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The role of an alpha animal in changing environmental conditions

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HIGHLIGHTS

- The alpha male appears to have an outstanding position in the group.
- The alpha male had the highest value of connectedness in the group.
- The alpha male had a higher stress hormone level as his group members.

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ABSTRACT

The maintenance and development of conservation areas by grazing of large herbivores, such as Przewalski's horses, is common practice. Several nature conservation areas house male bachelor groups of this species. When males are needed for breeding they are removed from the groups, often without considering group compositions and individual social positions. However, alpha animals are needed for ensuring group stability and decision making in potentially dangerous situations in several species. To investigate the role of the alpha male in a bachelor group, we observed the behaviour of five Przewalski's horse males during the enlargement of their enclosure. We analyzed the group's social structure and movement orders, as well as the animals' connectedness, activity budgets, and whether they moved with preferred group members and how factors such as social rank influenced the horses' behaviour. We also investigated the excretion of glucocorticoid metabolites (GCM) via faeces of the horses while exploring a new area as a parameter of glucocorticoid production. Our results show that the alpha male is important for a bachelor group in changing environmental conditions. The alpha male had the highest level of connectedness within the group. When exploring the new environment, its position in the group changed from previously being the last to being the first. Furthermore the whole group behaviour changed when exploring the new area. The stallions showed reduced resting behavior, increased feeding and did not stay close to each other. We found that the excretion of glucocorticoid metabolites of most horses rose only marginally during the first days on the new area while only the alpha male showed a significant increased amount of glucocorticoid production during the first day of the enclosure enlargement.

1. Introduction

The maintenance and development of conservation areas by grazing of large herbivores, such as horses, red deer, cattle or others, is frequently practiced [1,2]. Aside of the grazing, these so called semi-reserves offer space for keeping species with space requirements that are difficult to meet in limited zoo housing, such as the Przewalski's horse (*Equus ferus przewalskii*) [3]. Especially Przewalski's horse males need lots of space for avoiding conflict with other stallions as they tend to show more aggressive behavior than domestic horses [4–7]. Their aggression level is particularly high when they are kept in small enclosures, which is one of the most common management problems in several species (horses [8,9], chimpanzee [10], and hens [11]). Other factors which may affect the aggression level of Przewalski stallions are group size, age and the presence of other equids in close vicinity [6,22].

However, the management of male horses in bachelor groups is very important [3] for providing breeding stallions for species conservation programs, such as the European endangered species programme (EEP) [6]. The training of agonistic behavior and development of physical stamina in bachelor groups have been shown to be useful for adequate social development and for the males future reproductive

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success in many species (canids [12], squirrel monkeys [13], and rats [14]) for example, when obtaining and maintaining a future harem in horses [15–18]. Activities such as playing, fighting and mounting were assumed to improve the colt's social skills allowing appropriate interaction when paired with mares [19].

Debate remains about the importance of a stable social organization of managed groups. When males are needed for breeding they are often removed from the groups without considering group compositions and individual social positions [20]. Some authors propose to remove the alpha male and move him to a mare group, as, in unmanaged horse groups, the most dominant male is most likely to become a harem stallion [21]. It has been argued that replacements in bachelor groups are in line with frequent group changes of unstable bachelor groups in the wild [22]. However, in several species alpha animals are needed for reducing the aggression level within the group, for ensuring group stability, for group leading, and for decision making in potentially dangerous situations (primates [23–28], hyenas [29,30], deer [31] oryx [32], and horse [33]).

Before being extinct in the wild, Przewalski's horses are believed to have formed non-territorial harem bands and bachelor groups similar to feral horses [34]. Range establishment and area, as well as habitat use are discussed in Przewalski's horses. Re-introduced Przewalski's horse groups were reported to remain in separated home ranges, i.e. the area through which groups trek regularly, in search for food, water, minerals and shelter. The size of a group's home range was dependent on the season. Scientists expect home ranges of Przewalski's horse groups to overlap when the number of groups in a habitat increases [35,36].

