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The preliminary guidelines for field methods in mammalogy (*ad hoc* Committee on Acceptable Field Methods in Mammalogy, 1987) allow toe-clipping when no other marking methods are suitable; we concur with the implication that toe-clipping should be a method of last resort. Our personal observations are that ear-tagging seems to cause less discomfort in *Microtus ochrogaster*, but tags are often lost. Toe-clipping, although permanent, caused a short-term decrease in susceptibility to capture; this decrease persisted beyond the trapping period of marking in subadult animals. Also, toe-clipped males had a higher rate of movement than those ear-tagged. However, marking technique did not influence rate of change in body mass or disappearance from the grid, even though differences in susceptibility to capture could have influenced estimates of residence time. In general, therefore, we found no detrimental effects of toe-clipping that would preclude its use in field studies of *Microtus ochrogaster* populations.

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INFESTATIONS OF WILD *PEROMYSCUS LEUCOPUS* BY BOT FLY LARVAE

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The infestation of white-footed mice, *Peromyscus leucopus*, by the bot fly, *Cuterebra fontinella*, is by physical contact (Catts, 1982; Gingrich, 1981; Scholten, 1965; Wood, 1987). Bot flies lay eggs in environs frequented by *P. leucopus*. When stimulated by the body temperature of the mouse, the eggs quickly hatch and the larvae infest the host through the nose, eyes, or wounds. Because infestation requires that mice contact botfly eggs, mobile mice should encounter more eggs than sedentary mice. Many investigators of *P. leucopus* have shown that males are more mobile than females and adults are more mobile than juveniles (Adler and Tamarin, 1985; Goundie and Vessey, 1986; Krohne et al., 1984; Stickel, 1968; Wolff and Lundy, 1985; Wolff et al., 1988), which implies that infestations should vary among sex and age groups, assuming

TABLE 1.—Sex and age biased infestation of *Peromyscus leucopus* by bot fly larvae near London, Ontario, Canada during late summer 1987 and 1988. Expected values are calculated by assuming that only age and sex affect infestation rate.

Year	Age	Sex	Infested		Noninfested	
			Observed	Expected	Observed	Expected
1987	Adult	♂	6	6.6	4	3.4
		♀	3	3.2	9	8.8
	Young	♂	3	2.5	4	4.5
		♀	1	0.5	4	4.5
1988	Adult	♂	12	10.5	4	5.5
		♀	2	2.7	8	7.3
	Young	♂	5	6.4	13	11.6
		♀	1	0.6	5	5.4
Subtotal			33		51	

that mice do not have different degrees of resistance related to sex and age. This assumption is supported by empirical evidence (Gingrich, 1979; Scholten, 1965). We tested the hypothesis that the infestation of *P. leucopus* by bot fly larvae is biased by sex and age.

Our study was conducted north of London, Ontario, Canada (43°N, 81°W). According to Scholten's (1965) study on *C. angustifrons* (= *C. fontinella*—Catts, 1982; Sabrosky, 1986) in this area, adult females begin oviposition in late June. Well-developed larvae emerge in the inguinal region of *P. leucopus* in late July. Under laboratory conditions, 24% of mature larvae complete pupation in roughly 40 days and give rise to adults, whereas the remaining 76% enter diapause.

Local populations of *P. leucopus* inhabit deciduous forests where the breeding season extends from March to October (Millar et al., 1979). Our sampling periods for bot fly-infested mice were between 27 July and 26 August in 1987 and between 16 and 24 August in 1988; our sampling did not include the entire potential infestation period, which may include a second period of infestation, particularly at low latitudes (Wood, 1987). Populations of *P. leucopus* were sampled by use of Longworth live traps provided with cotton bedding and sunflower seeds. Forty-five live traps were used in 1987 and 88 in 1988. Sex, age (adult, juvenile, on the basis of pelage color), and number of externally visible bot fly larvae were recorded for each mouse. Captured mice were ear-tagged so that the same individual would not be recorded twice. These data were used to compare infestations of *C. fontinella* among sex and age groups of *P. leucopus* (Table 1). We used a log-linear model (Berenson et al., 1983; Bishop et al., 1975) for analyzing contingency tables.

Five hypotheses were tested by use of the data in Table 1. We first tested for the presence of three- and four-factor effects: whether the effect of sex on infestation depended on age, whether the effect of sex and age on infestation depended on year, and, if the effect of sex on infestation depended on age, whether this dependence changed from 1987 to 1988. The null hypothesis that there is no three- and four-factor effect was not rejected ($G^2 = 2.50$, $d.f. = 5$, $P = 0.776$). We next tested for the presence of two-factor effects. With four factors (year, age, sex, and infestation), there were six two-factor effects: age effect on infestation, sex effect on infestation, year effect on infestation, year effect on age structure, year effect on sex ratio, and age effect on sex ratio. The overall test revealed the presence of at least one two-factor effect ($G^2 = 19.51$, $d.f. = 6$, $P = 0.003$). To identify which of the six two-factor effects was responsible for the statistical significance, we tested the effect of sex on infestation ($G^2 = 10.14$, $d.f. = 1$, $P = 0.002$) and the effect of age on infestation ($G^2 = 5.97$, $d.f. = 1$, $P = 0.014$). These two two-factor effects together accounted for 83% [(10.14 + 5.97)/19.51] of all six two-factor effects. Finally, we tested whether predicted values based on sex and age effects on infestation fit sufficiently well to our observed data (Table 1) and found the fit satisfactory ($G^2 = 10.68$, $d.f. = 9$, $P = 0.298$). These results led us to conclude that males are more heavily infested than females and adults more heavily infested than juveniles.

