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Do precipitation and food affect the reproduction of brown brocket deer *Mazama gouazoubira* (G. Fischer 1814) in conditions of semi-captivity?

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ABSTRACT

The births of brown brocket deer (*Mazama gouazoubira*) in a secondary lower montane forest called "yunga" in northwestern Argentina were compared with rainfall. Analyses were performed with rainfall and flower-fruit fall in an attempt to determine the possible importance of these seasonal variables in birthing. The births were not directly correlated with rainfall, but rather with the flower and fruit fall of exotic plant species. This may be related to favor the development of fawns, which eat the new and more digestible plant parts, accessible one month after their births. The non-seasonal births observed around the year could be related to the selection by the deer of some plant species that have been introduced into the region (*Prunus*, *Morus* and *Psidium*), have a longer fruiting span than the scarce native plant species.

Key words: Argentina, birth phenology, fruit, rainfall.

INTRODUCTION

The brocket deer species (*Mazama* spp.) constitute a diversified Neotropical genus with six to eleven species, some of them of recent discovery or classification (Duarte and Merino 1997, Geist 1998, Medellín et al. 1998, Putman 1988, Weber and González 2003). The taxonomic value of the genus is also in doubt, since it could be polyphyletic and in fact a species, *M. americana*, is closer to the genus *Odocoileus* than to other *Mazama* species (Gilbert et al. 2006). Despite the broad distribution and apparent abundance of some species of brocket deer, most of their biology, including their reproductive cycle, remains obscure, although the latter is considered to be not seasonal since it lives in the tropics, with few seasonal climatic changes (Barrette 1987). Although birth synchrony in ruminants could be elicited by anti-predator strategies and food availability, seasonal patterns in climate tend to be one of the main issues accounting for the variance in ruminant birth-season length. In any case, according to Rutberg (1987) tropical and subtropical species of deer may give birth at any time of the year, showing only weak breeding peaks.

Some details are known about the reproduction of the red brocket deer *Mazama americana* (Erxleben 1777). This species reproduces along the year, although there seems to be a more marked concentration of births in the months considered to be most favorable for the development of fawns (Branan and Marchinton 1987). Thus, in Venezuela, fawns are most frequently observed during the periods of the year with the lowest rainfall (Bisbal 1994). In Peru, Gardner (1971) described the mating period of red brocket deer as occurring between July and September, coinciding with the dry season, while births occurred between February and April. Red

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brocket deer is also relatively seasonal in Surinam, where births are concentrated between September and April, in the first – and more moderate – of the two periods of annual rains in the region (Branan and Marchinton 1987). In the Misiones province (Argentina), red brockets reproduce with greatest frequency between August and October (Crespo 1982). In contracts, in northeastern Peru, the species did not show reproductive seasonality (Hurtado-González and Bodmer 2006). Macnamara and Eldridge (1987) observed that in captivity the red brocket reproduces at the same rate through the year.

Less is known about the reproductive biology of the brown brocket *M. gouazoubira* (G. Fischer 1814), (Richard and Juliá 2001a). However, in wild may show birth peaks (Stallings 1986, Frädrich 1987, Bisbal 1994). Also, as *M. gouazoubira* is a polyphletic species (Weber and González 2003, Hassanin pers. com.), the different papers on its reproduction could also refer to different species.

Few data are available about the reproduction of the deer in subtropical forests, such as those located at the southern limits of its distribution, like the premontane forest in northwest Argentina. This eco-region has a seasonal climate, with a dry season in which the deciduous trees lose their leaves (Prado 1995), and these variations could influence the reproduction strategy of the deer (Richard et al. 1995a). Although brocket deer forage on about 75 plant species, they prefer only a few of them (Richard and Juliá 2001b). Since the reproductive parts of plants (flowers, fruits and seeds) are an important, although seasonal, resource in the diet of brown brocket deer, with up to 68% of the diet (Gayot et al. 2004), we tested for possible correlations between the availability of the most important flowers and fruits in the deer diet and the births of fawns. Currently, these select items come from four exotic species that are very palatable to the deer and over the last 50 years became widely distributed on the lower slopes of the San Javier hills: namely, peach (*Prunus persica*), mulberry (*Morus alba* and *M. nigra*) and guava (*Psidium guajava*). The present study analyses the reproductive data of the species in a relative human modified subtropical seasonal forest, with two variables – local rainfall and consumption of fruit by the deer – that may influence its reproductive strategy.