Studies in feral horses indicate that the social organization and the behavior of equids have remained relatively unaffected by domestication [37,33,38]. Bachelor groups include young males which live separate from the natal band and older males who do not hold an own harem [33,18,39]. Usually, small male groups show linear hierarchies [40,34,41]. In breeding groups, movement initiation correlates with social rank, so that dominants are usually followed by subordinates (African Buffalo [42], cattle [43,44], pigeons [45], hyenas [46], feral dogs [47], and horses [37,48]). However, in bachelor groups, the alpha male usually is the last animal in the line, like harem stallions which herd their mares from behind [33,3]. Herding is used to maintain group cohesion when other groups approach or some of the group members separate from the group [6]. Feral dogs [47] and primates [49,28] prefer to move with particular group members, which is not the case for feral horse harems. It remains to be investigated, whether Przewalski's horse males align with certain animals when moving.

The social rank is considered to affect the animal's stress level. In some species, high-ranking males show higher stress hormone levels (glucocorticoids) than lower-ranking males (apes [50] and wolves [51, 52]). In a natural population of savannah baboons [50] and in wolves [51], the highest-ranking male even had the highest glucocorticoid concentration. In contrast, higher ranking red deer had lower glucocorticoid levels than lower ranking ones [53]. A recent study suggests that stress levels in female domestic horses are independent from rank (study in press). The finding correlates with the suggestion of environmental changes having a clear impact on the stress level of individual animals [54], as reported for dogs [55,56] and mice [57].

In this study, we analyzed the behavior and glucocorticoid level of five semi-wild Przewalski's horse bachelors when their enclosure was enlarged. We analysed the horses' social ranks by applying an Average Dominance Index (ADI) because of its reliability and computational simplicity [58]. We observed the activity budgets of the individual horses and furthermore, we recorded the movement orders, and the distances between the animals by drawing spatial distribution graphs. Moreover, we analyzed the group structure and the connectedness of the horses in affiliative interactions.

The study addresses the following questions: (1) What is the group structure and how are animals connected in the bachelor group? (2) Does the horses' behaviour change while they are exploring a new, unknown area? (a) Does then movement order change? (b) Do males preferentially move with certain group members? (c) Do they align with the preferred animals when exploring the enlarged enclosure? (d) Do males show an enhanced glucocorticoid production while exploring a new area and are there any differences between group members?

2. Materials and methods

2.1. Animals

We investigated a group of five Przewalski's horse males (*Equus ferus przewalskii*) living in the Stadtwald Augsburg, Germany, which is part of a large municipal forest. The horses' ages ranged between 1.5 and 6 years with a median of 2.6 years. All horses were individually identified by their brands and colouration (Table 1). Their social history was comparable, as they were all born into small harem groups in zoo housing. They were separated from their natal group when they were between 1 and 2 years old and integrated into the bachelor group at the Stadtwald Augsburg. The horses fed on the natural vegetation in the area; additional food was not provided. The housing area consisted of a 15 ha pine forest, which was enlarged by 15 ha of heathland on October 22, 2012. Both areas were separated by a fence with two gates.

2.2. Data sampling

For social rank evaluations behavioural data was collected by continuous recording for 15 h ad libitum [59] in September 2012. Moreover, at the pine forest in September 2012 (18th to 21st) and after entering the new area (the heathland) in October 2012 (23rd to 26th) the animals' activity budget, the movement order in the group, the movement directions, and the distances between the animals were documented, both for 16 h by scan sampling [59] every 5 min. These observations were distributed evenly over 8 daylight hours and were spread over 4 consecutive days.

During the enlargement day at October 22nd, the activity budget, the movement order and direction, as well as the distances between the animals were noted by scan sampling every minute for 3 h, from the time point when the horses passed the gates. During all observation days in October we collected faecal samples of all horses for measuring glucocorticoid metabolites. The observer stood about 20 m away from the animals, depending on their spatial distribution. Due to the fact that the horses are accustomed to people, their behaviour was not influenced by the observer's presence.

2.3. Social rank

We counted agonistic behaviours of the group members, such as threats to bite or to kick, bites, kicks, chases, retreats and approaches in agonistic contexts [18,60]. The social rank of each horse was calculated with the average dominance index (ADI) from their agonistic encounters (Table 1) as follows. The dominance index per pair of individuals, w_{ij}, is the number of times an individual won against a certain opponent divided by the total number of agonistic encounters between

Table 1
Individual horse data.

Studbook no.	Name	Born	Living in Augsburg since	ADI	Social rank
4839	Marlon	20.07.2006	06-2007	0.950	1
5648	Solongo	07.06.2010	09-2011	0.516	2
5665	Xaran	05.07.2010	09-2011	0.467	3
5732	Vinter	13.01.2011	06-2012	0.243	4
5639	Kalmoek	25.05.2010	01-2012	0.083	5

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