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*Capybara (*Hydrochoerus hydrochaeris*) behaviour and welfare: implications for successful farming practices*

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Abstract

*Capybara (*Hydrochoerus hydrochaeris*) farming in Latin American countries was hampered at the outset by limited knowledge of species behaviour and inappropriate husbandry protocols, which resulted in low reproductive rates, lethal adult fights and consequent reduced well-being. As the peculiarities of capybara social behaviour are still ignored by many species' breeders, both in commercial or research centres, we aim here to provide a review of successful experiences in Brazil by evaluating a number of social behaviour issues that are directly associated with the species' welfare. We highlight special points on group composition and facilities needed, such as water tank and corral-trap structures, which may affect capybara health, productivity, and animal welfare. It has been shown that trying to form new aggregates by mixing adult or sub-adult animals obtained from different groups does not work. Conversely, we did not find a difference in the frequency with which mothers from the same group nurse their own young or those of other females. This knowledge may lead to successful trials for female adoption when necessary. In conclusion, capybara welfare is strongly linked to cohesion among animals. Additionally, assessment of vocal emissions is discussed as a potential, non-invasive measure to evaluate improvement in capybara handling procedures.*

Keywords: *animal cohesion, animal welfare, captivity, farming, handling practices, social behaviour*

Introduction

Their fast growth rate, high reproductive output, sociality and cheap diet have encouraged researchers and farmers in Latin American countries to establish a captive breeding programme for capybara (*Hydrochoerus hydrochaeris*) as an alternative to commercial hunting (Nogueira Neto 1973; Alho 1986; Ojasti 1991; Moreira & Macdonald 1996). This activity, however, is still incipient. In Uruguay, for example, there are only 14 capybara farms (JL Cravino, personal communication 2012). In Venezuela, frequent changes in the laws and bureaucracy do not allow this activity to grow (Alvarez 2011). This country is the main market for capybara meat, furnished through harvesting the wild population in the Venezuelan *llanos*, and traditionally consumed during Lent and especially Holy Week (Ojasti 1991; González-Jiménez 1995). On the other hand, in Brazil — where commercial hunting is forbidden by federal law — wildlife farming is increasing at a rate of 17% per year; more than half (n = 124) of the total wild mammal farms (n = 226) breed capybara (Le Pendu *et al* 2011).

There is no official information available on the market for capybara products (Le Pendu *et al* 2011), but it is known that meat is the main product in Brazil (Nogueira & Nogueira-Filho 2004). Conversely, leather is the main product in Argentina, but the insignificant number of legal capybara farms does not provide enough for commercial demand, which is instead supplied by unsustainable hunting (Dominguez *et al* 2009). Ninety-eight percent of the *carpincho* leather production in Argentina — estimated at 75,000 units per year — is sold on the local market and 2%, approximately 1,500 units per year, is exported, mainly to Italy (Dominguez *et al* 2009). Published data on capybara farming are scarce in other Latin American countries, but the figures above show the potential scale that capybara farming can reach in Latin American countries.

Early captive breeding attempts in the 1970s and 1980s were hampered by limited knowledge of capybara behaviour and inappropriate husbandry protocols, which resulted in low reproductive rates, infanticides, and lethal adult fights (Alho 1986; Lavorenti 1989). Not surprisingly, these early breeding programmes, in mostly intensive systems, were not profitable and different approaches were proposed, such as a semi-intensive production system (Nogueira-Filho 1996). This was achieved through behavioural studies that focused mainly on basic aspects of capybara biology, such as reproduction (Lopez-Barbella 1984; Nogueira 1997; Cueto 1999; Nogueira *et al* 2000; Alvarez & Kravetz 2006), social behaviour (Cueto 1999; Michi 1999; Nogueira *et al* 1999), and feeding behaviour (Mendes *et al* 2000).

Capybara husbandry and management practices in Brazil have improved considerably over the years. The use of knowledge of the species' social behaviour resulted in captive productivity enhancement along with a reduction in production costs (Nogueira-Filho & Nogueira 2004). However, the peculiarities of social behaviour of capybara are still ignored by many breeders, both in commercial and research centres, in Latin American countries (see Alvarez & Kravetz 2006). Most of the failed experiences in the past could have been successful if farmers had been aware of the information contained in this review. This highlights the importance of our presentation of the accumulated knowledge on capybara social behaviour and related aspects, for the guidance of the species' welfare in captivity. In this review, we describe the facilities and husbandry practices that can affect the species' behaviour and welfare — and consequently its productivity — and provide advice on improving handling techniques.