MATERIALS AND METHODS

The study was carried out at the Reserva Experimental Horco Molle (REHM), a protected area supervised by the Faculty of Natural Sciences and the Miguel Lillo Institute of the National University of Tucumán, Argentina (Richard 2000). It is located on the eastern slopes of the San Javier hills (26°38′-26°57′S to 65°26′-65°20′W) in the province of Tucumán (northwest Argentina). Mean annual rainfall in the zone is about 1313 mm. The study area has a dry season, with less than 75 mm/month on average, that extends from May to October, and a rainy and hot season between November and April, with more than 95 mm/month of average rainfall. The original premontane forest vegetation has been strongly altered, and the vegetation now comprises pastures, shrub and secondary forests (Aceñolaza 1989). In 1988, six brown brocket deer were confined in an enclosure of around 18 ha with the same natural vegetation as on the lower slopes of the San Javier hills, located near the study area. The species is common in the REHM outside the enclosure. The origin of the research individuals come from the surroundings hills (2) and the rest of the herd, from a Chaco forest of Santiago del Estero province. Both, Chaco and premontane forests show seasonality, although the last is a drier region. In spite of the long study period, the enclosure, although large enough (>25 ha) and with habitat similar to its surroundings (including vegetation and occasional predation by ocelot (*Felis pardalis*), the mixed stock origin of the animals could affect some of the data interpretation. The number of deer in the area fluctuated from eight to 16 individuals during the 14 years of the study, with an average between 10 to 14 animals (on average there were only 2-3 males at the same time). Data were obtained daily by wardens and the authors from September 1988 to June 2001, and sampling was performed throughout the enclosure, following marked routes. Sampling units were the direct observation of births, fawns, or the mothers with their fawns. Three miscarriages were observed (Juliá and Richard 2001), and their estimated dates of birth were added to the data. The dates of birth of the fawns were estimated as from one month of age and recorded according to their size, "hider type" behaviour (Lent 1972) and skin color pattern (Richard et al. 1995b). When the age of the fawns

could not be determined, such observations were discarded. Births were ordered by month and possible conceptions were estimated on the basis of the period of gestation of the species, which is around 7 months (Barrette 1987).

The only seasonal variables considered were rainfall and the availability of palatable fruits for deer and the fall of flowers (mulberry) (Richard and Juliá 2001b).

The importance of the plants as food was calculated from 1991 to 1995, following direct observations 4-6 hours per day and 3-5 days per week. Deer were observed at a distance of 3 to 10 m, which permits identification of the plants and their parts consumed, and the proportion of fruits and other plant pants in diet were estimated by direct observation (Richard and Juliá 2001b). The observations were established by combining the presence/absence of fallen flowers/fruits under trees from a sample of 6 peach, 10 guava and 10 mulberry trees and the percentage of these fruits in the diet of the deer. We established an estimator that combined the presence of food – the proportion of samples (n = 840) with fallen fruit or flowers – and its importance in the diet by ranks. These were: 0 = almost complete absence of fallen flowers and fruits and importance in the diet of less than 1%; 1 = low availability flowers and fruits (10/15% of the sample and importance in the diet from 1-10%); 2 = medium availability flowers and fruits (more than 20% and less than 50% of the samples) and importance in the diet between 11 and 20%; 3 = medium-high availability flowers and fruits (51-100% of the samples) and importance in the diet greater than 20%.

Monthly rainfall data, obtained from a local station, were from 1978 onwards (Ortiz pers. comm). A Mann-Whitney *U*-test was performed to determine whether there were significant differences between the number of births per month in the dry and rainy seasons. The Spearman correlation test evaluated the relationship between rainfall and births and between the presence and consumption of flowers/fruits and fawn births.

