

## Twinning in Tufted Capuchins (*Cebus apella*): Rate, Survivorship, and Weight Gain

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### Key Words

Twins · Twinning · Capuchin · *Cebus apella* · Multiple births · Reproduction

### Abstract

We calculated the rate of twinning across four captive collections of tufted capuchins (*Cebus apella*) to be 2.4%. This rate contrast with previous reports that twinning in tufted capuchins is rare. Additionally, we present data on the survival and weight gain of twins in this species as compared to singletons. Twins face their greatest risk of mortality on or before the first day of life, when 45% will die compared to 16% of singletons. After the first day of life, twins and singletons demonstrate comparable survival rates. This, in conjunction with the finding that at no time during the first year of life do twins and singletons differ significantly in their weights, suggests that twinning is a viable reproductive form for these animals, especially in the captive setting where nutritional demands are met.

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### Introduction

Singleton births are the reported norm in *Cebus* [Napier and Napier, 1967; Nagle and Denari, 1982; Hayssen et al., 1993]. Indeed, we found only 6 published reports of twinning in the literature for this genus. Stott [1953] reported that a set of twin tufted capuchins (*Cebus apella*) had been born in August of 1952 in the Zoo-

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logical Garden of San Diego, but the report provided no information as to the twins' survival or development. Eisenstein and D'Amato [1973] reported another instance of twinning in *C. apella*; 1 twin was stillborn. No information (except sex) concerning the surviving twin was provided. Bushmitz Moshe reports 3 cases of twinning in *C. apella*, with 2 individuals from different twin pairs surviving [as reported in Pissinatti et al., 1999]. Mannu and Ottoni [2000] report 2 instances of twinning in a colony of semi-free-ranging *C. apella* in the Tieté Ecological Park of São Paulo, Brazil. Both sets of twins were born to the same mother and comprised 2 of the 11 observed litters in a 4-year period. Of the first set of twins, 1 infant did not survive birth, while the other was 3.5 years of age at the time of the report. In the second set of twins, 1 infant died on the second day of life and the other was still alive at 1 year of age (at the time of the report). Additionally, Pissinatti et al. [1999] report a surviving set of twins was observed in *Cebus xanthosternos* [taxonomy per Rylands et al., 2000]. Manson [1999] provides the only documentation of twinning in wild capuchins (*Cebus capucinus*), a single case in which both twins survived for at least 3 months. Collectively, these reports suggest that twinning is rare in the genus, and that survivorship of twins is only moderate.

Here we document the rate at which twin litters occur in several colonies of tufted capuchins and the subsequent survival rates of twins compared to singletons. In addition, we describe the weight gain of twins from one colony by comparing their weight gain over the first year to that of singleton infants in the same colony.

## Methods

We gathered data on birth rates and survival of singleton and twin infants born over a 15-year period (1985–1999) using the records of breeding colonies of tufted capuchins maintained by the Laboratory of Comparative Ethology at the National Institutes of Health Animal Center in Poolesville, Md., USA (NIHAC), the University of Georgia (now maintained by LABS of Virginia in Hampton, S.C., USA), Kassel University, Kassel, Germany (data provided by C.W.), and the Istituto di Psicologia, CNR, Rome, Italy (data provided by E.V.).

A total of 425 pregnancies resulting in litters formed the database from which rates of twinning were calculated.

### *Rate of Twinning*

To calculate the rate of twinning we recorded the total number of pregnancies that resulted in twin litters and divided this number by the total number of pregnancies resulting in litters.

### *Survivorship of Twins*

We recorded the outcome of each litter observed as one of the following: stillbirth or death on day 1, death between day 2 and day 30, and survived first 30 days. Day 1 was defined as the first day the infant was observed to be present in its group. The category of 'stillbirth or death on day 1' was used due to the variability among the four collections in how they recorded stillbirths and fetal deaths. Therefore, any infant found dead when it had previously not been observed was recorded as a 'stillbirth or death on day 1'. We calculated the percentage of twin and singleton litters resulting in each reproductive outcome from these data.

**Table 1.** Survivorship of twins versus singletons in the first month of life

Birth type	Total individuals born	Stillbirths or deaths on day 1	Deaths during days 2–30	Survived first 30 days
Singletons	415	65	64	286
Twins	20	9	2	9

#### *Weight Gain of Twins*

We compared weight gain of twins ( $n = 6$  individuals) and singletons ( $n = 37$ ) over the first year of life for infants of the NIHAC colony. These infants were used because infants from this colony are weighed during frequent medical examinations in their first year, although birth weights are not collected. Since weights were not collected on a regular schedule, we averaged weights for individual animals in 3-month blocks (months 1–3, 4–6, 7–9 and 10–12). Weights of twins and singletons were then compared by block using an independent-samples  $t$  test, with two-tailed  $\alpha$  set at 0.05.

## Results

#### *Rate of Twinning and Survivorship of Twins*

Of the 425 pregnancies that resulted in litters, 10 pregnancies resulted in twin litters. Thus 435 individuals were born, 20 of which were twins. The rate of twinning in tufted capuchins in our sample is therefore 2.4% (10 sets of twins/425 pregnancies). Four of the 10 sets of twins were born in the NIHAC colony, 3 sets in the UGA/LABS of Virginia colony, and the remaining 3 sets were born in the CNR (Rome) colony. The total number of individuals born during this 15-year period was 80 for the NIHAC colony, 140 for the UGA/LABS of Virginia colony, 42 for the CNR (Rome) colony, and 173 for the colony at Kassel University.