Reproductive characteristics used to improve captive management procedures for capybara

In the tropics, captive capybara may breed throughout the year (Nogueira 1997), while in temperate regions they present two breeding peaks (Cueto 1999); their gestation period comprises five months (Lopez-Barbella 1984). Since they do not experience lactational anoestrous (Nogueira 1997; Cueto 1999) they are able to conceive up to two litters per year. The age at which capybaras first undergo successful parturition in captivity is 12 months (Chapman 1991) and they can reproduce until at least 10 years of age (Nogueira 1997). Moreover, the litter sizes in captivity are similar to those in the wild, ranging from 3.3 (± 1.5) (Nogueira 1997) to 3.7 (± 1.7) (Cueto 1999). Female capybara have the potential to produce up to almost 100 young during their entire reproductive life.

However, the mean (± SD) age of the first successful parturition in captivity was 48.3 (± 24.8) months, while the mean inter-birth interval was 514.6 (± 348.0) days. Females older than seven years showed a sharp increase in inter-birth interval, so they are usually culled at this age (Nogueira-Filho & Nogueira 2012). Moreover, the newborn mortality rate in captivity can reach up to 41.3% (Alvarez & Kravetz 2006). Thus, a capybara female may successfully wean just four young in her entire reproductive life, mainly due to the adoption of erroneous handling procedures. Indeed, the high variation in the birth interval recorded in captivity, ranging from 193 (± 23) days in Buenos Aires, Argentina (Alvarez & Kravetz 2006) to 514.6 (± 348.0) days in Piracicaba, Brazil (Nogueira 1997) can be explained, among other factors, by reproductive suppression by high-ranking females. Cueto (1999) recorded that in captivity the dominant females interfered in the courtship and copulation of the most subordinate females. Therefore, it is essential to improve husbandry practices that allow the low-ranking females the chance to mate.

Conversely, the large variation in the age at first parturition recorded in captivity, ranging from 16.2 to 95 months (Nogueira 1997), may also be explained by the management procedures adopted. Male capybara reach sexual maturity later than females (López-Barbella 1984; Altermann & Leal-Zanchet 2002). Thus, young females paired with immature males will reproduce later (Nogueira 1997). These few examples illustrate the scarcity of publications on the behaviour, welfare and farming of the species, making it clear why this information is needed to help improvements in its husbandry.

Feeding characteristics and captive management procedures

In the wild, capybara consume mainly grass (Ojasti 1973; Alho *et al* 1986). This is one of the notable advantages to farming capybara, since the main feedstuff of capybara, grass, is cheap to produce (Mendes & Nogueira-Filho 2012) and the animals convert it into high-quality animal protein for human consumption (Emmons 1987). In addition, due to intense mastication and the microbial fermentation that occurs in the caecum, capybara are highly efficient in the digestion of roughage (Ojasti 1973). The microbes in the caecum also provide a direct source of protein through caecotrophy (the re-ingestion of caecal content or caecotroph). Mendes *et al* (2000) described this caecotrophy behaviour in capybara and suggested that the act is optional, since it often occurs when the nutritional quality of the forage is low. Indeed, this behavioural characteristic can decrease production costs by lowering expenditure on protein supplements (Mendes *et al* 2000).

On the other hand, since tropical grasses are low in both energy and protein (Pond *et al* 2004), some concentrated feedstuffs, with higher energy and protein contents than grass, should be provided to growing and reproducing capybara (Mendes & Nogueira-Filho 2012), resulting in higher reproductive performance (Cueto 1999), better feed-conversion rate (efficiency in converting feed mass into increased body mass), and higher daily weight gain, in comparison to a grass-only diet (Silva Neto 1989; Andrade 1996). Further studies, however, must be done to determine the best protein proportion in the capybara diet to combine the natural occurrence of caecotrophy, reproductive parameters, live weight gain, protein gain and a decrease in production costs (Mendes & Nogueira-Filho 2012).

