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

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Social behaviour of collared peccaries (Pecari tajacu) under three space allowances

SS da C Nogueira*†, MG Silva†, CT dos S Dias‡, S Pompéia§, M Cetra† and SLG Nogueira-Filho†

† Laboratório de Etologia Aplicada, Universidade Estadual de Santa Cruz, UESC, Rod Ilhéus Itabuna km 16, Ilhéus, Bahia, Brazil 45662-000
‡ Escola Superior de Agricultura 'Luiz de Queiroz', Universidade de São Paulo: USP, Av Pádua Dias s/n, Caixa Postal 09 Piracicaba, São Paulo, Brazil 13418-900
§ Dep de Psicobiologia, Univesidade Federal de São Paulo, UNIFESP R Napoleão de Barros, 925, Vila Clementino, São Paulo, SP, Brazil
* Contact for correspondence and requests for reprints: selene@uesc.br

Abstract

*Captive breeding of peccaries is on the increase in neotropical countries. Few studies, however, have reported behavioural responses of wild animals under farmed conditions. Therefore, the aim of this study was to evaluate the effects of space allowance on the occurrence of social behaviour patterns on farmed collared peccary (*Pecari tajacu*). We observed three herds of collared peccaries each containing eight acquainted individuals. Using a 3 × 3 Latin square design, herds were allocated, in a random order, to one of the three experimental enclosures, each with a different size: 375, 750 and 1,500 m² of total available area, each with three wooden shelters. We recorded all the occurrences of selected positive and agonistic behavioural patterns that occurred 90 min before and during feeding. Enclosure size had a significant effect on agonistic patterns of peccaries during feeding, in that more agonistic behaviour was observed in smaller spaces. We also found that shelter usage increased as space decreased. Differing space allowances, however, did not have an effect on the occurrence of positive interactions that were more frequent before compared to during feeding. We concluded that enclosure size had an effect on the expression of agonistic behaviours and the use of shelters by collared peccaries. Thus, animal welfare can be improved by adopting at least 187.5 m² per peccary. In addition, our study also confirmed the importance of shelter areas in collared peccary husbandry.*

Keywords: *animal welfare, captive breeding, collared peccary, shelter usage, social behaviour, wildlife farming*

Introduction

The collared peccary (*Pecari tajacu*) is a favoured species for hunting throughout its range, and represents an important source of income and protein for rural and peri-urban inhabitants in Brazil and other neotropical countries (Sowls 1997). Commercial hunting is forbidden in Brazil, but wildlife farming is legal and even encouraged by governmental agencies due to the growing demand for game meat in the country's largest cities (Nogueira-Filho & Nogueira 2004). In addition, captive breeding of peccaries is on the increase in neotropical countries due, in part, to European market demand for peccary leathers (Bodmer *et al* 2004; Nogueira-Filho & Nogueira 2004).

Two main production systems have been adopted for peccary breeding in Brazil: confinement and semi-confinement. The confinement system is used mainly by small-scale farmers, universities and research centres (Nogueira-Filho & Nogueira 2004). In such a system, family herds comprising of a male and up to three females are maintained in small pens ranging from 12 to 40 m² or small herds consisting of up to 15 individuals, with a ratio of 1 male to 4–5 females in 400 to 600 m² enclosures. Most of the peccary farmers in Brazil adopt the semi-confinement production system. Here, the farmers use marginal areas of their properties ranging from 1,000 to 50,000 m². The breeders utilise the same confinement system sex ratio providing 90 to 250 m² per individual (Nogueira-Filho & Nogueira 2004).

Both production systems are based on wild peccary herd characteristics. In Central and South American rainforests, this species lives in stable and cohesive herds consisting of 6 to 34 individuals, and the sex ratio is on average 1:1 (Castellanos 1983; Robinson & Eisenberg 1985; Fragoso 1994, 1998). The herd members, young and adult, forage, eat, and sleep together. Their herd size and composition does not change throughout the year, except for when herds are temporally fragmented due to a seasonal lack of food resources (Robinson & Eisenberg 1985). Only the pregnant females stay apart from the other animals at the time of parturition but rejoin their herd a number of hours later (Sowls 1997). Although peccary farmers try to recreate the wild animals' environment (group size, larger spaces, dirt floor and natural vegetation), some breeders are concerned about

