

REPRODUCTIVE BIOLOGY AND CONSERVATION OF MURIQUIS

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Abstract

This paper summarizes some of the major findings on the reproductive biology of one group of northern miquis (*Brachyteles hypoxanthus*) at the RPPN Feliciano Miguel Abdala (previously known as the Estação Biológica de Caratinga). Long-term monitoring of individual members of the Matão group, combined with non-invasive fecal sampling to measure hormone levels, provide insights into ovarian function, reproductive seasonality, and factors that influence individual and population reproductive rates. All of these parameters have direct applications for assessing the long-term viability of this population, and for conservation of this critically endangered species. These findings were presented at the first meeting of the Committee for the Conservation and Management of the Muriqui (IBAMA), held in Teresópolis, Rio de Janeiro, in October 2002; more recent data have been added or are included in the references.

Key Words – primates, *Brachyteles*, reproductive biology, conservation

Introduction

Systematic research on miquis at the Estação Biológica de Caratinga (EBC) in Minas Gerais, Brazil, has been underway since 1982. The goals of the long-term project have always been two-fold: i) To collect basic data on the behavior, ecology, and reproduction of miquis for the development of informed conservation efforts on their behalf; and ii) to train Brazilian students in methods of non-invasive field research and its applications to conservation (Strier, 1999). Publications generated from this research through 1997 are included in the PHVA Briefing Book (Rylands *et al.*, 1998). A list of publications from the project from 1998 to the present can be obtained from the author. A list of the students who have participated in the field study of the Matão group from its onset is provided in the Appendix.

In 2001, the forest was officially transformed into a protected reserve, now known as the RPPN Feliciano Miguel Abdala (RPPN-FMA). The miquis there are now considered a species distinct from populations to the south: *Brachyteles hypoxanthus* (Kuhl, 1820) is the northern miqui of Minas Gerais and Espírito Santo, and *B. arachnoides* (É. Geoffroy, 1806) is the southern miqui, occurring in the states of Rio de Janeiro, São Paulo and Paraná.

Northern miquis have been ranked among the World's 25 Most Critically Endangered primates (Strier *et al.*, 2006a), and the population at the RPPN-FMA is one of the largest populations known (Strier *et al.*, 2002, 2006b). The Muriqui Project of Caratinga has documented the remarkable recovery of this population, which has nearly quadrupled in size to more than 226 individuals over the past 23 years (Strier *et al.*, 2006b). Demographic data

obtained from the Matão group provided the basis for the first Population Viability Analysis (PVA) (Strier, 1993/94), and the subsequent Population and Habitat Viability Analysis (PHVA) Workshop on Muriqui in May 1998 (Rylands *et al.*, 1998).

The success of the RPPN-FMA miquis to date can be attributed to the low mortality and female-biased infant sex ratio documented in the main study group (the Matão group), which increased in size from 22 to 84 individuals from July 1982 to October 2005. Here, I summarize new findings on the reproductive biology and demography of the Matão group, and discuss their implications for the conservation of the northern miquis at the RPPN-FMA.

Reproductive Biology

Typically, females in this population transfer out of their natal groups when about six years old (prior to becoming sexually active), and give birth to their first infants at about nine years old (Strier and Ziegler, 2000). Births are concentrated during the dry season months, from May to October, with a peak from June to August (Strier *et al.*, 2001). Females begin to wean their infants some 12–24 months post-partum, and resume sexual activity during their infants' second year of life. The annual mating season usually begins at the end of the dry season to early rainy season, and the median interbirth interval is three years when infants survive to weaning age. Extrapolating from what we now know to be the age at first reproduction in females at the RPPN-FMA, females that were carrying infants in 1982 are now estimated to be more than 30 years old. They are still sexually, and in most cases reproductively, active.