Facilities required

Capybara are normally found near water, which is the vital resource that they use for escaping from predators and for thermoregulation (Ojasti 1973, 1991). Moreover, the breeder must bear in mind that capybara social behaviours and species-specific skills develop and take place in water (Ojasti 1973). In the wild, adult females introduce their offspring to water and take care of them while swimming (Macdonald 1981). Sub-adults and juveniles regularly play in the water, developing their motor skills (Nogueira 1997). Adult capybara often copulate and display other reproductive behaviours in the water (Ojasti 1973; Herrera & Macdonald 1993).

Therefore, intensive capybara breeding systems require considerable investment in water tanks (Nogueira-Filho 1996) or other sources of water. To reduce costs, Silva-

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Neto (1989) attempted, unsuccessfully, to replace water tanks with less expensive showers. There was, at that time, only a limited understanding of the importance of water for behaviour, with breeders assuming that it was only needed for thermal comfort (Azcarate 1980). Comparing facilities that have water tanks with those only fitted with showers revealed that animals must be fully submerged in water to keep their skin healthy. Most of the animals (8 out of 11) in the treatment with showers developed scabies (Lavorenti *et al* 1989; SLG Nogueira-Filho, personal observation 1994) and had a daily weight gain that was, on average, 15% lower than that of animals in paddocks with water tanks (Silva-Neto 1989).

The lack of access to water did not affect only animal health. Meat from capybara housed in paddocks without water tanks contains more saturated fats (42.3 [± 1.6] versus 35.0 [± 1.7]% and cholesterol (52.1 [± 5.8] versus 45.9 [± 4.4] mg) (Girardi *et al* 2005). This was probably because higher physical activity, such as swimming and playing, leads to lower deposits of saturated fats and cholesterol in the meat of capybara raised in paddocks with water tanks. Based on the fact that saturated fatty acids ingested in the human diet are responsible for increased levels of serum cholesterol, it can be suggested that healthier meat will be obtained from capybara that have access to bodies of water.

Physical environment and handling practices are known to have a strong influence on the behaviour of animals (Maple & Perkins 1996; Young 2003). A number of wild species have been described responding with similar types of behaviour indicating stress when kept in captivity (McPhee & Carlstead 2010), such as increasing occurrence of aggression, eg in the gorilla (*Gorilla gorilla gorilla*: Peel *et al* 2005), inactivity and listlessness or stereotypic behaviours, such as pacing, eg in the ocelot (*Leopardus pardalis*: Weller & Bennett 2001). As an example of a stress response in captivity, Nogueira *et al* (2004) compared the behaviour of captive-born versus wild-caught capybara. The authors reported that the presence of the keepers in the enclosure changed the timing of wild-caught capybaras' bathing activities. In the early morning and at sunset, when the keepers were present in the enclosure, the wild-caught animals spent more time in the water tank than captive-born ones (Nogueira *et al* 2004).

Capybara well-being is thus clearly and strongly linked to the presence of bodies of water (Nogueira 1997). To avoid the high costs of building water tanks, breeders can fence areas around small lakes or water ponds available on the farm (Nogueira-Filho & Nogueira 2004). In general, these areas are considered marginal or set-aside land, because they are inadequate for traditional agricultural or livestock production and can be used for capybara production (Lavorenti 1989; Ojasti 1991; Nogueira-Filho & Nogueira 2004).

Besides a body of water in which to swim, capybara require dry ground, along with a clump of trees or bushes to be used as natural shelter when resting (Ojasti 1991). In a semi-intensive system, the animals normally graze on natural pastures. However, stocking rates greater than three adults per hectare normally result in depletion of pastures through trampling (Ojasti 1973). Building capybara-proof fences is very expensive (Ojasti 1991; Nogueira-Filho 1996), so it may not be feasible to keep animals in large fenced fields planted with appropriate grasses. Instead of fencing large areas, as proposed by Silva Neto *et al* (1996), it is more practical to keep capybara in their restricted paddock, with highly productive grasses, such as elephant grass (*Pennisetum purpureum*), planted in a separate field. The farmer then cuts this grass daily and feeds it to the animals inside a corral-trap. As well as economising on fenced areas, this structure makes capture and handling practices much easier by getting capybara used to approaching the corral (Nogueira-Filho 1996; Silva-Neto *et al* 1996). It is easier to handle the animals at night (SLG Nogueira-Filho, personal observation 1994) when the farmer directs the animals to the door of one of the corral-traps where a transport or restraining cage has previously been placed (Nogueira-Filho 1996). Such procedures avoid unnecessary pursuit, animal injuries, and even mortality recorded among the young in extensive management (Lord & Lord 1988).