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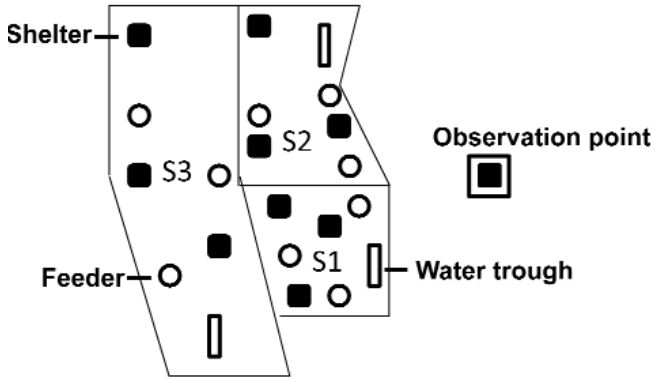
Figure 1



Schematic representation of the distribution of feeders, shelters and water troughs in each paddock.

low economic returns (Santos *et al* 2009). Most economic problems in the farming of peccaries are as a result of poor husbandry practices, such as high mortality rates caused from deadly fights and infanticide that occur both when they are maintained under confinement or semi-confinement systems (Nogueira-Filho & Nogueira 2004; Mayor *et al* 2007). There are two reasons to explain conflict and potential infanticides in peccary farming: unacquainted animals included in the same herd (Packard *et al* 1990, 1991) or inadequate stocking density (Nogueira-Filho *et al* 2006b). The first explanation would appear relatively easy to resolve, but stocking density requires more investigation. The space between individuals is based on avoidance behaviour, however, if avoidance is not possible, agonistic interactions might occur (Blanchard *et al* 2001). Thus, the space allowance is an important issue for shaping and maintenance of social groups (Keeling 1995; Petherick & Phillips 2009).

The quality of social relationship can result in more or less aggression (Fraser & Rushen 1987) and the environment in which animals live can either provide possibilities of escape or not do so. Under natural conditions, Sowls (1997) described many situations in which peccaries make use of areas of shelter, such as trees, burrows, mine tunnels and caves to escape from aggressive individuals in their herds or seek shelter from inclement weather. However, in most peccary farms, shelter areas are not provided and there are yet to be any studies focusing on such facility improvements.

To improve peccary farming systems we sought conventional pig farming solutions. A number of studies have found a positive relationship between social stability and increased space availability (Jensen *et al* 2000; Hötzel *et al* 2004; Wills 2005; Weeks 2008). In pig production, poor animal welfare is associated with restricted space in barren enclosures and poor management practices (Barnett *et al* 1992; Broom & Johnson 1993; Poole 1997; Postollec *et al* 2006). Additionally, serious concerns exist regarding the relationship between feeding periods and agonistic behaviour both in traditional pig production systems (Petherick *et al* 1987; Spoolder *et al* 1999; Millet *et al* 2005) as well as peccary farming (Nogueira *et al* 2007).

In this context, it was our assertion that as feeding time is a critical moment for animals' social stability, agonistic behaviour patterns of collared peccaries would increase and positive interactions reduce when space allowance decreased. Moreover, shelter usage by the animals would increase when less space was available.

Materials and methods

Animals and housing

We observed three herds of collared peccaries, each one comprised of two males and six females, all captive born and marked with plastic ear tags of different shapes. The herds were housed in three different experimental enclosure sizes: S1 (375 m^2); S2 (750 m^2); and S3 (1,500 m^2) total available area, at the Universidade Estadual de Santa Cruz-UESC, Ilhéus, Bahia, Brazil. The areas of the three different enclosure sizes were chosen to represent the average range of enclosure sizes used in most of the peccary farms in Brazil (Nogueira-Filho & Nogueira 2004). Enclosures were surrounded by a 1.5-m high net wire fence and had a dirt floor with low vegetation, one water trough (0.6 × 0.3 m; length × breadth), three feeders (1.0 × 0.3 m) and three wooden shelters (2.0 × 1.0 × 1.5 m; length × breadth × height) (Figure 1). The feeders and shelters were 2.0 m apart in the smallest enclosure, and the distance between them increased two-fold each time the enclosure area was enhanced. We fed the animals twice daily, at 1030 and 1730h, with an experimental diet established by Nogueira-Filho *et al* (2006a); water was made available *ad libitum*.

