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Availability of Water for Voles in Green Vegetation Following a Period of Low Precipitation

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ABSTRACT

Free water within grasses and forbs from tallgrass prairie, bluegrass, and alfalfa habitats was measured at the end of a severe 2-month drought in east-central Illinois. There was sufficient free water within the plant tissues of both grasses and forbs in all three habitats to satisfy the water requirements of *Microtus ochrogaster* and *M. pennsylvanicus* while meeting their daily dietary requirements.

INTRODUCTION

Because dew formation and precipitation are sporadic, free water present in green vegetation is presumed to be the most consistent source of water for herbivorous arvicoline rodents inhabiting upland grasslands (Getz 1970). During periods of low precipitation, however, vegetation often appears dry and wilted, suggesting decreased free water within the plants. If so, low water availability in green plants during drought periods may adversely impact water balance of individuals and in turn population demography. There are, however, no data regarding amount of free water in plants during drought periods.

During the course of a study of population dynamics of the prairie vole, *Microtus ochrogaster*, and the meadow vole, *M. pennsylvanicus*, in east-central Illinois, I obtained data relating to free water present in green vegetation under drought conditions. Measurement of free water within the green vegetation in three habitats was obtained after two months of exceptionally low precipitation, when free water in the plants would be expected to be especially low.

METHODS AND MATERIALS

Study sites

Data were obtained from tallgrass prairie, bluegrass, and alfalfa habitats located in the University of Illinois Biological Research Area ("Phillips Tract"), 6 km NE of Urbana, Illinois (40°15'N, 88°28'W). The prominent plant species in the tallgrass site included: big bluestem, *Andropogon gerardii* (38%); Chinese lespedeza, *Lespedeza cuneata* (25%); Beard tongue foxglove, *Penstemon digitalis* (16%); and Indian grass, *Sorghastrum nutans*

(19%). All other species represented < 1% relative abundance (Getz et al. 1979). Relative abundances of plants in bluegrass were: bluegrass, *Poa pratensis* (70%); dandelion, *Taraxacum officinale* (14%); about 25 other species with relative abundances of ≤ 10% (Getz et al. 1979). Alfalfa (*Medicago sativa*) comprised approximately 75% of the vegetation in the alfalfa site. Other species included bluegrass; goldenrod, *Solidago*; timothy, *Phleum pratense*; brome grass, *Bromus inermis*; clover, *Trifolium repens* and *T. pratense*; and plantain, *Plantago* spp. (Getz et al. 1979).

Methods

Vegetation samples were taken during early afternoon on 3 August 1991. Precipitation the previous two months totaled only 8.12 cm, 13.25 cm (62%) below the previous 30-year average for the region (Illinois State Water Survey Local Climatological Data monthly summary for June-July 199l). Ten 0.25 m^2 circular frames were positioned at random in each site, utilizing a random numbers table and a 10-m small mammal live-trapping grid in the site. Sample sites were located at a 45° angle 5 m from the selected station to avoid bias from trampling of vegetation during the small mammal trapping of the sites. All vegetation within the frame was cut at the soil surface, sorted as to grasses and forbs, and placed in paper bags, the tare for which had been measured earlier. Tops of the bags were folded to avoid evaporative water losses. The bags were weighed and placed in the un-ventilated, un-cooled attic of Shelford Vivarium on the University of Illinois campus and the tops of the bags opened. Temperatures in the attic exceeded 40 °C most of the time. Thirty days later, when the vegetation was dry and brittle, the bags were weighed and water loss and proportion of the original wet weight of the vegetation that was comprised of free water calculated.

