The effects of toe clipping on the survival of the meadow vole (*Microtus pennsylvanicus*)

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A total of 68 pairs of female and 72 pairs of male voles were used to examine the effect of toe clipping on the survival of *Microtus pennsylvanicus*. Toe clipping did not significantly influence female life-span (average difference in life-span was 0.1 weeks) ($p > 0.05$), but did lower male life-span ($p = 0.07$). On average, toe-clipped male voles lived 2.1 weeks less than the controls. We suggest that the difference, although not statistically significant, may be biologically important. Shortening of life-span may have been a result of increased movement by toe-clipped males, brought upon by vole–vole interactions, into unfamiliar, possibly suboptimal habitats where increased mortality may have occurred.

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Soixante-huit paires de femelles et 72 paires de mâles de campagnols des prés (*Microtus pennsylvanicus*) ont servi au cours d'une étude sur les effets de la mutilation des orteils (amputation jusqu'à la jointure entre les deux premières phalanges) sur la survie. La mutilation des orteils n'a pas eu d'effet significatif sur la longévité des femelles (différence moyenne de longévité de 0,1 semaine) ($p > 0,05$), mais a diminué la longévité des mâles ($p = 0,07$). En moyenne, les mâles aux orteils mutilés ont vécu 2,1 semaines de moins que les mâles intacts. Bien que cette différence ne soit pas statistiquement significative, elle peut avoir une importance biologique. Il se peut que les interactions entre individus aient poussé les mâles à orteils mutilés à des déplacements vers des habitats non familiers, possiblement sub-optimaux, où la mortalité serait plus élevée.

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Introduction

Permanent identification of small mammals by toe clipping has been used for many years by biologists who require an inexpensive, rapid, and permanent identification system for rodent populations (Walker 1935; Ghiselin 1970; Kumar 1979). A number of alternative methods are also available (Short and Woodnott 1969; Southwood 1978), yet their relative effectiveness has not reduced the popularity of toe clipping.

Toe clipping may be applied in a number of forms depending on whether it is used alone (Kumar 1979) or in combination with ear notches (Walker 1935). Regardless of the manner in which it is applied, testing of possible effects of toe clipping on the survival of small mammals has been limited (Fullagar and Jewell 1965; Tamarin and Krebs 1969; Ambrose 1972).

Tamarin and Krebs (1969) examined the effects of taking blood samples by toe clipping their voles. In general, toe-clipped and bled voles had lower survival than nontoe-clipped and nonbled voles, especially among males during the summer months. However, the confounding effects of toe clipping and loss of blood makes it difficult to separate the two factors. In addition, proper controls were not used, so that survival of animals of different size classes were compared.

Ambrose (1972) examined the effects of toe clipping on the susceptibility of *M. pennsylvanicus* to predation by a semitame barn owl and Fullagar and Jewell (1965) looked at obvious physical defects on the toes of *Microtus* specimens. The results from these experiments suggested that toe clipping neither influenced predation nor produced any obvious detrimental consequences on the health of the voles.

This paper presents the results of a study on the effects of toe clipping on the survival of field populations of *M. pennsylvanicus*. We also attempted to differentiate between effects caused by the wounds and by the lack of toes.

Materials and methods

Individual *M. pennsylvanicus* were trapped with Longworth live traps baited with whole oats and supplied with cotton bedding. Three abandoned pastures in southeastern Ontario were selected as sites: Wolfe Island, neighbouring Amherst Island, and a site 2 km west of Amherstview (on the mainland). Traps were set in a 7 × 7 matrix at 7.6-m intervals.

All newly trapped voles were sexed (males: scrotal or abdominal; females: lactating, pregnant, both, or neither), weighed, and ear-tagged with fingerling prenumbered tags. In addition, as each second vole with similar weight (± 5 g) and sexual condition to a vole trapped during the same session was trapped, it was toe clipped (see Kumar (1979) for the method). The specific toes clipped were restricted to the toes corresponding to the number on the individually numbered ear tag. Toes were clipped at the interphalangeal joint of the first and second phalanges. Since pairs of voles were used in this experiment, one vole was ear-tagged and served as a control for its partner, who was ear-tagged and toe clipped. Paired mean tests (SAS package, "MEANS," Ray 1982) were used to analyse the data.

