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SEASONAL RATES OF VOCALIZATIONS IN EASTERN CHIPMUNKS[1]

RICHARD H. YAHNER[2], Department of Zoology and Microbiology, Ohio University, Athens, OH 45701

Abstract. Vocalizations in a population of eastern chipmunk, *Tamias striatus*, were studied from October 1973 to November 1976. Mean rates of vocalizations in the population peaked in late spring (May and June) and in autumn (October and November) coinciding with the dispersal and the recruitment of spring-born and summer-born juveniles, respectively, into the population. High rates in the spring peak were also attributed to the resumption of regular, post-torpor surface activity by all members of the population. High rates in the autumn peak resulted also from a pronounced increase in above-ground activity which was associated with larder hoarding.

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Vocalizations in the eastern chipmunk, *Tamias striatus*, can be divided into three categories: a chip, ranging from an isolated chip to a series of chips separated by greater than 1 second; chipping, a series of chips given at intervals of 1 second or less; and a chip-trill, a chip followed by a rapid series of jumbled notes (Damon 1941, Dunford 1970, Wolfe 1966). These investigators concluded that the calls formed a graded sound system and functioned as alarm signals. Dunford (1970) suggested that chipping may also act as a mechanism to space individuals into non-overlapping core areas, but Yahner (1978) found no evidence that chipping served this function. Seidel (1960) observed that rates of vocalizations were highest in autumn compared to other times of the year, but Sherman (1926) reported that vocalizations were more frequent in the breeding season. If population levels of vocalizations vary seasonally, then an essential question to answer is whether vocalizations occur more often in a poulation because individuals comprising the population are more vocal per unit time spent above ground at certain times of the year, or can differences in the occurrence of vocalizations during the year be explained by other factors. In this paper, seasonal rates of vocalizations in a population of *Tamias* are presented.

METHODS AND MATERIALS

I studied the behavior and social system of a population of eastern chipmunks on a 5-hectare deciduous woodlot near Athens, Ohio, from October 1973 to November 1976. Field observations, totaling 2500 man-hours, were conducted 4–7 days per week and 2–12 hours per day to insure that all portions of the annual and diurnal cycles were studied adequately. Sixty National live traps were set at least twice weekly near occupied burrow systems and in areas frequented by chipmunks in daily activities. A total of 180 different chipmunks were captured during the study. At initial capture, each chipmunk was sexed, aged, and marked with numbered ear tags (#1, National Band & Tag Co.) and a unique pattern of fur dye (Nyansol D) which was visible from 30 to 40 meters using 7 x 35 field glasses. On initial and subsequent captures of each individual, weight (g) and reproductive condition were noted.

RESULTS AND DISCUSSION

The three categories of vocalizations were noted in 1508 instances during the study. Sixty-three percent of the total were chips, 13% were chipping, and 24% were chip-trills. Of this total, the identity of the vocal animal was known in 555 cases, and these were used in the analysis. Because each of the three categories of vocalizations are generally considered to

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[2]Present address: Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul, MN 55108.

be alarm signals (Dunford 1970), I did not analyze the seasonal occurrence of each separately but pooled the results giving each category equal weighting.

The mean rates of vocalizations in the population per hour of field study varied among months (table 1). The mean vocalization rate in October exceeded those of other months ($P<0.05$, Student-Newman-Keuls test, Sokal and Rohlf 1969). Mean rates in June and November were comparable, but both were greater than mean rate in May ($P<0.05$). Mean rate in May was higher than mean rates in either July or September ($P<0.05$). Moreover, mean rates in February, March, April, and August were not significantly different from each other but were lower than any of the other months ($P<0.05$).

The mean rates of vocalizations, which ranged from 0.6 to 3.0 per hour of field study in six randomly-selected chipmunks of different age and sex classes, did not vary among months (tables 1 and 2). These results indicate that although mean rates of vocalizations differ markedly with season in the population, they are not due to seasonal fluctuations in individual frequencies of calling per unit time that the animals are active above ground. The reasons for seasonal differences in rates of vocalization in the population become more apparent when activity and behavior of members of chipmunk populations in southeast Ohio are examined over the annual cycle.

TABLE 1

Mean rates of vocalizations in a population of eastern chipmunks from February to November.

Month	Mean Rate of Vocalizations*
February	0.09
March	0.04
April	0.07
May	1.02
June	1.21
July	0.69
August	0.14
September	0.59
October	2.03
November	1.17

*Expressed as the number of vocalizations heard per hour of field study. Significant differences occurred among months in the mean rates of vocalizations. $F=29.5$; $df=9, 545$; $P<0.001$; single-classification analysis of variance; Sokal and Rohlf (1969).

Chipmunks in southeast Ohio are inactive above ground and presumably torpid from mid-November to mid-February. A winter breeding season occurs from mid-February to early March. At this time, adult males briefly emerge each morning in search of estrous females; adult females generally emerge only on the day of estrus, and sexually-inactive animals rarely come above ground. Sub-

TABLE 2

Mean rates of vocalizations in six randomly-selected chipmunks of different age and sex classes.

Individual No.	Mean Rate*	Deg. Freedom	Significance**
179	3.0	8,68***	$P<0.05$
258	1.4	7,43	ns
463	1.2	5,49	ns
566	0.7	6,25	ns
607	0.8	5,23	ns
651	0.6	8,31	ns

*Rate is expressed as the number of vocalizations given per hour of field study during months in which data were available for each chipmunk.

**Level of significance is based on the F-ratio obtained by a comparison of rates among months for each individual using single-classification analyses of variance (Sokal and Rohlf, 1969).

***Degrees of freedom 8,68 designate that the rate for this individual is based on data obtained during 8 months of observation and $68+1=69$ observation bouts (see Yahner, 1978, for detailed description of behavioral observations).

sequent to the winter breeding season, a lull in surface activity occurs and chipmunks are seldom seen until April or May depending on ambient temperatures. All chipmunks terminate torpor by late May. In mid-May, juveniles born in the spring emerge from natal burrow systems and disperse to new home sites. This dispersal continues well into June. A summer breeding season takes place in July and is followed by a lull in population activity in August. Activity then gradally increases in September and peaks in October during the larder hoarding of a winter food supply. In October, juveniles born in the summer disperse and establish burrow systems. These juveniles remain active until early or mid-November, whereas most of the population is torpid by late October (Yahner 1978, Yahner and Svendsen 1978).

The maximum seasonal rate of vocalizations in October (table 1) is a product of two factors: 1. the recruitment of juveniles born in the summer into the population 2. individuals typically spend more time above ground during the day preparing a food cache for winter use compared to other times of the year. The vocalization rates in June and November were also high because juveniles born in the months preceding each of these were still present and the population density was high. In June, all animals terminated torpor and exhibited above-ground activity for the first time. In November, although many individuals commenced torpor, most juveniles born in summer were still active gathering acorns and nuts (mast) for winter consumption. July and September coincided with the beginning and end of a population lull in summer activity, thus explaining the lower rates of calling in these months. Extremely low rates of vocalizations in February, March, April, and August resulted from an overall decline in surface activity. Thus, seasonal fluctations in rates of vocalizations of a population of eastern chipmunks appear to be a function of population dynamics and seasonal changes in levels of surface activity among members of a population. My findings parallel those of Brand (1976) which indicated that seasonal rates of vocalizations in chipmunks (*Eutamias* spp.) were correlated to the degree of above-ground activity in members of the population and population density, and that no type of vocalization functioned as a mechanism of spacing.

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