Data Analysis

The proportion free water in the vegetation was used to determine the amount of green vegetation needed to be consumed by the voles to meet daily water requirements (*M. ochrogaster*, 6.6 g/day; *M. pennsylvanicus*, 8.2 g/day; Getz 1963), assuming that free water in the vegetation was the only source of water. These values were compared with the average daily food consumption of the two species as reported elsewhere (*M. ochrogaster*, 16 g/day, Cole and Batzli 1979; *M. pennsylvanicus*, 29 g/day, Golley 1960). Although the food consumption data were from captive animals under laboratory conditions, they provided an estimate of total daily consumption of fresh green vegetation. These values are similar to those obtained by Bailey (1924) and others, as summarized by Golley (1960). Differences in water content of the vegetation among habitats was tested by use of one-way ANOVA and between grasses and forbs within habitats by *t*-tests (Zar 1999).

RESULTS AND CONCLUSIONS

Although measured at the end of a lengthy drought, except for grasses in bluegrass habitat, more than half the wet weight of both grasses and forbs in all three habitats consisted of free water (Table 1). Water content of forbs was greater than that of grasses in all three habitats. For grasses, those in the alfalfa habitat contained the most free water and those in bluegrass the least. Forbs were least succulent in tallgrass (Table 1).

The amount of food needed to be consumed to meet the daily water requirements (*M. ochrogaster*: alfalfa, grasses, 9.8 g and forbs, 9.4 g; bluegrass, grasses, 16.1 g and forbs, 9.2 g; tallgrass, grasses, 11.4 g and forbs, 10.8 g. *M. pennsylvanicus*: alfalfa, grasses, 12.2 g and forbs, 11.7 g; bluegrass, grasses, 20.0 g and forbs, 11.4 g; tallgrass, grasses, 14.1 g and forbs, 13.4 g) was less than that needed to meet daily dietary requirements in all three habitats. Because both species preferentially feed on forbs (Thompson 1965; Zimmerman 1965; Lindroth and Batzli 1984; Haken and Batzli 1996), individuals would easily meet their water requirements in the course of normal daily food consumption.

Getz (1963) reported that metabolic water production was sufficient to meet 15% of the water requirements of *M. pennsylvanicus* and 20% of that of *M. ochrogaster*. This would reduce the amount of free water needed to be obtained from the vegetation by individual voles. It appears, therefore, that even during periods of unusually low precipitation, there is adequate free water in green vegetation, including grasses, to meet the daily moisture requirements of both *M. ochrogaster* and *M. pennsylvanicus*. In this study, the entire plant was used in measuring free water. Much of the plant tissue in the samples included stems and old leaves, which would not be eaten by the voles. Most likely voles select the more succulent young leaves and stems or young shoots, which would be expected to contain more free water per gram plant tissue than does the entire plant.

Air humidity within the enclosed surface runways utilized by both species is relatively high at all times and does not adversely impact water balance of either species (Getz 1965, 1970, 1971). Evaporative water losses most likely are not sufficiently greater during these dry periods so as to result in water requirements greater than could be achieved from free water in the vegetation. I, therefore, conclude that water availability necessary to meet physiological requirements is not a factor influencing individual viability and in turn demography of either vole species. Unfortunately, population densities of both species were too low (< 5 voles/ha) in all three habitats throughout 1991 (Getz et al. 2001) to compare indices of physiological condition of individuals (body mass and proportion reproductive) in August 1991 with that during periods of normal precipitation.

Low population densities of *M. ochrogaster* and *M. pennsylvanicus* during spring-winter of 1991 (Getz et al. 2001) did not appear to be related to low precipitation during June-July of that year. Precipitation during April-May was 19.1 cm (10.1 cm above average); there was, however, no population growth of either vole species during the spring. Population densities of *M. ochrogaster* dropped from peaks in October 1990 in alfalfa, November 1990 in bluegrass, and December 1989 in tallgrass, to low densities by February 1991 (Getz et al. 2001). Population densities remained very low in all three habitats through the winter of 1992-1993. Population densities of *M. pennsylvanicus* were very low in all three habitats from at least 1989 through 1993. Precipitation during April-August 1992 was 62.7 cm (5.5 cm above average) and 32.9 cm September-November (11.6 cm above average).

Both species utilize small surface runways below the vegetation and detritus layer. Even though the vegetation in general appeared rather dry at the end of the drought, there was still ample cover for protection of the voles from predators.

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