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ago a very large Leopard seal was reported at Lord Howe. It was badly wounded and in a very bad temper. It is supposed to stayed about a month, but I did not see it."

I am most grateful to Mr. Rhoades for reporting the most recent occurrences of leopard seals on Lord Howe Island, and also to the Naval Historical Library, Ministry of Defence, London, for providing a photocopy of the relevant parts of John MacGillivray's journal.

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#### FOOD TRANSIT TIME IN *MYOTIS LUCIFUGUS* (CHIROPTERA: VESPERTILIONIDAE)

Several investigators have sought to identify, with varying success, the prey of various insectivorous bats by studying stomach contents (Pine, 1969; Easterla and Whitaker, 1972; Whitaker, 1972), fecal pellets (Hamilton, 1933; Black, 1972; Coutts, 1972; Coutts *et al.*, 1973), or culled insect fragments dropped by the bats at roosts (Poulton, 1929; Ross, 1961; 1967). Others have reported on feeding efficiency (Gould, 1955; 1959) or rates of food ingestion and energy utilization (Brisbin, 1966; O'Farrell *et al.*, 1971; Coutts *et al.*, 1973). Estimates of the total number of insects taken or studies of energy budgets must include allowance for rates of passage through the digestive tract and the number of times per night that the stomach is filled and emptied. However, few data are available concerning the rates of passage of food through bats. On one occasion, a European noctule (Vespertilionidae: *Nyctalus noctula*) began passing the remnants of beetles and mealworms 28 minutes after mastication began (Cranbrook, 1965). Big brown bats (Vespertilionidae: *Eptesicus fuscus*), when fed on "glop" (Davis and Luckens, 1966) containing 10 percent barium sulfate, defecated the marked material as early as 90 minutes after feeding (Luckens *et al.*, 1971). Klite (1965) studied two species of neotropical insectivorous bats, *Chilonycteris rubiginosa* (= *Pteronotus parnellii*) (Mormoopidae) and *Molossus major* (Molossidae), with respective mean body weights of 24.1 grams (g) and 10.7 g. In both species, the indigo-carmin dye solution which was injected into the stomachs via an orogastric catheter reached the terminal portion of the intestine in only 15 minutes. It is not clear, however, whether such a short passage time would occur with a normal diet of insects. Because of this paucity of information, I performed the following experiments to gather data on the passage times for the little brown bat, *Myotis lucifugus*.

One adult male and one adult nonparous female were mist-netted in early June 1973 as they left a colony at the Rockefeller University Center for Field Research near Millbrook, New York. They were maintained separately in small hardware cloth cages (14 by 18 by 24 centimeters) at room temperature. Both always had access to water and were fed, using forceps, each evening on mealworms (*Tenebrio molitor*) and a variety of local insects. After 3 days on this diet, I fed each bat six tent caterpillar moths (*Malacosoma americana*), a species that seemed particularly palatable to them, for two consecutive evenings (six moths per evening). On the third evening, I changed the diet to six large mealworms of approximately the same weight as the moths. Each daily ration weighed 1.0 to 1.2 g, enough to result in a reasonably full stomach for *M. lucifugus* (Gould, 1955). In all the trials, the bats consumed all the food in less than 5 minutes, usually culling the wings of the moths. After they had finished feeding, I simply noted the time when each fecal pellet was dropped and mapped its position on the floor of the cage. Several hours later, the pellets were collected, arranged in the

order in which they were dropped and examined under a 14–60 $\times$  zoom binocular dissecting microscope. After soaking a pellet in a Petri dish with water and teasing it apart, one could easily distinguish between the moth and mealworm fragments. Bright orange, relatively hard and thick pieces of exoskeleton characterized the mealworms whereas a multitude of scales and fragments of the thin, soft abdominal segments served to readily identify moth remains. To determine whether moths and mealworms were passed at different rates, I also performed the reciprocal of the above experiment; that is mealworms were fed for two evenings, then moths on the third evening.

I suspected that the degree of activity the bats displayed after eating was an important variable affecting transit time. On some occasions, they were very active, crawling about their cages intermittently for several hours. At the other extreme, one or both bats sometimes returned immediately to the cage ceiling after eating and became immobile within about 5 minutes. It seemed likely that their metabolic rates and passage times would differ depending upon their degree of activity. For this reason, postfeeding periods were judged as “active” when the bat frequently moved about its cage, had its eyes fully open, and responded rapidly to noises during the first 3 hours after eating. An “intermediate” level of activity included alert, mobile periods alternating with intervals of lethargy and sleep. A bat designated as “quiet” returned to its sleeping posture within 5 minutes after consuming the food and did not move about the cage for the next 3 hours, although it may have changed its posture to eliminate or groom for a short time.

Regardless of the composition of the food or the subsequent degree of activity, both bats voided usually one, and occasionally two fecal pellets during the feeding bout or within 10 minutes after its completion. Invariably, these pellets contained only fragments of the previous night's contrasting meal and a hair wad probably ingested during grooming sometime after eating. Luckens *et al.* (1971) concluded that 2 to 4 millimeters (mm) of the first 10 to 15 mm pellet dropped by *E. fuscus* after feeding contained the final remains of the previous day's food. In the wild, *M. lucifugus* probably would have voided these pellets during their thermogenic activity at the roost or shortly after leaving it. I found no appreciable amounts of hair in feces dropped later during the first 3 hours after feeding. Of eight adult *M. lucifugus* caught one evening in early May as they left the roost, three had completely empty digestive tracts, three had one pellet each remaining near the anus and two bats defecated one pellet each during handling while retaining a final pellet near the anus. Each of these pellets contained a sizable hair wad.

