

Lactation in male fruit bats

SIR — Although male lactation is physiologically possible¹, it is isolated and rare. It has been observed in domesticated mammals^{2,3} and in humans^{4,5}, but it has not been reported in wild, free-ranging species. Here we report lactation by males in a population of Dayak fruit bats, *Dyacopterus spadiceus* (Chiroptera: Pteropodidae), in the Krau Game Reserve, Pahang, Malaysia.

In July and August 1992, we captured 18 *D. spadiceus* in mist nets 8–30 m above the ground in the subcanopy of a lowland rainforest at Kuala Lompat in the game reserve. Of the 13 males that were captured, 10 were judged to be mature based on fully-ossified wing joints and descended testes. Each of the mature males also had functional mammary glands from which small amounts of milk were ex-

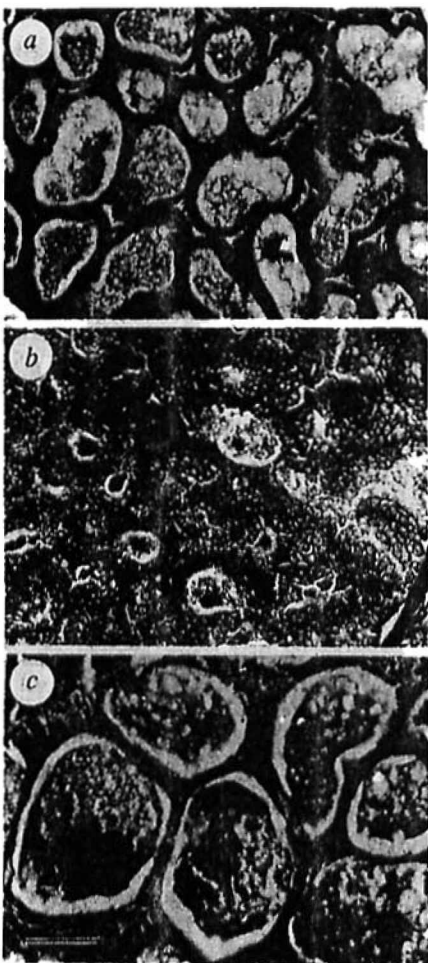


FIG. 1 Histological sections of mammary gland alveolar tissue in a lactating female *D. spadiceus* (a), a non-lactating female (b) and a lactating male (c). The glands were fixed by immersion in 10% buffered formalin, passed through a dehydrating series of ethanols followed by xylene, and embedded in Paraplast Plus. Sections were cut to a thickness of 10–15 μm and stained with Delafield's haematoxylin and eosin. Bar, 50 μm .

pressed. Among the five females that we captured, three were mature, but milk could be expressed from only one in response to manual palpation.

Although some milk was expressed from each of the adult males, the amounts were relatively small. From two males captured in late August, only 4–6 μl were obtained, compared to 350 μl from the right mammary gland of a single adult female. The nipples of the males were smaller and less cornified than those of the females, suggesting little if any suckling activity by the young.

We examined histological sections of the mammary glands and testes of three males, and the mammary glands of two females (one of which was lactating), using light microscopy (Fig. 1). The secretory tissue of the lactating female (a) was thicker and better developed than in the non-lactating female (b). In the males, secretory tissue occupied a layer similar in total thickness to that of the non-lactating female. In two of the males, most alveoli were more distended than in the lactating female, ranging in diameter from 80–140 μm (c). The distension of the alveoli, as well as the consistent presence of secretory material, suggests that milk may have accumulated in the alveoli as a result of not being suckled. In the third male that we examined, the alveoli were less distended, resembling those of the lactating female.

Large mammary ducts were conspicuous in males. These ducts contained secretory material and coursed centrally towards the nipple from the peripherally located alveolar tissue. Multiple lactiferous ducts entered the nipple and opened onto its surface (Fig. 2).

The histological appearance of the testes in the two males with the more distended alveoli was consistent with active spermatogenesis. All stages of developing germ cells were observed in the seminiferous tubules, and these tubules had patent lumina. The significance of testicular histology in the third male was uncertain, as germ cells in all developmental stages were present, but there were few seminiferous tubules with open lumina.

Male lactation may not occur in all populations of *D. spadiceus* or it may vary seasonally. For example, from another sample of 17 individuals netted in Septem-



FIG. 2 Vertical section of the nipple of a lactating male *D. spadiceus*, illustrating lactiferous ducts. At the tip of the nipple (top), material expressed from these ducts appears to have adhered to the epithelium during fixation. Bar, 200 μm .

ber 1992 in Sabah, six were mature males with enlarged testes, but none was obviously lactating, nor were the eight apparently mature females. In contrast, one of four mature males caught in August 1993 in Perak was lactating, as was one of the five mature females captured at the same time (two females were pregnant).

Male lactation has been reported only in highly inbred domestic animals^{2,3} or in humans in association with hormone treatments or pathological conditions^{4,5}. Reports of gynecomastia^{6,7} (breast development) in human males indicate that given sufficient levels of oestrogen and progesterone, mammary glands will undergo hypertrophy and hyperplasia. Elevated circulating oestrogen levels may result from: liver malfunction, which can hinder its inactivation and clearance; from 5 α -reductase deficiency, in which failure to convert testosterone to dihydrotestosterone provides excess substrate for aromatization of androgen to oestrogen; or from dietary or topical exposure to phytoestrogens. Another possibility is that in male *D. spadiceus* mammary glands contain an aromatase system that converts circulating testosterone into oestrogen, in the same way that the hypothalamus of a neonatal male converts circulating testosterone locally to oestrogen during hypothalamic masculinization. If, in addition, there are high circulating levels of progesterone derived from the adrenal gland, as in some species of *Pteropus* (L. Martin, personal communication) and circulating levels of prolactin are adequate, an endocrine status conducive to lactation can be imagined.

Studies on circulating hormones in this

- Daly, M. *J. theor. Biol.* **8**, 325–345 (1979).
- Nair, B. R. K., Mathai, E. & Kunjikutty, N. *Kerala J. Vet. Sci.* **1**, 145–150 (1981).
- Daly, M. *Sex, Evolution and Behaviour* (Prindle, Weber & Schmidt, Boston, 1983).
- Huggins, C. & Dao, T. L.-Y. *Cancer Res.* **14**, 303 (1954).
- Greenblatt, R. B. *Med. Asp. Hum. Sexual.* **6**, 25–33 (1972).
- Cowie, A. T. in *Reproduction in Mammals* Book 3 (eds Austin, C. R. & Short, R. V.) 106–143 (Cambridge University Press, 1972).
- William, R. & Turner, C. W. *J. Dairy Sci.* **44**, 524 (1961).

bat will help clarify the physiological basis for male lactation. On theoretical grounds, functional male lactation would be most likely to evolve in monogamous species¹, in which males share in the care of the young and have high certainty of paternity. Studies of the social structure of *D. spadicus* are required to determine whether they fit these criteria, and whether they actually provide young with milk.

Charles M. Francis

*410 Huron Avenue South,
Ottawa, Ontario K1Y0X1, Canada*

Edythe L. P. Anthony

*Department of Biology,
Rhode Island College,
Providence, Rhode Island 02908, USA*

Jennifer A. Brunton

Thomas H. Kunz*

*Department of Biology,
Boston University,
Boston, Massachusetts 02215, USA*

* Author for correspondence