A total of 422 previously unmarked animals were trapped in the three areas from late August 1982 to early November 1983, while population densities were increasing or at high levels. Of these, 140 pairs of voles (280 voles) were incorporated into our analyses, since many voles could not be matched with an appropriate partner at the same site during the same trapping session. Matches were not made between areas. The fates of the 140 pairs of voles were monitored at various time intervals (2–6 weeks) after their initial capture and life-span was calculated. We recognize that this estimate of life-span cannot separate death on the area from emigration and, thus, it should be viewed as an index of residency.

Results

Sixty-eight pairs of female voles and 72 pairs of male voles were used in our analyses. On average, the body weights of the toe-clipped groups (mean $\pm$ SE: 28.7 $\pm$ 1.2 g/female, 32.1 $\pm$ 0.7 g/male) did not differ from their respective control groups (28.4 $\pm$ 1.2 g/female, 32.3 $\pm$ 1.0 g/male) ($p > 0.05$). Within

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TABLE 1. *t*-tests of paired comparisons of mean life-spans for male and female voles

Group	N	Mean difference (weeks)	SEM	<i>t</i>	<i>p</i> > <i>t</i>
Female	68	-0.1	1.62	-0.06	0.95
Male	72	-2.1	1.14	-1.85	0.07

pairs of voles, difference in weight rarely reached 5 g and this difference occurred randomly across treatment (toe clipped) and control groups. Since every treatment vole was uniquely associated with a control animal and results were similar for the three sites, the data were grouped to increase sample sizes. The mean life-span between toe-clipped and control groups of females did not differ (0.1 weeks, $p > 0.05$; Table 1); however, toe-clipped males had shorter life-spans than control males (2.1 weeks; $p = 0.07$). This represents a decrease in life-span of 47%.

To determine whether any difference in life-span was due to the lack of toes or caused by toe clipping, we analysed the data with respect to (i) the number of toes clipped and (ii) whether the toes had been clipped from the front paws or the hind feet (Table 2). If the effect was due to the wounds, we might expect similar results whether the toes were clipped from the front paws or the hind feet. If the effect was due to the lack of toes, we might expect a more severe effect if the toes were clipped from the front paws, which are used more for food handling and in social encounters, than if they were clipped from the hind feet.

No comparison was statistically significant (Table 2). However, there are a number of trends in the statistics. In most cases the control animals, especially among males, lived longer than their toe-clipped partners. The mean difference (weeks) represents the average difference between the life-span of the toe-clipped voles and their controls. Negative values indicate that the control voles lived longer, on average, than the toe-clipped voles. The last three columns in Table 2 are a summary of the distribution of three outcomes: (i) the frequency with which toe-clipped voles lived longer than their controls (freq. $T > NT$), (ii) the frequency with which control voles lived longer than their toe-clipped partners (freq. $T < NT$), and (iii) the frequency of no differences recorded in life-span (freq. $T = NT$). A plus sign (+) identifies the larger value between freq. $T > NT$ and freq. $T < NT$. For example, +6 in row 1 (freq. $T > NT$) means that there were six pairs of voles in which the control vole lived longer than the toe-clipped vole and that this category occurred more often (+) than the reverse situation.

These results suggest that, among females, toe clipping does not seem to affect life-span in any consistent manner. Three of the seven conditions (mean difference, weeks) showed an increase in life-span with toe clipping, whereas the remaining four conditions suggested the opposite. Among males, however, six of the seven conditions resulted in the control voles having longer life-spans than the toe-clipped voles. In addition, the differences were larger, but not significantly so, as the number of toes clipped was increased. Among females, toe-clipped voles lived longer in 24 pairs, whereas control voles lived longer in 25 pairs. Among males, toe-clipped voles lived longer in 9 pairs, whereas control voles lived longer in 20 pairs.

Comparisons between front paws and hind feet were not consistent. In general, there are no obvious differences in the

results between the groups. However, the data were far from ideal as a result of great disparity in sample sizes.

Discussion

Toe clipping does not have any significant effect on the survival of female *M. pennsylvanicus*, but may have detrimental effects on male survival, whose normal (nontoe-clipped) life-span is generally 2.4 weeks shorter than females. Male life-span differed from an average of 4.5 weeks in control voles to 2.4 weeks in toe-clipped voles. Therefore, toe-clipped male voles lived 4.5 weeks less than control females.

