

Escape from Social Suppression of Sexual Behavior and of Ovulation in Female Common Marmosets^a

WENDY SALTZMAN,^b NANCY J. SCHULTZ-DARKEN,^b JESSICA M. SEVERIN,^{b,c} AND DAVID H. ABBOTT^{b,d}

^b*Wisconsin Regional Primate Research Center,*

^c*Department of Chemistry, and*

^d*Department of Obstetrics and Gynecology*

University of Wisconsin-Madison

Madison, Wisconsin 53715-1299

In cooperatively breeding species, socially subordinate animals typically curtail their reproductive efforts and help to rear the offspring of the dominant individuals. This reproductive inhibition can be mediated by social suppression of reproductive physiology and/or sexual behavior and is thought to be triggered by behavioral or sensory cues from the dominant animals. Such social suppression of reproduction is exemplified by the common marmoset (*Callithrix jacchus*), a small, cooperatively breeding New World monkey that usually gives birth to dizygotic twins. Most social groups of this species contain only a single, dominant, breeding female; subordinate females usually fail to ovulate and do not engage in sexual behavior.¹⁻³ However, reproductive suppression appears to be highly variable: subordinate females occasionally ovulate,^{3,4} and wild groups have been reported to contain two breeding females.⁵

To clarify the proximate causes of variation in the occurrence of reproductive suppression, we characterized the ovulatory activity of female common marmosets housed in either intact natal families ($n = 41$) or families into which an unrelated adult male had been introduced ($n = 13$) following the death of the father when the daughters were 10-11 months old (prepubertal) or following the experimental removal of the father when the daughters were 18-21 months old (postpubertal). Blood samples were collected twice weekly and assayed for plasma progesterone (P) by enzymeimmunoassay. Ovulation was considered to have occurred on the day preceding a sustained elevation of P above 10 ng/ml, and pregnancies were identified from P profiles and abdominal palpation and were confirmed by ultrasonography.⁷ To characterize the behavioral correlates of escape from reproductive suppression, we collected a total of 4 hours of focal-animal behavioral data from each of 17 daughters in intact natal families and 8 daughters in families containing an unrelated male.⁷

Ovarian activity ranged from anovulation to isolated ovulatory cycles to regular, repeated cycles. In intact natal families, 46.3% of daughters (19 of 41) ovulated at

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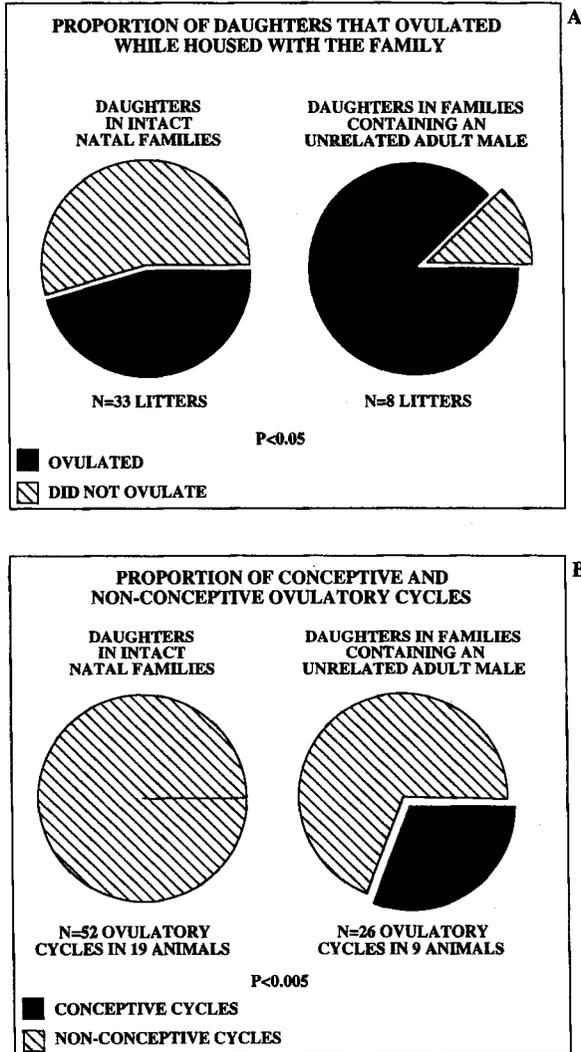


FIGURE 1. (A) Proportion of litters in which at least one daughter ovulated while housed in intact natal families or in families in which the father had been replaced by an unrelated adult male. (B) Proportion of conceptive and non-conceptive ovulatory cycles in daughters that ovulated while housed in intact natal families or in families in which the father had been replaced by an unrelated adult male.