Results from non-invasive fecal steroid analyses have provided additional insights into the reproductive biology of wild female and male muriquis (Strier and Ziegler, 1994, 1997, 2000, 2005a; Strier *et al.*, 1999, 2003; Ziegler *et al.*, 1997). Specifically:

- The seasonal onset of copulations coincides with the onset of female ovarian cycling. Intervals between periovulatory periods average 21.0 ± 5.4 days ($n = 7$), and females experience from 2–7 ovarian cycles prior to their conception cycles.
- Gestation length averages 216.4 ± 1.5 days, or 7.2 months ($n = 5$).
- Females disperse from their natal groups prior to the onset of puberty. The onset of sexual activity in their new group coincides with the onset of their ovarian cycles.
- Inexperienced females do not conceive before their second mating season.
- There is no evidence of seasonal fluctuations in male testosterone levels, despite the seasonal concentration of copulations, conceptions, and births.
- Cortisol levels in males, but not females, exhibit seasonal elevations that coincide with the conception season.
- Females appear to require minimum levels of estradiol to resume post-partum cycling and to conceive.

Fecal steroid analyses are time-consuming and costly, and numerous samples from specific, recognized individuals have been necessary to yield meaningful results to address the kinds of questions we have examined in muriquis

(Strier and Ziegler, 2005b). Nonetheless, they emphasize the importance of hormonal data to the accurate interpretation of behavioral observations. For example, we now know that females frequently copulate during the intervals between their ovulations when conceptions are unlikely to occur. Thus, although observations of mating behavior may be a reliable indicator of the onset of ovarian cycling at the onset of the mating season, they do not necessarily coincide with ovulation over the duration of the mating season. Moreover, although all of the oldest females in our study group still cycle and copulate, two of them appear to be experiencing reduced fertility similar to that of inexperienced females during their first mating seasons. This indicates the importance of considering female age and reproductive history when evaluating variance in female muriqui fecundity from behavioral observations alone.

Demography of the Matão Group

Despite the late age at which female muriquis reproduce and their relatively slow (3-year) rate of reproduction, the Matão group has increased steadily in size (Fig. 1). This increase can be attributed primarily to their low mortality rates relative to birth rates.

Mortality has been low for all age-classes, but particularly among infants, immature males and adult females. Until recently, 94% of all infants survived their first 12 months of life (Strier *et al.*, 2001), but in recent years first-year survival has dropped in this group (Strier *et al.*, 2006b). Two 13-month-old infants (1 male, 1 female) are suspected to have died due to predation (Printes *et al.*, 1996).