Each herd was randomly allocated to and observed in all three experimental enclosures, following the experimental 3 × 3 Latin square design. All pregnant females gave birth during July 2005, and to avoid interfering with the social dynamics as a result of changes in herd size, we stopped all observations until after weaning at six weeks of age, when data collection was restarted. Therefore, all herds remained in the same enclosure until the end of August. Only at the end of August were they allocated to the next experimental enclosure.

Observation sessions

The observational study was conducted from March to October 2005, with the exception of July and August when our studies were hampered both by births and intense rainfall. In order to adapt the animals to each new enclosure, the peccaries remained in their new environment for 30 days prior to the observational period. Each herd then remained in each experimental enclosure for at least 60 days: 30 days for habituation to occur plus 30 days for data collection. The observation sessions took place between 0900 and 1200h. Data collection was carried out for 90 min before and

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Table 1 Ethogram of agonistic and positive behaviours (modified from Byers & Bekoff 1981).

Behavioural category	Description
Agonistic pattern	
Face-to-face	One animal approached by or approaching a conspecific, standing with all four legs planted squarely and with the head held level. Head not lowered and ears may or may not held back.
Altercation	Two animals facing each other, raising snouts, opening mouths and emitting snarls and growls. Usually making biting movements also.
Fast head turns with open mouth	One animal rapidly swings its head towards a conspecific with the mouth open.
Fast head turns with closed mouth	One animal rapidly swings its head towards a conspecific with the mouth remaining closed.
Snaps	One animal directing a rapid biting movement at a conspecific without making contact.
Snarl growls	Reminiscent of the same vocalisation seen in dogs but with readily audible differences.
Tooth clacks	Sound beginning with low-pitched growling, giving way to an explosive series of clacks or pops made by rapid mandibular movement.
Bristle hair	One animal approached by or approaching a conspecific, standing with all four legs planted squarely and with the bristling of hair.
Positive pattern	
Mutual rubbing	Two animals oriented head-to-tail with sides touching, rubbing the sides of their heads over each other's rump in the dorsal gland region. Usually starting and finishing simultaneously.
Unreciprocated mutual rubbing	Typical mutual rubbing posture with a conspecific standing motionless.
Grooming	One individual sniffs a conspecific in close proximity and displays rapid mouth movements.

90 min during the first feeding session at 1030h. In this way, each herd was observed over seven alternate days, totaling 21 h per herd for each treatment.

Data were collected via the all occurrences method (Altmann 1974), recording chosen agonistic and positive interactions originally described by Byers and Bekoff (1981) (Table 1). The agonistic behavioural patterns selected were: face-to-face, altercation, fast head turns with mouth open, fast head turns with mouth closed, snaps, snarl growls, tooth clacks, and bristle-hair actions. The positive interactions recorded were: mutual rubbing, unreciprocated mutual rubbing and grooming actions. We recorded the usage of shelters by the animals and their activities inside or directly related to them also using the all occurrences method. This work followed the *Principles of Laboratory Animal Care* (NIH publication No 86-23, revised 1985) and Brazilian federal laws.

Data analysis

The behavioural elements scored were combined into two single categories — agonistic and positive, both during pre-feeding and feeding periods. We summed the occurrence of each selected behaviour from multiple days to create one record per individual in each enclosure size. To analyse the shelter usage we scored the incidence of animals' visits in each enclosure size.

To determine the effects of different space allowance treatments on occurrences of positive and agonistic acts, as well as shelter usage, we conducted separate analyses of variance (ANOVAs) with repeated measures followed by *post hoc* Tukey HSD tests (Statistica version 5.0, StatSoft 1995), when appropriate. Factors in the ANOVA for shelter usage were space allowances (3 levels), gender, and order of allocation to space allowance (3 levels). For agonistic and positive acts, the factor moment (pre-feeding and during feeding) was added. Due to the lack of consistent effects of order when apparent, in addition to using a Latin square design to allocate groups to different enclosure sizes, we conducted another ANOVA excluding this factor. All analyses used a significance level of 0.05.

Results

The statistical model relative to agonistic behaviour revealed an interaction between paddock size and moment of feeding ($F_{2,44} = 7.98$, $P = 0.0001$). *Post hoc* tests showed there was a larger occurrence of agonistic acts in smaller paddocks during feeding, whilst in the larger paddock such acts did not differ between pre-feeding and feeding periods ($P < 0.003$; Figure 2a).