There is a clear relationship between passage times of the food items and the degree of activity of the bats (Table 1). A more active bat passes the insects in a shorter time. The passage time for a fully active, free-flying *M. lucifugus* may well be even less than the minimum of 35 minutes reported here for an active, caged individual. The bats returned to a quiet state after eating in eight of the 16 trials and required from 2.9 to 3.4 times longer to begin passing the same food items as when they were active. The retention times for both types of insects were roughly comparable despite the greater amount of hard chitin in the mealworm exoskeleton. The passage times reported here correlate reasonably well with those reported for *E. fuscus* by Luckens *et al.* (1971). Having approximately twice the weight of *M. lucifugus*, *E. fuscus* ( $N = 22$ ) required an average time of 122 minutes to pass marked food. The authors did not consider activity level of the bats. A transit time of 28 minutes for one *N. noctula* after eating beetles and mealworms (Cranbrook, 1965) is surprisingly short, especially considering that this bat has a body weight of 15 to 40 g (Walker, 1968), or approximately two to five times that of *M. lucifugus*. Again, however, no mention was made of the bat's postfeeding activity.

On the basis of this small sample, there appear to be no sex-dependent differences in transit times between a male and a nonparous female. However, pregnancy may affect this time markedly. Four female *M. lucifugus* carrying nearly full-term fetuses were collected in late June as they left the roost. Instead of having entirely or very nearly

TABLE 1.—*Passage times of mealworms and moths through the digestive tracts of two M. lucifugus.*<sup>1</sup>

Sex	Postfeeding activity level	Passage time (minutes) after feeding on	
		Mealworms	Moths
Male	Quiet	133, 122	170, 139
	Intermediate	65	79
	Active	46	54
Female	Quiet	165, 142	118, 160
	Intermediate	74	88
	Active	50	35

<sup>1</sup> Each datum represents one trial.

empty digestive tracts, all had several boluses of digesting food and fecal pellets in the posterior half of the intestine. Apparently, the compression and displacement of the intestine by the relatively large fetus causes the food to move more slowly.

In addition to the high caloric intake required of a small bat when it is homiothermic, the rapid transit times in active individuals make it even more reasonable to expect that *M. lucifugus*, and small bats in general, often fill and empty the digestive tract two or more times during a single night's foraging. The passage times for these later feeding bouts may be even shorter than the figures presented here for bats which started the feeding bout with virtually voided digestive tracts.

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#### TAXONOMIC STATUS OF *MICROTUS PENNSYLVANICUS ARCTICUS* COWAN

Cowan (*J. Mamm.*, 32:353-354, 1951) described *Microtus pennsylvanicus arcticus* on the basis of several voles trapped on the tundra at Kidluit Bay, Northwest Territories (69° 31'N, 133°47'W), that were significantly larger than *M. p. drummondii* in body length, tail length, condylobasal length, zygomatic width, greatest length of nasals, and greatest width of nasals. He also noted that the new *Microtus* was gray whereas *M. p. drummondii* in the forested parts of the Mackenzie Delta was characteristically brown. He postulated that *arcticus* arose from *drummondii* stock carried downstream on flotsam and isolated from the present stock by the intervening tundra and river. He did not, however, state why frequent re-introductions would not have occurred by the same means.

While studying *Clethrionomys rutilus* in the Mackenzie Delta from April 1971 through September 1973, I obtained 105 specimens of *M. pennsylvanicus* which permitted a re-examination of the status of *arcticus*. Three tundra series (Kidluit Bay, July 1973; Fish Island, 69°21'N, 134°54'W, August 1972; Tununuk Point and 11 to 13 kilometers north, 69°00'N, 134°40'W, July-September 1971-73) and one forest series (Inuvik, 68°21'N, 133°43'W, July-September 1971-73) were compared with Cowan's data from tundra (Kidluit Bay, July 1947) and forest (Aklavik, 68°12'N, 135°00'W, summer 1947). Specimens were examined from eight other tundra sites but the material was insufficient for statistical comparisons.

Only animals taken in summer with a high degree of cant formation on the skull were used to ensure that only fully grown (overwintered) individuals were compared. The "basal length" measurements reported by Cowan are not consistent with other published basal length measurements for *M. p. drummondii* but are consistent with condylobasal length measurements. Therefore I assume that there was a typographical error in the original paper and that Cowan's "basal lengths" are in reality condylobasal lengths. An analysis of variance and Duncan's new multiple range test were run on the populations. Representative specimens have been placed in the Zoology Museum of the University of Alberta.

The several series examined showed a general gradient in size from south to north, with the largest individuals living on the tundra (Tables 1 and 2). Cowan's Kidluit Bay animals and the Fish Island series are the largest in total length, condylobasal length, and zygomatic width, but this may be due in part to the general level of the