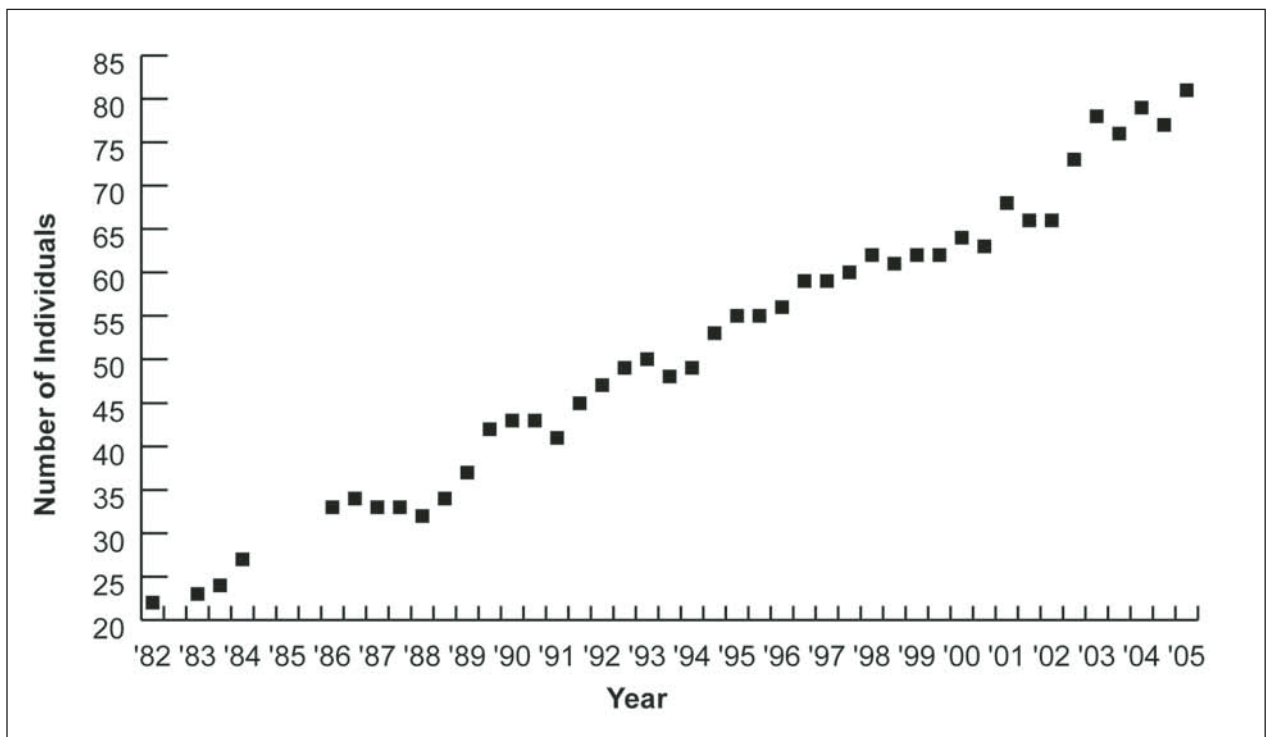


Figure 1. The Matão study group, RPPN-Feliciano Miguel Abdala, Caratinga, Minas Gerais. Growth in size from July 1982 to 2005.

All of the males born since 1982 that have survived to 3 years of age are still alive and present in their natal group. Survival rates of immature females are more difficult to document because only three of the natal females that survived to six years of age have remained and reproduced in this group (Strier *et al.*, 2006b; updated from Martins and Strier, 2004). Data on female survivorship after dispersing from the Matão group are limited for females that dispersed prior to 1994. However, 17 of the 22 natal Matão females that dispersed between 1994 and 2004 have been confirmed in their new groups, and 16 of these 17 females are still alive as of October 2005 (Strier *et al.*, 2006b). Ages at first birth are now known for six of these females, and are consistent with those estimated for females that immigrated into the Matão group (Strier *et al.*, 2006b, updated from Strier *et al.*, 2002).

Seven of the eight adult females present in 1982 are still alive. By contrast, all of the six adult males and both of the old juvenile/subadult males present in 1982 have died, with the longest surviving of these adult males dying in September 2005.

The number of female immigrations into the Matão group matched or exceeded that of Matão emigrants until 1993. Since then, however, female emigrations have outpaced immigrations (Fig. 2).

There are a number of possible explanations for this phenomenon, each of which requires close and continuous monitoring of infant and immature females in the entire population. For example, the higher emigrant-to-immigrant

ratio for the Matão group might reflect a high mortality rate (~43%) characteristic of dispersing females. To evaluate whether this is the case, we need to monitor all females that disperse from their natal groups to determine whether they succeed in joining another group, or die during the process of dispersing. Alternatively, it could reflect differences in infant sex ratios and survivorship in different groups. The high emigrant-to-immigrant ratio would then be a product of the disproportionate number of females born and surviving in the Matão group relative to other groups in the forest. It will be important to document the long-term survivorship of Matão emigrants, including those that are confirmed to have joined new groups. Until recently, the Matão group appeared to be a “source” of females in this population, but it was not possible to determine whether natal Matão females were dispersing into a “sink.” We now know that a disproportionate number of dispersing females from other natal groups prefer to transfer into the Matão group, and that most recent Matão emigrants survive and reproduce in their new groups (Strier *et al.*, 2006b).

One of the strongest results to emerge from the long-term demographic data is the female-biased infant sex ratio that has characterized the Matão group since the onset of the study (Strier, 2000). A total of 118 infants have been born from June 1982 to October 2005, of which 114 have been sexed. Of these 114 infants, 65, or 55.26%, were female. The number of females born was equal to or greater than the number of males born in most of the annual birth cohorts until 2000, when this female-bias in infant sex ratios began to reverse (Fig. 3).