Nine of the 20 individual twins were stillborn or died on the first day of life (45%), whereas 65 of the 415 singletons died in this period (16%). Two of the remaining 11 twins died between days 2 and 30 of life (18%), whereas 64 of the remaining 350 singletons died during this time (18%). Therefore, 45% of all twins (9 individuals) and 69% of singletons delivered survived past 30 days (see table 1). The 9 twins that survived the first month of life consisted of 3 complete surviving sets of twins and 3 individuals.

#### *Weight Gain of Twins and Singletons*

The weights of twin and singleton infants did not differ significantly in any 3-month block across the first year [ $t(11) = -0.590$ ;  $t(17) = -0.927$ ;  $t(9) = -1.049$ ;  $t(18) = -1.225$ ;  $p = 0.57, 0.37, 0.32$  and  $0.24$ , respectively].

## Discussion

Previous reports have stated that twinning is rare in *C. apella* [Napier and Napier, 1967; Nagle and Denari, 1982; Hayssen et al., 1993]. From our records of reproduction in four collections of captive tufted capuchins it has become clear that

twinning, although not common, occurs more often in this species than previously reported (2.4% of all births).

It is important to note that we have no reports yet of twinning in tufted capuchins (*C. apella*) in a completely wild setting, although Manson's [1999] report of an instance of twinning in wild *C. capucinus* and the 2 cases observed by Mannu and Ottoni [2000] in a semi-free-ranging group of *C. apella* suggest that this will eventually be observed. However, it seems likely that twinning is more common in captive than in wild populations. A possible explanation for the presumed difference between wild and captive populations in the rates of observed births of twins concerns the differential health of females in the two circumstances. Captive environments provide adequate nutritional and medical support to meet the demands of gestating and feeding a second infant; natural environments may not, or not to the same degree. In support of this argument, rates of twinning in highly provisioned semi-free-ranging groups of ringtailed lemurs (*Lemur catta*) are significantly higher than in groups experiencing low provisioning or no provisioning [Pereira, 1993]. On the other side of this argument, there are factors that may lead to underestimating the rate of twinning in the wild as compared to the captive environment. These factors include lack of detection of twin sets in the wild due to infant sharing among females, which may go unnoticed by the observer (this may also lead to the declaration of a 'pseudo-twin' when a female is observed carrying two infants), and a potential increase in twin mortality during the perinatal period in the wild, which could decrease the detection of twins [Geissmann, 1989].

Tufted capuchin twins' greatest risk for mortality is stillbirth or death during the first day of life, a time when 45% of twin infants (as compared to only 16% of singleton infants) die. This finding suggests that supporting the growth of 2 fetuses is a greater challenge, even for a well-fed and healthy female in a captive colony, than supporting the growth of a single fetus. If a twin does survive its first day after birth, then its chances for survival are similar to that of singletons during the first month of life (18% mortality for both cases). This, in combination with the finding that at no time during the first year of life were twins and singletons significantly different in weight, suggest that twin infants can grow normally and that the mother is capable (in captivity, at least) of supporting the lactational demands of rearing 2 infants.

The extent of allonursing in this genus may contribute to the survival of twin infants after birth. Capuchins are unusual in the extent to which females nurse infants other than their own, both in captivity and in nature [Robinson and Janson, 1986; O'Brien, 1988; Weaver, 1999]. It is easy to see how allonursing could contribute critically to survival of a twin infant in nature. Manson [1998] reports that a *C. capucinus* mother of twins took 1 twin and disappeared from the group for a period of days. When the group was located again, both twins appeared healthy; presumably the second twin was allonursed by other females in the group. In captivity, allo-nursing is probably not critical to the survival of the twin infant, although it could still contribute to normal weight gain. A female's ability to rear 2 offspring simultaneously in captivity was demonstrated in 2 cases we observed in the UGA/LABS of Virginia colony, where females adopted infants less than 1 month old, rearing them thereafter as their own while still rearing their own young infants. In effect, this is facultative twinning. Unfortunately, since the analyses conducted here used pre-existing colony records, we were unable to document the pres-

ence of allonursing for these sets of twins. Analysis of allonursing in subsequent twin births could provide a test of the hypothesis that twins are more likely to be allonursed than singletons.

Determining the links in nonhuman primates between nutrition and other aspects of health on the one hand and the rate of conceiving twins and their survival on the other hand is an interesting task for reproductive biologists. Our findings suggest that health factors (adequate nutrition of mothers and infants in a captive setting) significantly affect the conception and survivorship of twins. Also of interest would be an examination of the genetic contributions to twinning in this and other species. In our observations, 2 mothers each conceived 2 sets of twins. Additionally, 1 of these mothers was the maternal granddaughter of a female that had also produced twins. Mannu and Ottoni [2000] also report 2 instances of twinning to the same mother. These observations suggest the potential for a genetic contribution to the production of twins in *C. apella*.

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