Most previous investigators of the infestation of *P. leucopus* by bot fly larvae have not reported clear differences in infestation rates between the sexes. Of 11 studies dealing with sex-related infestations of *P. leucopus* by bot fly larvae, nine showed no significant differences in infestation rates between sexes (Childs and Cosgrove, 1966; Dalmat, 1943; Dunaway et al., 1967; Hunter et al., 1972; Miller and Getz, 1969; Scholten, 1965; Test and Test, 1943; Timm and Cook, 1979; Wecker, 1962), and only two (Geortz, 1966; Sealander, 1961) reported significantly male-biased infestations. Moreover, when one sex tended to have heavier infestations than the other, it was not always males (Dalmat, 1943; Timm and Cook, 1979). In his exhaustive review on the biology of New World bot flies, Catts (1982) cited six studies to support the statement that

infestation rates are generally higher in males than in females. Three of the six (Hunter et al., 1972; Timm and Cook, 1979; Whitaker, 1968) dealt with infestation of *Peromyscus* by bot fly larvae: Whitaker (1968) did not compare infestation rates between the sexes; Hunter et al. (1972) compared between sexes but found no statistically significant difference between them; Timm and Cook (1979) discussed why males were more heavily infested than females in *P. leucopus*, but they did not directly compare infestation rates between the sexes and their data showed that the average number of bot fly larvae per female was slightly greater than that per male. Thus, there are apparent inconsistencies among different studies in revealing a sex effect on infestation rate. These inconsistencies may reflect real differences among the host or parasite populations in different geographic areas, but they also may be related to differences in data-handling techniques by different investigators.

A close examination revealed that data in all previous studies were pooled by age, years, or populations, to test for sex differences in infestation rates. This practice of pooling data can result in erroneous conclusions. For example, suppose that infestation rates for adult males, adult females, juvenile males, and juvenile females are 60%, 50%, 6%, and 5%, respectively. If a sample of 116 animals with 10 adult males, 16 adult females, 50 juvenile males, and 40 juvenile females is obtained, six (=10 × 60%) adult males, eight adult females, three juvenile males, and two juvenile females likely will be infested. If age is ignored, the conclusion would have been that females tend to be infested more heavily than males because nine of 60 males (15%) are infested but 10 of 56 females (18%) are infested. Thus, pooling data leads to a false conclusion. Pooling data for different years or different populations with different infestation rates, age structures, and sex ratios may distort sex and age effects in a similar way. The inconsistencies in previous studies concerning sex effects on infestation rates may be related to the practice of pooling data.

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PHYSIOLOGICAL MONITORING OF GRAY WOLVES (*CANIS LUPUS*) BY RADIOTELEMETRY

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Remote monitoring of heart rate and body temperature by radiotelemetry provides a means to assess the response of an animal to the environment or to experimental manipulation without the obfuscation of physical or chemical restraint (Stohr, 1988). Heart rate or body temperature have been recorded telemetrically in many species (Ysenbrandt et al., 1976), but not gray wolves (*Canis lupus*). Herein, we report on the successful use of implantable radiotransmitters in gray wolves to monitor heart rates and patterns, respiratory rates, and body temperatures.

An adult breeding pair and their 2-year-old male and female offspring were housed in a 0.13-ha enclosure in Minnesota. All data reported herein were obtained from these four wolves. They were fed commercial dry dog food supplemented with vehicle-killed white-tailed deer (*Odocoileus virginianus*) and provided water ad lib. All wolves were free of heartworm (*Dirofilaria immitis*) infection. In January, a two-cell, 400-g radiotransmitter (Cedar Creek Bioelectronics Laboratory, East Bethel, MN) was placed surgically in the abdomen of each wolf. The animals were anesthetized with 400 mg ketamine hydrochloride and 50 mg promazine hydrochloride, placed in dorsal recumbency, and an area immediately distal to the xyphoid along the ventral midline was clipped and surgically scrubbed. Aseptic techniques were employed throughout the procedure. A 10-12-cm incision was made 4 cm distal to the xyphoid. Two sterile, 2-0 braided, stainless-steel suture wires were preplaced through holes drilled perpendicular to the long axis of the transmitter at both ends. The sterilized transmitter then was inserted into the abdomen with two heart-rate electrodes emerging from the cranial aspect of the incision. The ends of the preplaced suture wire were drawn through the abdominal wall and under the skin 2 cm lateral to each side of the incision. After closing the linea alba, the cranial and caudal suture wires were tied over the incision. Placement of the electrodes was accomplished by tunnelling subdermally in an anteriodorsal direction to either side of the heart in a lead I electrocardiographic configuration (Bolton, 1975). Subcutaneous tissue and skin then were closed with absorbable sutures.