

Food-Passage Time in *Nyctophilus gouldi* (Microchiroptera: Vespertilionidae)

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FOOD-PASSAGE TIME IN NYCTOPHILUS GOULDI (MICROCHIROPTERA: VESPERTILIONIDAE)

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Temperate-zone insectivorous bats have attracted great interest because of their physiological and behavioral adaptations to pronounced seasonality (McNab, 1982). As mammals with an energetically expensive mode of locomotion and a limited food supply, bats should, and often do, feed rapidly (Fenton, 1982). One relevant physiological adaptation that has received little attention is the rate at which food is passed through the digestive tract of bats. Rapid processing of ingested food is of obvious advantage to energy-limited animals, particularly when insect prey are not equally available at all times of the night (Swift, 1980; Williams, 1935, 1939), and should be exploited as efficiently as possible.

Food passage times of bats on insect diets are known only from two *Myotis lucifugus* (Buchler, 1975) and one *Nyctalus noctula* (Cranbrook, 1965). Buchler (1975) found that passage time of a male and a nulliparous female *M. lucifugus* were similar, but varied with postfeeding activity level. He also suggested that passage times of females may vary with reproductive state. The purpose of the work reported herein was to examine the effect of reproductive state on food-transit time in an Australian vespertilionid, *Nyctophilus gouldi*.

Animals used in this study were four male and four female *N. gouldi* from a captive colony at the Australian National University, Canberra. Bats were maintained on mealworms (*Tenebrio*) provided on a tray in their flight arena (a 6- by 3- by 2.5-m flyscreen enclosure), and always had access to water. To determine food-passage time, I followed Buchler's (1975) procedure of feeding the bats only with a new prey type (in this case, an assortment of noctuid and geometrid moths) on a given evening and noting the time for traces of the new diet to appear in feces. Individuals were either hand-fed moths or presented with free-flying moths; females in late pregnancy, for example, showed little interest in pursuing flying prey. To assess potential variation related to meal size, some bats were fed only two moths whereas others were allowed to consume as many as eight in a feeding bout. After feeding, bats were caught in a hand net and confined to a clean nestbox (the normal daytime roost), where they were watched until they defecated. To standardize the activity level during the trials, each bat was allowed to fly, either during or after feeding, for approximately 15 min. Near-term pregnant females again were reluctant to fly, and it was considered undesirable to stress them. The time that each fecal pellet appeared in the nestbox was noted, and all were removed for analysis. Pellets were teased apart in water under a zoom binocular microscope, and the contents identified. Fragments of mealworm cuticle were spotted easily as thick and ochre-colored, and moth scales were immediately distinguishable.

For passage times of moths, each pregnant female was tested twice, within 14–17 days and 5–8 days of parturition (12–15 November) and each lactating female was examined 10 and 20 days after the young were born. Each male also was tested twice between early October and mid-November. To assess passage time for mealworms and moths, males and lactating females were fed moths for the remainder of the night of the first trial, and on the following night; feces produced on the 2nd night bore no trace of mealworms. On the 3rd night of each trial, the same bats were fed mealworms, which they took from the feeding tray as usual. They were allowed 15 min of flight, usually enough time to eat 10 or more mealworms, then caught. Feces were collected and examined as in the earlier trials. Three males and three lactating females each were tested twice for passage time of mealworms.

The first fecal pellet collected always contained traces of the most recent meal. There was no difference between passage times for moths and mealworms (t -test, males: $t = 0.05$, $P = 0.96$; lactating females: $t = 0.52$, $P = 0.61$), nor was passage time for moths affected by meal size ($t = 1.36$, $P = 0.22$), so these data for each class (males, pregnant females, and lactating females) were combined. Food-transit times within each class were surprisingly constant (males: $\bar{X} = 61 \text{ min} \pm 1.00 \text{ SE}$, $n = 14$; pregnant females: $63 \text{ min} \pm 0.68$, $n = 8$; lactating females: $45 \text{ min} \pm 0.41$, $n = 14$) and those of pregnant females were not significantly different from those of males ($t = 0.462$, $P = 0.66$). Data for pregnant females probably represent a maximum food-passage time, and do not support Buchler's (1975) idea that pregnancy greatly slows food transit. Passage times for lactating females did not change between 10 and 20 days after parturition ($t = 0.311$, $P = 0.76$), and were significantly shorter than those of males ($t = 11.81$, $P < 0.0001$). This decrease of about a quarter corresponds to a general increase in metabolism during lactation (Kunz, 1980), and is an appropriate response to the high food consumption required during this period (Grant, 1987; Studier et al., 1973). For all bats tested, a number of feces were passed in a short period. Thus, four–five pellets, representing almost the entire indigestible portion of each meal (estimated at 12–15%; Kunz, 1980) were ejected within 45 min (lactating females) or 1 h (other bats) of finishing the meal. This rapid flow-through of the whole meal contrasts with Kunz's (1974) data for *Myotis velifer*, in which most feces were retained for over 2 h, and some for as long as 8 h. It is noteworthy that *M. velifer* feeds in two main periods, one at the beginning and one at the end of the night, whereas lactating females of *N. gouldi* feed intermittently throughout the night when in captivity and probably also in the wild (Grant, 1987). For species feeding in many closely spaced bouts, rapid egestion of all feces before feeding excursions may be important in reducing body mass, hence flight costs.

Comparing data for male *N. gouldi* (body mass 11–12 g) with those for 'active' male and nulliparous female *M. lucifugus* (7–8 g, mean passage time 46 min; Buchler, 1975), there is an apparent increase in food-passage time with mass. The mean passage time of 122 min for *Eptesicus fuscus* (body mass 15–20 g) found by Luckens et al. (1971) also agrees with this trend, although these animals were fed an artificial food mixture (Davis and Luckens, 1966), and unfortunately attention was not given to the activity level of the bats. Cranbrook's (1965) observation of a 28-min passage time by one *N. noctula* feeding on mealworms

and beetles does not fit the pattern, but the activity level of this bat was not reported. Further work on this topic may yield a predictive equation based on body size that will find wide application in physiological, behavioral, and ecological studies of insectivorous bats.

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