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## NOTES

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VERTEBRATES ASSOCIATED WITH GOPHER TORTOISE BURROWS IN  
ORANGE COUNTY, FLORIDA

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At least 302 species of invertebrates and 60 species of vertebrates have been reported to use gopher tortoise (*Gopherus polyphemus*) burrows to some degree (Jackson and Milstrey 1989). One of every 10 burrows may contain a vertebrate associate (Witz et al. 1991). Burrow associates may feed on fecal matter or on other burrow associates, seek refuge from the winter, or use the burrows as nesting habitat (Speake 1981, Campbell and Christman 1982, Woodruff 1982, Eisenberg 1983). The burrow association may be obligate or non-obligate, and associate use may be frequent, occasional or accidental (Cox et al. 1987). A recent relocation effort to accommodate a highway project in Lake Buena Vista, Orange County, Florida provided an opportunity for the further study of burrow associates.

A total of 155 active and inactive burrows occurring within an area of approximately 50 acres was excavated with a backhoe excavator between 12 October and 11 November, 1992. The burrows were located in xeric oak (*Quercus geminata* with *Serenoa repens* understory) and sand pine plantation (*Pinus clausa* with sparse *Aristida* spp. groundcover) habitat, with a resulting capture of 61 tortoises and 33 associates (Table 1). A vertebrate associate was located, on average, in one of every 5.2 burrows.

Consistent with Witz et al. (1991), a Test of Association (Ludwig and Reynolds 1988) revealed that, collectively, vertebrate associates were not significantly associated with burrows occupied by tortoises (14 of 33 occurrences,  $\chi^2$  1 df = 0.58,  $0.50 > p > 0.25$ ). This finding reinforces the hypothesis that associates use burrows in response to various factors and for differing reasons.

Southern cricket frogs (*Acris gryllus dorsalis*), eastern indigo snakes (*Drymarchon corais couperi*), a southeastern five-lined skink (*Eumeces inexpectatus*), and Florida mice (*Podomys floridanus*) only occurred in unoccupied burrows, but the majority of these occurrences were too infrequent to test for association. However, cricket frogs ( $n = 7$ ) were negatively associated with the presence of gopher tortoise ( $\chi^2$ , 1 df = 4.27,  $0.05 > p > 0.025$ ). This apparently amensalistic relationship was not expected and may in fact be an artifact of sample size. Nevertheless, cricket frogs could possibly benefit from the shelter and food of the burrow, although only two of seven frogs occurred in burrows with insects or insect parts. If cricket frogs use burrows solely for shelter, it is unclear how the presence of a gopher tortoise interferes with this use, particularly in light of the positive association (see below) between gopher tortoises and gopher frogs.

Worm lizards (*Rhineura floridana*) occurred in both occupied (1) and unoccupied (3) burrows, and gopher frogs (*Rana capito*) occurred in more occupied (11) burrows than unoccupied (4) burrows ( $\chi^2$ , 1 df = 9.52,  $p < 0.005$ ). The latter finding is consistent with that of Eisenberg (1983) and suggests that gopher frogs benefit directly from the presence of gopher tortoises, most likely through feeding on the invertebrates associated with tortoise feces and nest material.

In general, gopher frogs and lizards are more likely to occur in active burrows than in inactive or abandoned burrows (Eisenberg 1983, Witz et al. 1991). Witz et al. (1991) speculated that some characteristic of the active burrows, such as food availability or microcli-

**Table 1. Number of vertebrates excavated from 155 gopher tortoise burrows in a Lake Buena Vista, Orange County, Florida xeric oak and pine plantation habitat.**

Class	Species	Number
Amphibia	Southern cricket frog, <i>Acris gryllus dorsalis</i>	7
	Peninsula Newt, <i>Notophthalmus viridescens piaropicola</i>	1
	Gopher Frog, <i>Rana capito</i>	15
Reptilia	Eastern indigo snake, <i>Drymarchon corais couperi</i>	2
	Southeastern five-lined skink, <i>Eumeces inexpectatus</i>	2
	Worm lizard, <i>Rhineura floridana</i>	4
	Scrub lizard, <i>Sceloporus woodi</i>	1
Mammalia	Florida mouse, <i>Podomys floridanus</i>	1
Total		33

mate, may be attractive to lizards. Alternatively, active burrows may be more conspicuous than inactive or abandoned burrows to lizards seeking refuge from predators. Other vertebrate associates are equally likely to occur in active, inactive or abandoned burrows (Witz et al. 1991).

Some burrow associates appear to be somewhat dependent upon active burrows, so the disappearance of the gopher tortoise, either from disease or in response to anthropogenic disturbance, may result in the disappearance of the associate. The gopher frog appears to fit this description. As noted by Witz et al. (1991) and suggested by this study, other burrow associates appear to be indifferent to burrow status. The worm lizard may be one such species. Still other associates, for example the cricket frog as this study suggests, appear to prefer unoccupied burrows. For associates that use unoccupied burrows, abandoned gopher tortoise colonies may be important components of the landscape, thereby requiring consideration during land planning efforts. The relationship between gopher tortoises and burrow associates is still poorly understood. This is especially true of the effect of burrow status on associate use of the burrow. The importance of active and inactive burrows to associate persistence, as well as the role of abandoned burrows in supporting associated fauna, warrants further investigation.

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