Social organisation and handling implications

Understanding a species' social organisation is fundamental to planning its husbandry (Berger & Stevens 1996; Carlstead 1996) and improves its welfare in captivity. Capybara groups have a closed reproductive unit, within which the females are probably all related (Macdonald 1981; Herrera *et al* 2011). Thus, in captivity, the groups' composition must not be changed by the introduction of new individuals (Ojasti 1991).

Despite that, in the 1980s, capybara farmers often mixed animals from different groups to form new aggregates in an attempt to improve production (Nogueira Filho & Nogueira 2004). However, because of the peculiarity of capybara social behaviour, if a female gives birth in the presence of an unfamiliar female, the latter may kill the entire litter (Nogueira *et al* 1999). From 34 births where unfamiliar females were present in the same enclosure, 24 (70.5%) resulted in infanticides. Infanticide may occur even if the females have been living together for a long time in apparent harmony (Nogueira *et al* 1999; Nogueira 2009). Therefore, when using wild-caught capybara as the founder group, the breeder must keep the original wild formation intact.

In the wild, capybara are found in groups comprised of adult males and females, with more females than males, plus young and juveniles (Ojasti 1973; Azcarate 1980; Macdonald 1981; Schaller & Crawshaw Jr 1981; Herrera & Macdonald 1993).

In such groups, the males show a linear dominance hierarchy maintained through symbolic agonistic interactions (Herrera & Macdonald 1993). Despite that, groups cannot contain more than one adult male in captive facilities. For instance, in the small enclosures of the intensive system, and even in semi-intensive enclosures less than one hectare in size, some attempts to maintain more than one adult male in each enclosure clearly failed (Nogueira 1996; Lopes 2007). The subordinate male suffers aggression from both the dominant male and the females (Lopes 2007).

Studies carried out with captive capybara have clarified the species' social structure, allowing improvement of their production in captivity. Both Cueto (1999) and Lopes (2007) identified a linear hierarchy within capybara captive groups, where the male was dominant and there was a pecking order among females: the heavier a female, the higher her status. The relation between live weight and hierarchical status was also observed by Ojasti and Sosa-Burgos (1985), who stated that higher ranking individuals have more access to food and consequently are heavier than the subordinate ones. This type of hierarchy will require handling strategies that decrease conflicts during feeding time. Therefore, feeding troughs and grass must be dispersed around the enclosure to avoid competition for food and consequent chronic stress among low-ranking animals.

Alloparental behaviour among capybara has been reported in the wild (Ojasti 1973; Macdonald 1981) and confirmed in captivity (Nogueira *et al* 2000). While average litter size is approximately four, a single female may nurse up to ten young. Captive females apparently do not discriminate between their own young and those of pen-mates; they have been reported nursing their pen-mates' young in 45% of total nursing occurrences (n = 127; Nogueira *et al* 2000), and there is no difference in the frequency with which mothers nurse their own young or those of other females. The authors suggest that lower status females spend more time nursing all young (their own and others) than do dominant females, but due to the small number of animals analysed in Nogueira *et al*'s (2000) study, further work needs to be done to confirm this hypothesis. This knowledge promoted successful experimental tests for females adopting motherless offspring, mimicking the latter's natural odour. Non-toxic odour was applied to both the introduced and the resident young, as is commonly done with other livestock (Holmes *et al* 1989), and the surrogate mothers accepted the introduced litter (Nogueira-Filho & Nogueira 2012).

The knowledge that litters from different females are nursed together and that juveniles form crèches (Ojasti 1973; Macdonald 1981) was useful in designing new protocols for group formation in captivity. Nogueira *et al* (1999) showed that it is possible to form new breeding groups using young capybara from different unrelated groups when the young females start cohabitation on weaning, which is at 60 days of age. The young females get used to one another and do not kill each others' litters. Attempts to form a group along with sub-adult females, aged 180 days, failed: when adults they killed their companions' litters (Nogueira 1996). This suggests that there is a critical period in which breeders can form artificial groups, which ends when capybara are around 60 days of age.