RESULTS

A total of 23 births of confirmed dates were recorded from September 1988 to October 2001. All parturitions afforded a single fawn and no twins were seen. No significant difference was observed in the birth rate between the dry and rainy seasons (Mann-Whitney *U*-test = 8.5), and although 65% of the births appeared to be concentrated within the rainy season (Fig. 1), no statistical correlation was obtained between births and rainfall ($r_s = 0.407$, *d.f.* = 12). However, it is important to point a significant correlation observed between the average rainfall and the births of the previous month ($r_s = 0.711 \leq 0.02$, *d.f.* = 12) (Fig. 1). Also, the statistical relationship between the births of fawns and the consumption by deer of the plant reproductive parts (flower-fruits) was highly significant ($r_s = 0.706 \leq 0.01$, *d.f.* = 12) (Fig. 2). The fawns began to eat small amounts of solid matter around the first week of life, but they did not begin to forage with their mothers until they are one month old. The months with the greatest availability of exotic fallen fruits were September, October, November, January, March and April.

DISCUSSION

According to the data obtained here, the brockets seems to reproduce with some slight peaks in the year, as reported for Venezuela (Bisbal 1994) and Bolivian Chaco (Noss et al. 2003), but in contrast with the Peruvian Amazon (Hurtado-Gonzáles and Bodmer 2006). Births have been observed throughout the year in habitats with a certain degree of climatic seasonality, such as the Paraguayan Chaco (Stallings 1986) and brocket deer in captivity in temperate regions (Frädrich 1987). Anyway, it is important to keep in mind that if *M. gouazoubira* is a poliphyletic species, those data could refer to different species. In any case, the length of the breeding season in most mammal species, from rodents to elephants, is affected by population density, with an extended period at low densities (Delany 1982). The density in the study area was very high in comparison with the maximum natural population, estimated at up to 12.55 brockets/km^2 (Ayala and Noss 2000). It is difficult to establish whether population density influenced the breeding season of brocket deer because other factors such as climate, the sex-ratio and sexual segregation, the mating system, dispersal, home-range size and the food supply interact with one another in complex ways (Durant 2000).

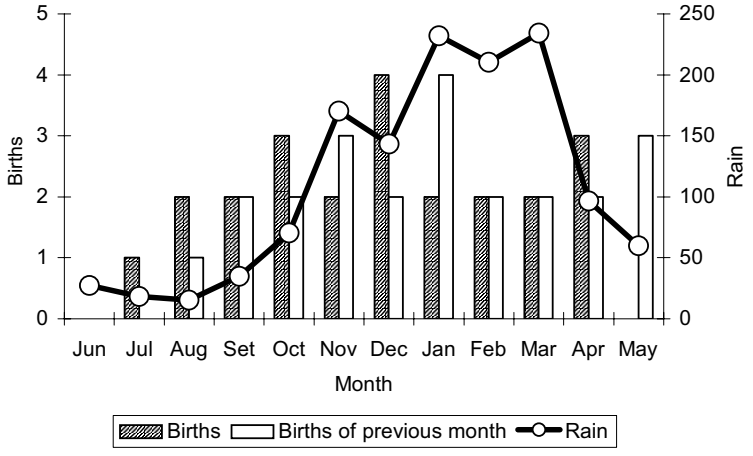

Fig. 1 – Monthly precipitation compared with births in the previous month of *M. gouazoubira* in the Horco Molle Experimental Reserve-REHM from September 1988 to June 2001.

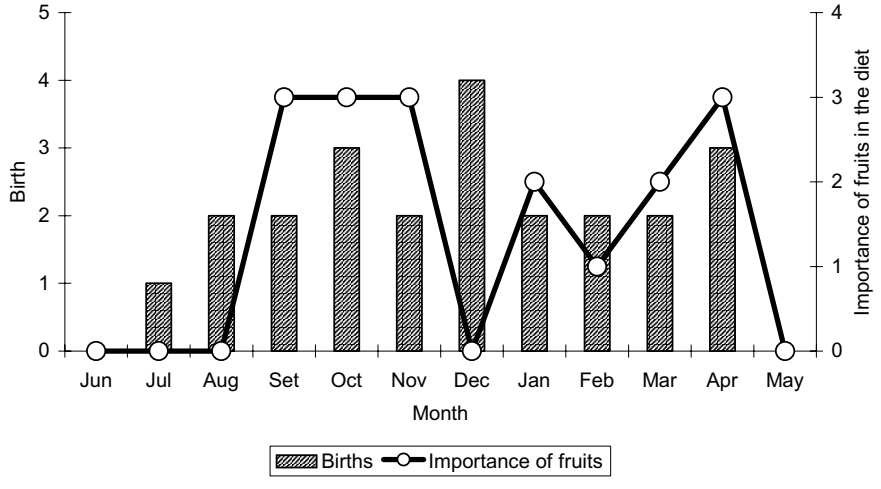

Fig. 2 – Importance of fruit in the diet and births of *M. gouazoubira* from 1988 to 2001.

