NOTES

Effect of the parasite *Wohlfahrtia vigil* on *Microtus townsendii* populations

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This paper gives the first record of *W. vigil* parasitizing a wild species in Canada. The incidence of parasitism of the vole *M. townsendii* was at a maximum from August to mid-September. Of 1933 voles observed during this time, 5.4% were parasitized, and all age-classes were equally susceptible. Parasitism by *W. vigil* appeared to be facilitated by the presence of botflies (*Cuterebra* spp.). Survival of voles parasitized by *W. vigil* was severely affected, with only 5% living 2 weeks later.

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C'est la première fois qu'on trouve des *W. vigil* parasitant une espèce sauvage au Canada. Le parasitisme est à son paroxysme, chez *M. townsendii*, du début d'août au milieu de septembre. De 1933 campagnols examinés à ce moment, on a trouvé des parasites chez 5.4%; toutes les classes d'âge sont également susceptibles d'être atteintes. Le parasitisme par *W. vigil* semble être favorisé par la présence d'œstres (*Cuterebra* spp.). La survie des campagnols parasités par *W. vigil* se trouve fortement affectée puisque seulement 5% des individus affectés vivaient encore après 2 semaines.

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During a study of the dynamics of *Microtus townsendii* populations in the Vancouver area, voles parasitized by the grey flesh fly (*Wohlfahrtia vigil* Walker)¹ were caught. This dipterous fly causes cutaneous myiasis in a number of animals, particularly in domesticated species such as mink, fisher, ferrets, fox, rabbits, dogs, and cats (Kingscote 1935; Strickland 1949; Lopushinsky 1970) as well as in man himself (Walker 1931; Haufe and Nelson 1957; Stabler *et al.* 1962). Little is known about the natural hosts of this fly, and this paper presents the first record of an infestation in a wild species in Canada. The only previous observation of such parasitism of wild animals is of nestling cottontails in Pennsylvania (Beule 1940).

Records of *W. vigil* parasitism have been obtained throughout southern Canada and northern United States (Faust *et al.* 1975). Although incidents of parasitism by the fly have not been published for the Vancouver area, the Spencer Entomological Museum at the Univer-

sity of British Columbia has adult flies raised from larvae that parasitized a kitten, a mink pup, a juvenile rabbit, and a young child. Faust *et al.* (1975) summarize the methods of infestation. Larviparous female flies deposit tiny white larvae on exposed body surfaces of living vertebrates, primarily the young ones. The larvae enter tender unbroken skin, feed on the subcutaneous tissues of the host for 7–9 days, and then enter a pupal stage on the ground for 10–12 days. The adult females begin to deposit their young 11–17 days after they emerge from the pupal cases. Although adults have well-developed mouthparts, they feed solely on nectar of wild flowers.

The general trapping technique used to capture the voles is described in detail in LeDuc and Krebs (1975). It involved live-trapping of the voles every 2 weeks on permanent trapping grids. Data from four of the main trapping grids at Westham Island are analyzed here. A description of these grids can be found in Boonstra (1976). Voles were classified as adult (>42 g), subadult (30 to 42 g), or juvenile (<30 g). Voles which were found dead or dying because of

¹Identification was made from two reared adults by B. Cooper, Biosystematics Research Institute, Ottawa.

TABLE 1. Number of *M. townsendii* infested with *W. vigil* in 1975 on Westham Island, British Columbia. Total catch, which includes recaptures, is shown in parentheses

Grid	July 21-31	August	September	October
Control	7 (525)	19* (862)	22 (1050)	0 (242)
Intact	1 (196)	18 (318)	22 (545)	2 (192)
Enclosure	1 (151)	2 (310)	10 (338)	1 (100)
Female	1 (118)	8 (252)	8 (354)	0 (140)
Total	10 (990)	47 (1742)	62 (2287)	3 (674)
%	1.0	2.7	2.7	0.4

*Two of these animals were caught with larvae twice during August within 1 week of their initial capture.

parasitism by larvae of *W. vigil* were brought back to the lab and either autopsied or placed in plastic containers, where the larvae completed their development and pupated.

Although incidents of parasitism were recorded from three different trapping areas around Vancouver, only the data collected in 1975 at Westham Island will be analyzed in detail. The earlier data are inaccurate because the voles were simultaneously parasitized by botflies (*Cuterebra* spp.), which produce subcutaneous lesions similar in appearance to those produced by *W. vigil*. A distinction was not always made between the two parasite species, with most incidents of infestation being ascribed to the more frequent botfly parasite. The earliest seasonal date of parasitism by the grey flesh fly was June 12, 1975; all other cases occurred between July 22 and October 14. In other studies, June and July were the main months of parasitism, and in no case was infestation ever reported as late as October (Lopushinsky 1970). The incidence of infestation was at a maximum during August and the first half of September.

I allowed all larvae which came from voles killed by *W. vigil* to pupate to verify species identification when the adults emerged. Of those which emerged in the same year that the vole had been parasitized, the average length of the pupal stage at room temperature was 20.6 days $\pm$ 0.6 (SE) ($n = 19$, range 18-29), which is about 10 days longer than that reported by Faust *et al.* (1975); the reason for this difference is unknown. In three cases, larvae which pupated in August and September 1975 did not emerge until the first 2 weeks of May. If this is also the time adults emerge in the field and if the maximum life-span of the adult flies is 53 days (Ford 1936), a record of parasitism on June 12 is reasonable.