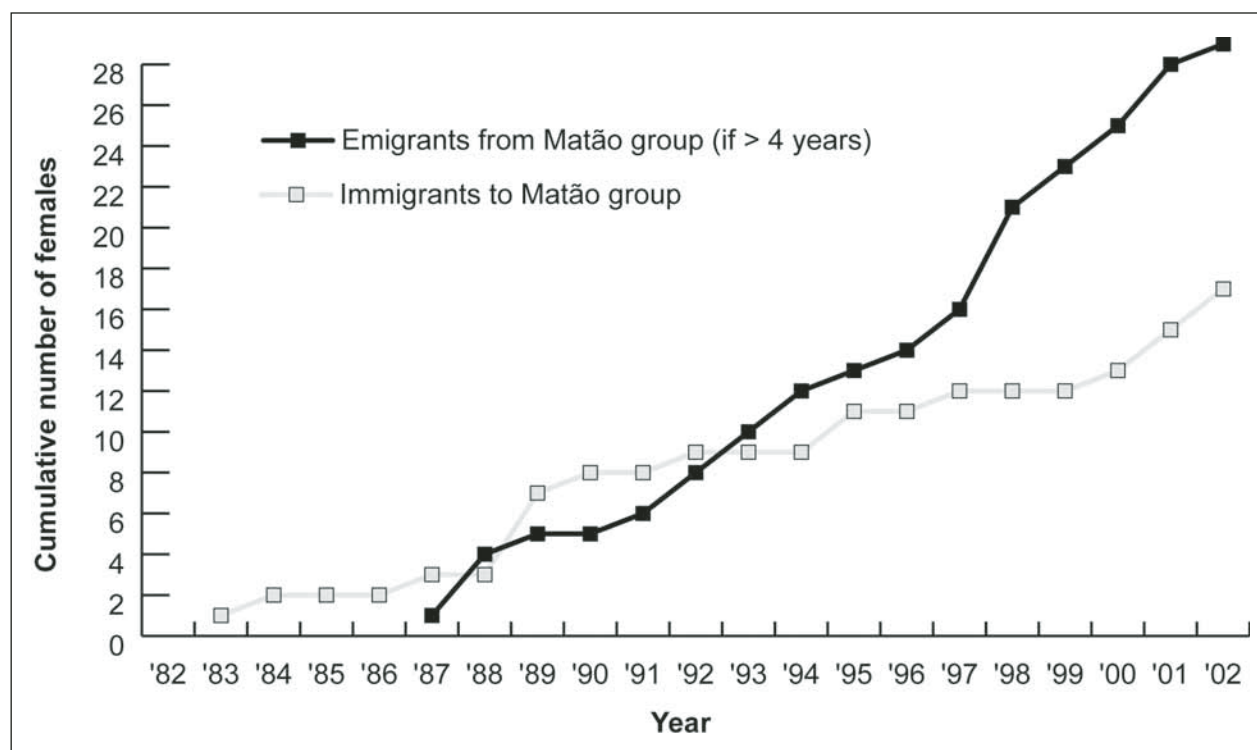


Figure 2. Dispersal patterns of females, Matão study group, RPPN-Feliciano Miguel Abdala, Caratinga, Minas Gerais. 1982–2002.

