common cause is behavioural deficiencies in released animals (e.g. Fleming and Gross, 1993; Kleiman, 1989; Shepherdson, 1994). This type of failure seems to be most frequent in species that learn most of their behavioural repertoires (Snyder et al., 1996), since a great deal of behaviours that are important to survival in the wild are learned by practice and this can not always take place in captivity (Brambell, 1977). Predator avoidance seems to be a critical matter for survival of reintroduced individuals into wild environments. After some generations of breeding and selection, Atlantic salmon (*Salmo salar* L.) show a reduced anti-predatory behaviour (Fleming and Einum, 1997; Einum and Fleming, 1997) and in a reintroduction situation, such behavioural modifications may have severe consequences. McPhee (2004) tested effects of captivity on predator response behaviours in oldfield mice (*Peromyscus polionotus subgriseus*), and found that the more generations a population had been in captivity, the less likely were the individuals to take cover after exposure to a predator. Furthermore, the social environment in captivity may deprive the young animal of specific stimulation necessary for the development of species-typical behaviour (Carlstead, 1996). Therefore, the composition of captive populations, with respect to age, sex and experience is important to consider. The decrease in number of opportunities for social conditioning in captivity may influence thresholds for agonistic behaviours (Price, 1984). Swain and Riddell (1990), for example, found that hatchery stocks of juvenile coho salmon (*Oncorhynchus kisutch*) were more aggressive than hatchery-reared wild stocks of juvenile salmon.

The overall aim of this research project was to investigate whether maintenance of small populations in captivity cause behavioural modifications which hypothetically can affect an animal's survival and reproduction capacity after reintroduction. In order to investigate this, behavioural differences between captive populations were examined and the red jungle fowl (*Gallus gallus*) was used as a model species. The red jungle fowl is considered to be the ancestor of all modern poultry and domestication occurred about 8000 years ago (Yamashita et al., 1994; West and Zhou, 1989; Siegel et al., 1992). The species still exists in the wild in Southeast Asia (Collias and Collias, 1967; Collias and Saichuae, 1967; Nishida et al., 2000; Nishida et al., 1992) and is also kept in zoos all over the world. A relatively large amount of behavioural research has been conducted in the zoo populations (Collias and Collias, 1996; Collias et al., 1994; Dawkins, 1989), but the behaviour of wild-living birds has been very little studied, mainly because of their extreme shyness and inaccessible habitat (Collias and Collias, 1967). Previous research has shown that in fowl, relaxation of natural selection pressures and selection for specific production traits during domestication, cause a modification of the natural behaviour towards less energy demanding strategies (Andersson, 2000; Schütz, 2002). Since domestication is largely an adaptation process, it is possible that similar effects will occur in any captive environment, even if the motive is maintenance of the animals rather than domestication.

The aim of the present study was to perform a first screening of morphological and behavioural variation between captive populations of red junglefowl in standardized test situations. The birds were tested in three different test situations in order to measure anti-predatory behaviour, social behaviour and exploratory behaviour. We predicted that anti-predatory behaviour and exploratory behaviour would be less pronounced in populations with a long background of captivity and in populations with a captive environment which is greatly protected. In captivity, the fitness benefits of responding to predator attacks and search for food may be reduced simply because there are no predators and food is provided for by humans. The social tolerance may either increase or decrease depending on the competition situation in the captive environment.