The dispersion of deer births over the year could be related in tropics with variability in rainfall between years, with peaks of births in those seasons with relatively better climatic conditions (Branan and Marchinton 1987, Bisbal 1994). However, no statistical analysis was performed by the last authors to sustain their comments. Slight birth peaks were observed in the REHM, although these could not be directly correlated statistically with precipitation, a significant correlation was observed between previous month average rainfall and births (Fig. 1). Also, there was a positive correlation between the abundance and availability of reproductive parts of the plants and births (Fig. 2). In other words, rain and fructification influence the reproduction seasonality of brown brocket deer in the study area.

When available, the reproductive parts of plants (fruits, seeds, and to a lesser extent flowers) are some of the main components in the diet of brocket deer in Peru (Bodmer 1989), Surinam (Branan et al. 1985), French Guiana (Gayot et al. 2004) and at the REHM (Richard et al. 1995a). The arrival of the rains in the study area coincided with the fall of the most impor-

tant fruits in the diet of the brocket (*Morus* spp), but also with the beginning of the period of greatest availability of young green shoots (Richard et al. 1995a). According to Demment and Van Soest (1985), small ungulates such as *Mazama* have poor efficiency in the digestion of fruits and mainly derive their nutritional uptake from seeds (Bodmer 1989). The birth of fawns in the rainy season could be advantageous for the mother, since they would have a greater quantity and quality of food (flowers, fruits and young green parts), appropriate for lactation. Additionally, the availability of forage for the fawns would accelerate their weaning.

Fawns are born one month before the beginning of the periods of greatest availability of fruit, shoots, and young leaves, thus fawns have a readily digestible and available diet one month later, when they begin to feed by themselves. In spite of the exotic nature of the fruit trees which have mostly replaced the natural fruit-bearing species in the premontane forest, they fructify in a period similar to that of autochthonous trees. Indeed, indigenous plant species such as *Allophylus edulis*, *Xylosma pubescens*, *Carica quercifolia*, *Eugenia pungens*, *Blepharocalyx gigantea*, *Cupania vernalis* and *Phoebe porphyria* bear fruits from November to March (Digilio and Legname 1966), coinciding with the rainy season. The fact that 65% of the births were observed in the rainy season – although not statistically significant – may indicate the natural disposition of the deer to give birth coinciding with the sprouting of native plants. The relatively low availability of these plant species on the low slopes of the San Javier hills, given their strongly modified vegetation over the last 50 years, may hinder the detection of any relationship between flowers and fruits from native plants and deer births. In fact, the longer fructification around the year of exotic plants (from September to April – 8 months) as compared with that of native plants, just 5 months (Boletta et al. 1995), underscores the adaptability of the deer to exploit these new and (owing to their availability) more profitable resources. The longer fruiting span in exotic plants could be related to the lengthened breeding season and increased conception rates of the brocket deer in the study area, a modified habitat, showing a possible adaptation of the deer to changes in plant distribution.

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RESUMO

Os nascimentos de veados-catingueiros marrons (*Mazama gouazoubira*) na floresta montana secundária chamada "yunga" no noroeste da Argentina foram comparados com a ocorrência de chuva. As análises foram conduzidas com chuva e com queda de flores e frutos em uma tentativa para determinar a possível importância dessas variáveis com o nascimento destes animais. Os nascimentos não foram diretamente correlacionados com a chuva, mas sim com a queda de flores e frutos das espécies de plantas exóticas. Isto pode estar relacionado ao favorecimento do desenvolvimento de filhotes, que comem as plantas novas e as partes mais digeríveis, que estão acessíveis um mês após seus nascimentos. Os nascimentos não sazonais observados ao longo do ano poderiam estar relacionados com a seleção pelo veado de algumas espécies de plantas que foram introduzidas na região (*Prunus*, *Morus* e *Psidium*), as quais possuem um período frutífero mais longo do que as escassas espécies de plantas nativas da região.

Palavras-chave: Argentina, fenologia de nascimento, fruto, chuva.

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