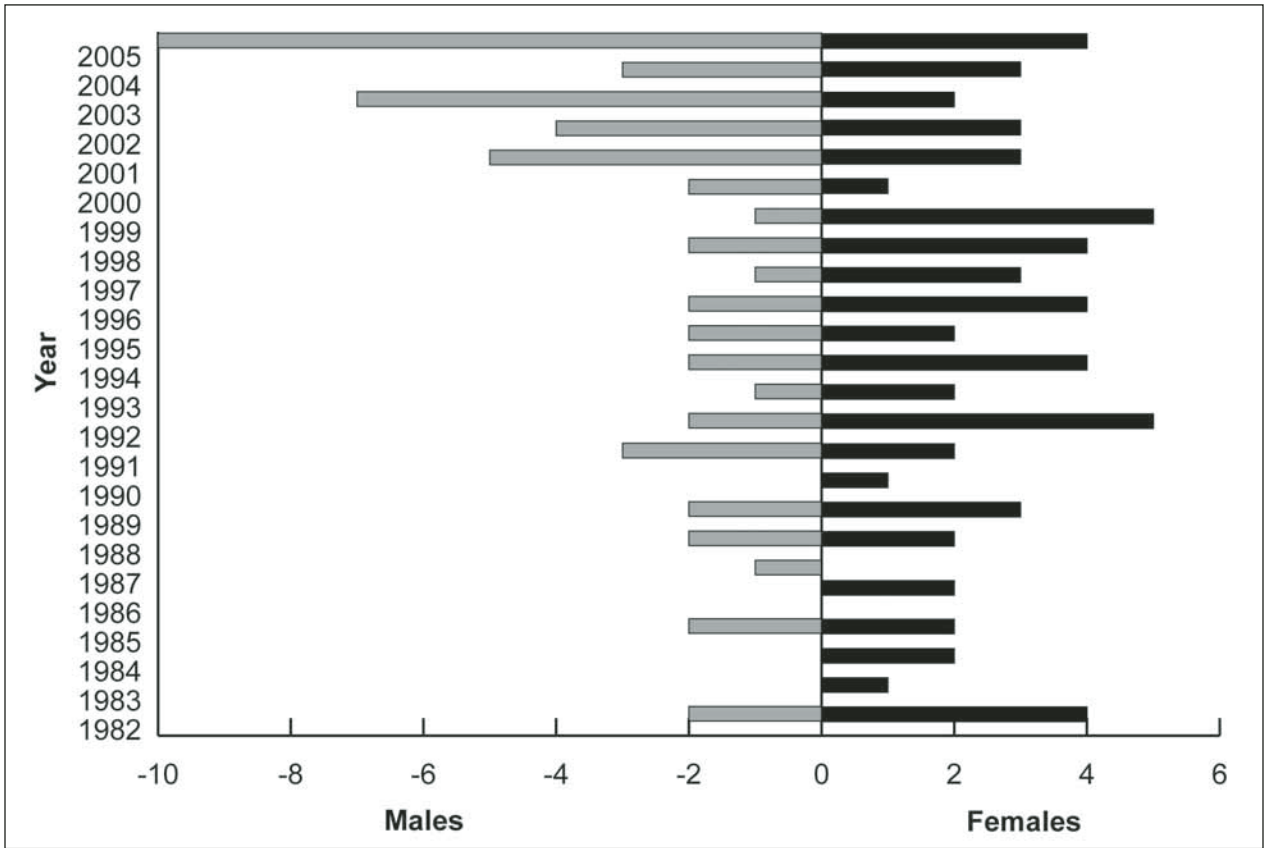


Figure 3. Sex by birth cohort in the Matão Group, RPPN-Feliciano Miguel Abdala, Caratinga, Minas Gerais, 1982–2005.

It is too soon to evaluate whether this recent shift from female to male-biased infant sex ratios will persist over time. Nonetheless, if this trend continues, it will have a dampening effect on the RPPN-FMA mureiquis' population growth (Strier *et al.*, 2006b). This effect will not be evident for another 10 years or so, when females from these birth cohorts begin to reproduce, as the PVA analyses indicated (Strier, 1993/94). Nonetheless, it may be an early indication that this population is beginning to stabilize.

Monitoring the behavioral changes that accompany changes in the demography of the RPPN-FMA mureiquis is now a priority for our ongoing research on the Matão group (for example, Dias and Strier, 2003). The demographic database is particularly important to maintain, not only for the insights on infant sex ratios and survivorship, but also because of the indications of declining fertility among some of the oldest females (>30 years) in this group. At the same time, understanding the ecological variables that contribute to the carrying capacity of the forest at the RPPN-FMA is a priority of the recent collaborative project initiated on the Jaó group in 2001 (Strier and Boubli, 2006).

The long-term viability of the RPPN-FMA mureiquis is critical to the future survival of this species. Our ongoing studies here will continue to provide valuable insights into the reproductive ecology and population demography of this vital population.