Most of the aggressive acts during feeding (47%) occurred when an individual tried to approach the feeder where another was already feeding. On such occasions, the aggressor stopped feeding and charged against the other with its mouth open. Regarding positive acts, we found only an effect of the time at which the act was committed ($F_{1,22} = 42.43$, $P < 0.0001$) whereby positive acts were more frequent during pre-feeding than feeding (Figure 2b).

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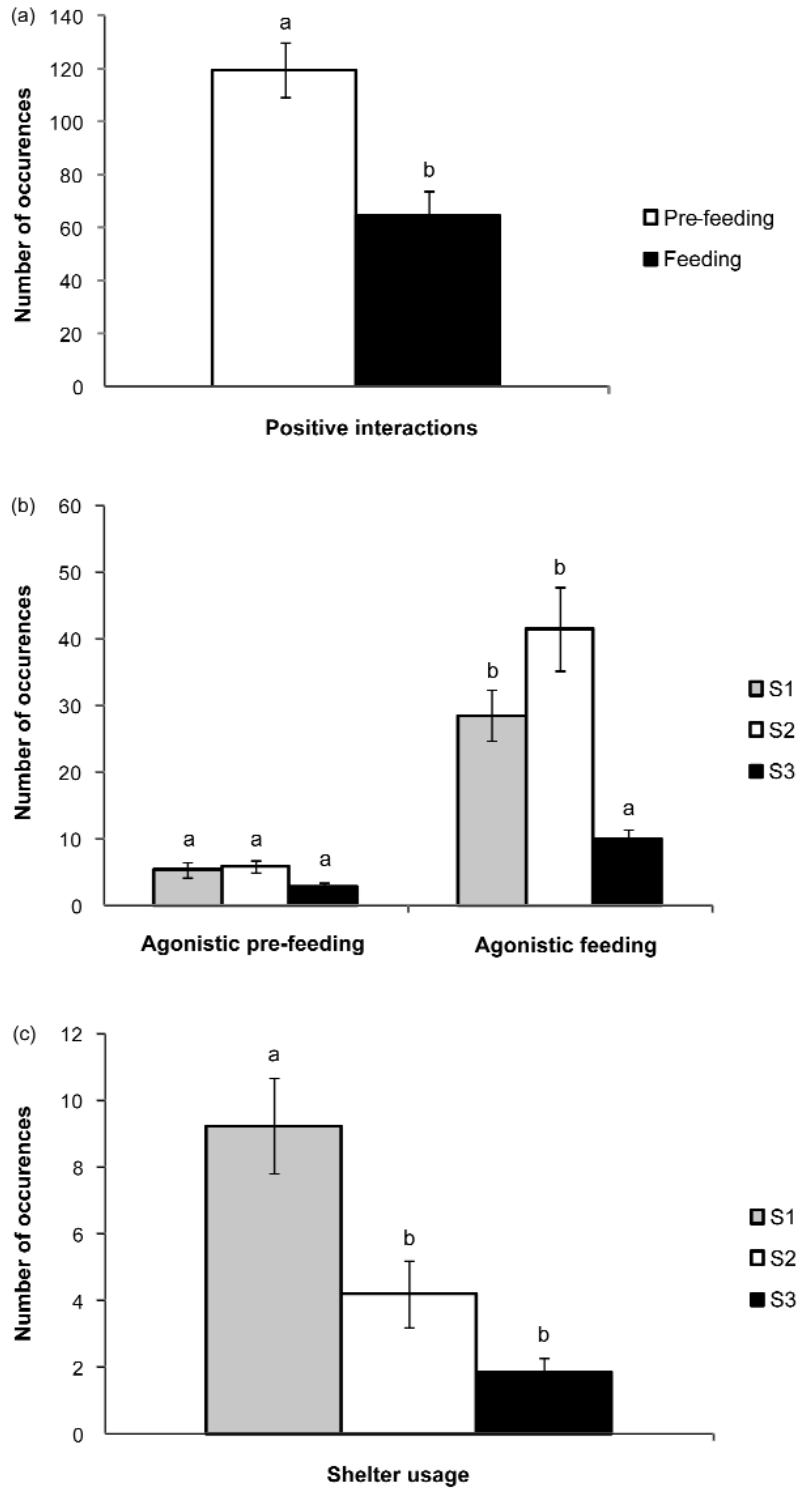
Figure 2



Mean (± SE) comparison of (a) positive and (b) agonistic occurrences between collared peccaries during pre-feeding or feeding periods and (c) shelter usage relative to enclosure size: S1 (375 m²); S2 (750 m²); and S3 (1,500 m²). Different superscripts denote significant differences between occurrences of positive acts ($P < 0.0001$), agonistic acts ($P < 0.003$), and shelter usage ($P < 0.03$).