Management techniques for group formation to re-establish capybara social welfare

In Argentina, Brazil, and Uruguay there are national laws regulating captive breeding and allowing the capture of wild individuals to begin a commercial farm (Resolución 26/92; Instrução Normativa 169/2008, and Decreto 186/002, respectively). Thus, it is important to ensure that all the captured animals belong to the same wild group and that no outsiders are captured along with them. To be sure of that, all animals must be captured on the same day. This is possible by using corral-traps, similar to the ones used in a semi-intensive production system (Nogueira-Filho 1996). However, even using corral-traps some farmers return to catch animals over a period of several days. This carries a high risk that the animals caught on separate days belong to different wild groups, which is likely to lead to fatal aggression among adults and to infanticides later (Nogueira 1996).

Capybara breeding groups should be composed of familiar females. Farmers must be aware that even captive capybara bought from a breeder may be inappropriate for establishing new breeding stock, especially if they have been raised on extensive breeding farms (Nogueira-Filho & Nogueira 2004). Under these conditions, several groups live around large lakes and there are a number of corral-traps, where supplementary feeding is provided, which facilitate the capture of animals (Nogueira-Filho 1996). This means that young between 6 and 10 months, or even adult females, may be caught in separate corral-traps and will form a new artificial group when released in a new area which will result, however, in lethal fights and infanticides (Nogueira *et al* 2003).

When farmers purchase a non-familiar capybara group caught in separate corral-traps, aggression will soon be noticed in their new environment. If there is only one male outsider it may be easily identified — remaining isolated from the others and presenting bites on its body (SSC Nogueira, personal observation 2003). However, if there is more than one female outsider, the farmer needs to identify these outsiders through observing the spatial location of each animal during feeding time (Nogueira *et al* 2003). Unfamiliar animals do not eat with group members, avoiding the central group and forming pairs outside it; they eat only when the group has moved away from the feeding spot. If it is impossible to identify the unfamiliar individuals, the best solution is to separate the animals into male and female pairs and restart the breeding programme by grouping new offspring as soon as they are weaned (Nogueira *et al* 2003).

Vocalisation as welfare indicator and its link with handling practices

The lack of information on capybara communication has made it difficult to increase knowledge that might use the species' vocalisations in improving handling and management practices.

The capybaras' repertoire is comprised of seven call-types (whistle, cry, whine, squeal, bark, click and tooth-chattering) recently described by Barros *et al* (2011). The calls were functionally categorised as contact, alarm, distress and agonistic calls, considering their behavioural contexts. Calls with ultrasound component-frequencies of 31.8 kHz in adults and 33.2 kHz in juveniles were also identified. Animals emitted such calls when restrained or injured during handling procedures (Nogueira *et al* 2012). In rats (*Rattus* spp), ultrasound emissions have been linked to predator detection (Blanchard *et al* 1991), isolation distress (Naito *et al* 2000), exposure to cold (Blumberg & Stolba

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1996) and defence/subordinate behaviour (Thomas *et al* 1983). This suggests that vocalisations can be used as a non-invasive measure to assess capybara welfare and to evaluate improvements in handling practices.

Other studies need to be carried out to understand capybara communication better, so that the function of these calls and the response of individuals can be used to improve management activities. Lord and Lord (1988) recorded the accidental death of 700 young during the seasonal capybara hunt in just one Venezuelan farm. Such a situation could have been avoided if sufficient knowledge had been provided on contact calls, for instance. Contact calls are used to promote cohesion among individuals that live in social groups (Caine & Stevens 1990; Bradbury & Vehrencamp 1998). Thus, studies in Brazil have been carried out to evaluate capybara contact calls' functionality (Pedroza 2011; Santos 2011), and they may be useful as bait to attract capybara to corral-traps, allowing animal capture without injuries and accidental deaths.

Animal welfare implications and conclusion

The social behaviour characteristics of capybara have been the most important obstacle to attempts to improve production in captivity, and this has been overlooked by most farmers and some researchers. It is not possible to mix adult or sub-adult animals obtained from different groups to form new aggregates. To manage this species properly, the breeder must preserve the original group formation or, eventually, form new groups by joining young up to two months old. The facilities must contain a natural or artificial water body that allows complete immersion baths. This will ensure animal welfare, measured by the expression of species-specific behavioural patterns and high growth rate, besides better meat quality. Despite such examples, further studies are needed to evaluate aspects of capybara group recognition and communication, which may also lead to a better understanding of their needs when farmed.

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