Acknowledgments

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Appendix

Student participation in the Muriqui Project of Caratinga, Matão Project. Strier and Boubli (2006) provide a list of all student participants in muriqui research at the RPPN-FMA through 2005.

2005–2006	Fernanda Tabacow (Bachelors from Universidade Federal de Espírito Santo)
2005–2006	Maíra de Loucenço Assunção (Undergraduate at Pontifícia Universidade Católica de Minas Gerais)
2004–2005	Janaina Fidelis de Oliveira (Undergraduate at Pontifícia Universidade Católica de Minas Gerais)
2004–2005	Danusa Guedes (Bachelors from Pontifícia Universidade Católica de Minas Gerais)
2003–2004	Karynna T. de Souza (Bachelors from Pontifícia Universidade Católica do Paraná; currently MA student)
2003–2004	Vagner de Souza (Bachelors from Universidade Federal de Espírito Santo; currently MA student)
2002–2003	Fernanda P. Paim (Bachelors from Universidade do Vale do Rio dos Sinos, Rio Grande de Sul)
2002–2003	Maria Fernanda F. F. Iurck (Bachelors from Pontifícia Universidade Católica do Paraná)
2001–2003	Carla de Borba Possamai (Bachelors from Pontifícia Universidade Católica do Paraná; currently MA student)
2001–2002	Regiane Romanini de Oliveira (Bachelors from Universidade Federal de Viçosa; currently MA student)
2000–2001	José Cassimiro da Silva Júnior (Bachelors from Universidade Federal de Minas Gerais)
1999–2001	Waldney P. Martins (Bachelors from Universidade Federal de Minas Gerais, currently MA student)
1999–2001	Vanessa O. Guimarães (Bachelors from Universidade Gama Filho, Rio de Janeiro)
1998–1999	Luiz Gustavo Dias (Bachelors and Masters from Universidade Federal de Minas Gerais)
1998–1999	Cristiane C. Coelho (Bachelors and Masters from Pontifícia Universidade Católica de Minas Gerais)
1998–1999	Cláudio P. Nogueira (Doctorate from Universidade Federal de Minas Gerais)
1997–1998	Dennison Carvalho (Bachelors from Universidade Federal de Minas Gerais)
1997–1998	Nilcemar Bejar (Bachelors from Universidade Federal de Minas Gerais)
1996–1997	Andréia Silene de Oliveira (Bachelors from Faculdades Metodistas Integradas Izabela Hendrix, Belo Horizonte)
1996–1997	Laiena T. Dib (Masters from Universidade Federal de Minas Gerais)
1995–1996	Cláudia G. Costa (Masters from Universidade Federal de Pará)
1994–1996	William A. Teixeira (Bachelors from Pontifícia Universidade Católica de Minas Gerais)
1994–1995	Maria Amélia F. Maciel (Bachelors from Universidade Federal de Viçosa)
1994–1995	Rodrigo Cambará Printes (Bachelors from Universidade Federal de Rio Grande de Sul; Masters from Universidade Federal de Minas Gerais, currently PhD student)
1993–1994	Sebastião da Silva Ramos Neto (Bachelors from Universidade Federal de Viçosa)
1993–1994	Adriana Odália Rímoli (Doctorate from Universidade de São Paulo)
1992–1994	Lúcio P. de Oliveira (Bachelors from Universidade Federal de Juiz de Fora)
1992–1994	Cláudio P. Nogueira (Masters from Universidade de Guarulhos)
1992–1993	Ana Rosa Dias de Carvalho (Bachelors from Universidade de Taubaté)
1991–1992	Paulo Coutinho (Universidade Federal de Pará, Masters earned)
1991–1992	Fernanda Neri (Universidade Federal de Minas Gerais, Masters earned)
1990–1991	Francisco D. Mendes (Doctorate from Universidade de São Paulo)
1987–1990	José Rímoli (Masters from Universidade de São Paulo)
1989–1990	Adriana Odália Rímoli (Masters from Universidade de São Paulo)
1986–1987	Francisco D. Mendes (Masters from Universidade de São Paulo)
1983–1984	Eduardo M. V. Veado (Bachelors from Universidade Federal de Minas Gerais)