The model also revealed an effect of space allowance on shelter usage ($F_2 = 10.23$, $P = 0.0005$). We observed a greater use of shelters (Figure 2c) among peccaries maintained in the smallest paddock in relation to the two others ($P < 0.03$). Most of the instances (89.4%), in which we observed the peccaries inside a shelter, they were hiding. This behaviour occurred when one individual entered the nearest shelter, or stayed outside it behind the shelter wall, to remain out of sight of an approaching antagonist. No other effects were observed including gender or interaction of gender (all $P > 0.67$).

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Discussion

The results partially confirmed our prediction. Indeed, feeding time is a critical period for peccary social stability. The occurrence of agonistic behaviour patterns increased when space allowance decreased during feeding. However, when more space was made available, peccaries kept the same low level of aggression during both pre-feeding and feeding. As regards positive behaviour, we observed a decrease in positive acts during feeding when compared to the amount recorded during pre-feeding. Nevertheless, the paddock sizes did not affect the occurrence of such interactions. In addition, the animals increased shelter usage when space allowance decreased.

In general terms, extensive production systems *per se*, such as the semi-confinement technique tested here, provide opportunities for conflict avoidance as opposed to the fight for priority of access to resources observed in a review of pig management systems (Millet *et al* 2005). Other studies on domestic pigs (Randolph *et al* 1981; Jensen & Wood-Gush 1984; Hyun *et al* 1998; Jensen *et al* 2000; Millet *et al* 2005; Wills 2005) and farmed deer (Pollard & Littlejohn 1996; Blanc & Thériez 1998), have found a positive relationship between social stability and increased space availability, as was recorded for peccaries in the present study, especially during feeding.

The precautionary measures of providing food in two daily meals in several spread-out feeders, as previously recommended (Nogueira-Filho *et al* 1999), were insufficient to control conflicts in the present study under crowded conditions. In domestic pigs, threat or aggression during feeding could cause intake changes, depressed growth or injuries (Spoolder *et al* 1999; Morrison *et al* 2003; Millet *et al* 2005). Therefore, further studies must be carried out to determine the optimum number of peccaries per feeder, special feeder distribution and feeder design to avoid or at least reduce behavioural conflicts when peccaries are maintained under high densities.

We were not able to confirm the prediction that under crowded conditions, a decrease in positive interactions would occur. No differences in the occurrence of such acts among the space-allowance treatments led us to suggest that positive interactions in peccaries might represent appeasement signals, as described for primates (see de Waal 2001). However, further studies are needed to support this hypothesis since, during feeding time (a critical period for animals' social stability), the average number of positive acts dropped to half compared to the amount recorded during pre-feeding.

To avoid conflict, the collared peccary used the shelter as an escape spot. When less space was provided, more animals entered shelters to hide from conspecifics. Our results confirmed the importance of shelter areas for collared peccaries and suggest that these structures can improve welfare under captive conditions, since they may have assisted in the decrease of the occurrence of conflicts under the most crowded condition. Moreover, as previously described in the wild (Sowls 1997), shelter areas form an integral part of the peccary's daily needs and must be made available by farmers.

These behaviours were found to be equivalent between males and females, with no gender effects observed, a result that could have been different had a larger number of males been used. However, our goal here was to test the sex ratio most often used in peccary farms (Nogueira-Filho & Nogueira 2004).

Animal welfare implications and conclusion

We conclude that farmers must consider space availability in order to guarantee peccary social stability, especially during feeding. A significant decrease in the occurrence of agonistic acts was recorded during feeding when peccaries were maintained in the larger paddock. Thus, animal welfare can be improved by adopting a space allowance of at least 187.5 m^2 per peccary. In addition, our study also confirmed the importance of shelter areas in the husbandry of collared peccaries.

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