More instances of parasitism in May and June could have been expected, but for the reason stated below did not occur.

Of the 1933 animals known to be alive during the period of maximum infestation (Table 1), 104 (5.4%) were parasitized by *W. vigil*. This figure is probably an underestimate because the development time for the larvae is 7-9 days (whereas our trapping interval was generally 14 days so that an infested vole could have been missed), because the probability of capture of animals in any trapping session was low (50-70%), and because of errors in identification.

Previous studies suggested that primarily younger animals are affected by this fly (Kingscote 1935; Strickland 1949; Lopushinsky 1970). However, I found that the frequency of parasitism was distributed according to the frequency of the various size classes in the trappable population ($\chi^2 = 3.70$, df 5, not significant) (Table 2). During the summer of 1975, few animals were breeding (Boonstra 1976), and few postweanling voles were exposed to these flies. This segment of the population may be more susceptible to parasitism by *W. vigil*, but adults and subadults are certainly not immune.

Wohlfahrtia vigil may be able to parasitize the older voles because of the presence of botflies. Botfly larvae create holes in the skin through which *W. vigil* larvae are able to pass; perhaps botflies also make the skin so tender that entry into older voles is easier. Figure 1 shows that the incidence and timing of botfly parasitism and *W. vigil* parasitism are closely associated. The correlation between the frequency of botfly parasitism and the frequency of *W. vigil* parasitism for all four grids is moderately good ($r = 0.54$, $n = 40$, $P < 0.001$). A number of *W. vigil* larvae were often found in the same lesion with a botfly larva. Throughout the summer, 32.2%

TABLE 2. Number of individuals in the various size classes infested with *W. vigil* from August 4 to September 17, 1975. Total catch, which includes recaptures, is shown in parentheses

	Male			Female		
	Adult	Subadult	Juvenile	Adult	Subadult	Juvenile
Total for all grids	37 (1149)	12 (274)	— (6)	38 (1077)	16 (671)	1 (13)
%	3.2	4.4	0	3.5	2.4	7.7

FIG. 1. The frequency of infestation of *M. townsendii* by botflies (*Cuterebra* spp.) and grey flesh flies (*W. vigil*) on the Intact grid, Westham Island.

($n = 121$) of the voles infested with *W. vigil* were simultaneously infested with botfly larvae. The frequency of this association was significantly higher ($P = 0.003$) than that of voles infested with botfly larvae in the general population during the period from August to mid-September (21.7% infested, $n = 2466$). Nevertheless, few voles were infested with both parasites at the same time. Susceptibility to parasitism by *W. vigil* may depend on prior infestation with a botfly. The evidence suggests that the presence of botfly larvae facilitates parasitism by *W. vigil*. However, it is not obligatory, because the case of parasitism by *W. vigil* in June occurred about 1 month before the first botfly infestation.

Of the 121 animals caught in 1975 that were infested with *W. vigil*, only 6 were known to be alive 2 weeks later (a minimum 2-week survival rate of 0.05). This compares with a survival rate of 0.66 per 2 weeks for the control population during the period from August to mid-September. Therefore, an animal parasitized by *W. vigil* is almost certain to die. Voles parasitized by this fly were sometimes found dead or dying

in the traps. Larvae were found feeding on body tissues in the inguinal region, along the hind legs, and along the lower portion of the back. Death of the vole often appeared to result from extensive hemorrhaging. Penetration of the abdominal cavity was also found in animals that had just died. The minimum number of larvae necessary to kill a vole was one (in this case the larva had cut the femoral artery of the vole), with the average number of larvae per infested vole being 14.5 ± 2.9 (SE) ($n = 22$, range 1–58). Kingscote (1935) reported that 5–20 *W. vigil* larvae were sufficient to kill the young of a number of species. The larvae do not appear to require a living host to complete their development. Several of the dead voles that had large numbers of larvae were reduced to hair and bones within a few days of being put into plastic containers.

There may be interspecific competition between botflies and *W. vigil*. I have no evidence that *W. vigil* kill botfly larvae directly. However, by killing voles that are simultaneously parasitized by both fly larvae, *W. vigil* may remove the food supply from the botfly larvae. Botfly larvae cannot develop in dead voles, as *W. vigil* larvae can, and so, if the botfly larvae are too young when the vole dies, they also die.

The effect of *W. vigil* on the vole population was probably relatively minor because of its low incidence. Over half the vole population disappeared per month during the summer even when the proportion of the total loss estimated to be caused by *W. vigil* was eliminated. The cause of the poor summer survival was in part related to the presence of botfly parasitism. For example, during the summer botfly season, males on the control grid which were not infested with botflies had a minimum 2-week survival rate of 0.69 compared with 0.50 for males infested with botflies ($\chi^2 = 11.37$, $P < 0.001$) (Boonstra, unpublished data). Females showed the same differences. However, Iverson and Turner (1968)

found that botflies had no effect on survival. The vole may serve as a major host species for *W. vigil* in this area, sustaining populations of this fly which may then secondarily infest man and his domestic animals.

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