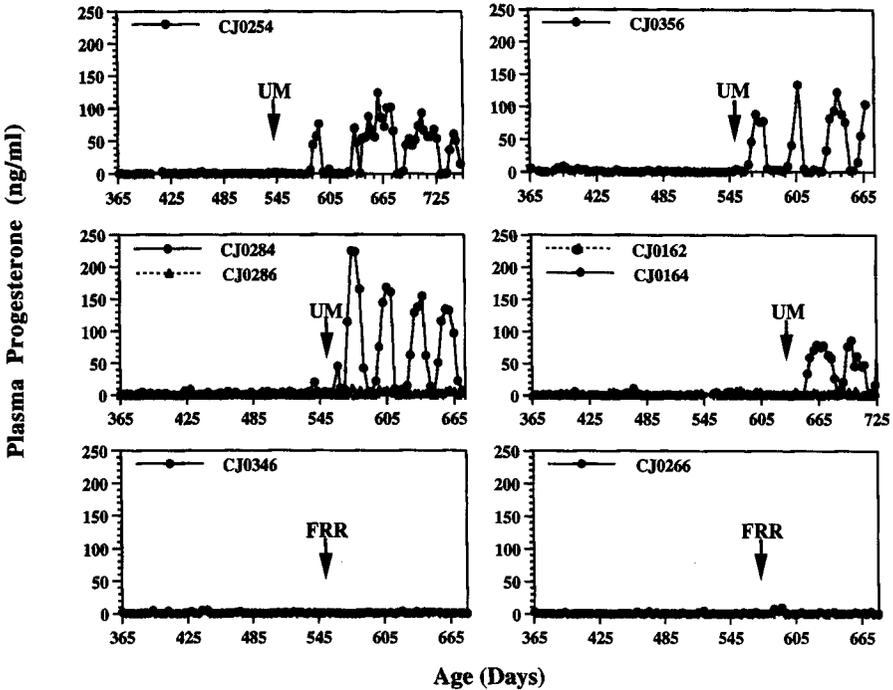


FIGURE 2. Representative plasma progesterone profiles of the eldest daughter (**top**) or eldest twin daughters (**middle**) in families in which the father was removed and replaced by an unrelated male or in which the father was removed and immediately returned as a control condition (**bottom**). Arrows indicate day of father removal/unrelated male introduction (UM) or father removal/return (FRR).

least once, and at least one daughter ovulated in 45.5% of all litters (15 of 33).⁶ In families in which the father had been replaced by an unrelated adult male, in contrast, a daughter ovulated in 87.5% of litters (7 of 8; $p < 0.05$; FIG. 1A). In these families, but not in intact families, ovulation was typically restricted to only one daughter in each litter. When unrelated males were introduced into families containing anovulatory, postpubertal daughters, immediately following removal of the father, the eldest daughter underwent her first ovulation after a mean \pm SEM latency of 17.0 ± 6.3 days (FIG. 2). Removal and immediate return of the father, in contrast, did not reliably stimulate ovulation in postpubertal daughters.

Replacement of the breeding male not only stimulated ovulation in daughters but also frequently led to conception: daughters in families containing an unrelated male conceived in 30.8% of ovulatory cycles (26 cycles in 9 daughters), whereas no daughter ever conceived in an intact natal family (52 cycles in 19 daughters; $p < 0.005$; FIG. 1B). Replacement of the breeding male also caused marked behavioral changes in adult daughters.⁷ Cycling daughters in families containing an unrelated male ($n = 5$) received significantly more sniffs from the breeding male than did

cycling ($n = 7$; $p < 0.05$) or acyclic daughters ($n = 10$; $p < 0.005$) in intact natal families or acyclic daughters in families containing unrelated males ($n = 3$; $p < 0.05$); moreover, they were the only daughters to receive mounts or attempted mounts from the breeding male and to perform proceptive and receptive behaviors to him ($ps < 0.05$). Additional changes were seen in the daughters' interactions with their mothers: cycling daughters in families containing unrelated males groomed and huddled their mothers significantly less often than did acyclic daughters in intact natal families ($ps < 0.05$). Furthermore, only 20% of cycling daughters in families containing unrelated males performed submissive behavior to their mothers, whereas 59% of daughters in intact natal families and all acyclic females in families containing unrelated males did so. Within intact natal families, cycling and acyclic daughters showed no significant differences in their behavioral interactions with their mothers.

These findings indicate that almost half of all common marmoset daughters escape from social suppression of ovulation, but not from suppression of sexual behavior, while living in intact natal families. However, incorporation of an unrelated adult male into a family reliably stimulates the onset of both ovulation and sexual behavior in adult daughters, resulting in mother-daughter polygyny. Thus, both rank-related ovulation suppression and avoidance of mating with close relatives may contribute to reproductive failure in subordinate female marmosets.

REFERENCES

1. ROTHE, H. 1975. Some aspects of sexuality and reproduction in groups of captive marmosets (*Callithrix jacchus*). *Z. Tierpsychol.* **37**: 255-273.
2. ABBOTT, D. H. & J. P. HEARN. 1978. Physical, hormonal and behavioural aspects of sexual development in the marmoset monkey, *Callithrix jacchus*. *J. Reprod. Fertil.* **53**: 155-166.
3. ABBOTT, D. H. 1984. Behavioral and physiological suppression of fertility in subordinate marmoset monkeys. *Am. J. Primatol.* **6**: 169-186.
4. HUBRECHT, R. C. 1989. The fertility of daughters in common marmoset (*Callithrix jacchus jacchus*) family groups. *Primates* **30**: 423-432.
5. DIGBY, L. J. & S. F. FERRARI. 1994. Multiple breeding females in free-ranging groups of *Callithrix jacchus*. *Int. J. Primatol.* **15**: 389-397.
6. SALTZMAN, W., N. J. SCHULTZ-DARKEN & D. H. ABBOTT. 1997. Familial influences on ovulatory function in common marmosets (*Callithrix jacchus*). *Am. J. Primatol.* In press.
7. SALTZMAN, W., J. M. SEVERIN, N. J. SCHULTZ-DARKEN & D. H. ABBOTT. 1997. Behavioral and social correlates of escape from suppression of ovulation in female common marmosets housed with the natal family. *Am. J. Primatol.* **41**: in press.