The reasons for the decrease in life-span between control and toe-clipped males are not obvious. Although other causes, such as alteration of social status leading to emigration, cannot be ruled out, mortality is likely the main factor. Mortality could have been a result of the wounds, of the difficulties caused by the absence of toes, or of a combination of both. Our experiment does not suggest that wounding, by itself, affects vole life-span in a consistent manner. Since we cannot justifiably make the assumption that females are less prone or more resistant to infection, the differences in survival between males and females suggest that behavioral interactions between conspecifics may be involved for males. We observed little blood loss during the toe clipping process and infected toes were rarely found on toe-clipped individuals. Voles recover from some seemingly serious injuries, such as the loss of a limb or from bite wounds (Rose and Hueston 1978), and it seems unlikely that a relatively small injury such as toe clipping, alone, would be responsible for a 47% reduction in life-span.

Male *M. pennsylvanicus* tend to range over a wider area when searching for a mate. Numerous males may move into an area guarded by a receptive female, suggesting intrasexual competition among males for the resident female (Madison 1980; Boonstra and Rodd 1983). Females, on the other hand, tend to remain in a given area which they defend against intruders. Ambrose (1972) showed that familiarity with a habitat was important in avoiding an avian predator; this may account for part of the overall longer life-span of females versus males. Both males and females are subjected to a certain amount of confrontation during their lifetime. In general, however, it seems that males are more often thrust into more competitive situations (high incidence of wounding) than females that establish territories; territories serve to reduce direct confrontation among females (Madison 1980). Toe clipping in males may simply aggravate competitive interactions or affect fitness such that injured voles are less likely to be successful in social encounters.

Toe clipping may increase the vole's ambulatory behavior during the breeding season if the procedure stresses the vole. This may force the vole to explore new, "safer" territories. Ambrose (1972) did examine the effects of toe clipping and familiarity of habitat on susceptibility to predation. However, his experimental design did not allow for social encounters as they occur in complex natural environments. In particular, his "mouse-proof barn" did not allow voles to leave the area to lead a more transient life. Both aforementioned possibilities have yet to be tested.

Our study does not suggest that the absence of increasing number of toes had any detrimental results on vole survival. However, our results were partly masked by uneven or small sample sizes, especially when comparing results between toes clipped from front paws and from hind feet. Thus, although Fullagar and Jewell (1965) observed that voles with missing

TABLE 2. *t*-tests of paired life-span data for various combinations of number of toes clipped from front paws (P) and hind feet (F) for male and female voles

Sex	P or F	No. of toes cut	N	Mean difference (weeks)	SEM	<i>t</i>	<i>p</i> > <i>t</i>	Freq. T > NT ^a	Freq. T < NT ^a	Freq. T = NT ^a
Females	P	1	15	-2.2	2.72	-0.81	0.43	4	+6	5
	P	2	33	-0.3	1.78	-0.15	0.88	11+	10	12
	P	3	7	9.7	7.21	1.35	0.23	4+	2	1
	P	4	13	-2.5	5.09	-0.50	0.63	5	+7	1
	Totals							24	25	19
	F	0	1	—	—	—	—	0	+1	0
	F	1	4	0	—	—	—	1	1	2
	F	2	13	1.5	6.17	0.25	0.81	5+	3	5
	F	3	24	-3.9	2.52	-1.54	0.14	7	+12	5
	F	4	26	2.8	1.69	1.64	0.11	11+	8	7
Males	Totals							24	25	19
	P	1	18	-1.8	1.40	-1.27	0.22	2	+6	10
	P	2	33	-0.3	0.85	-0.39	0.70	4	+6	23
	P	3	8	0	—	—	—	1	1	6
	P	4	13	-8.4	5.43	-1.54	0.15	2	+7	4
	Totals							9	20	43
	F	0	2	0	—	—	—	0	0	2
	F	1	9	-0.4	1.04	-0.43	0.68	1	1	7
	F	2	12	0.2	2.03	0.08	0.94	1	+2	9
	F	3	32	-3.0	2.16	-1.37	0.18	6	+12	14
Totals	F	4	17	-3.2	2.13	-1.52	0.15	1	+5	11
	Totals							9	20	43

^aSee text for explanation.

toes did not have difficulty in handling food items, we feel this aspect of the study must be examined in more detail under controlled conditions before generalizations can be made.

These results may have ramifications in studies incorporating capture-recapture techniques. Toe clipping may not be an unbiased marking technique in some classes of animals. Our results have linked toe clipping to shorter male life-span, possibly through a social mechanism. Future studies should determine which weight and reproductive classes are most affected and relate the effects to densities and dynamics of small mammal populations.

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