March 1981

EFFECT OF PHOTOPERIOD ON ACTIVITY PATTERNS IN PINE VOLES (*MICROTUS PINETORUM*)

Jack A. Cranford
Virginia Polytechnic Institute and State University, Blacksburg, Virginia

EFFECT OF PHOTOPERIOD ON ACTIVITY PATTERNS IN PINE VOLES (MICROTUS PINETORUM)

Jack A. Cranford
Biology Department
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Light is an environmental variable which has considerable effect on small mammal activity patterns. This constantly repeating 24 hour signal provides information on a daily basis and has been shown to synchronize all physiological patterns in an animals existance. Laboratory studies have shown that pine voles are slightly nocturnal (Pearson, 1947) or confined their activity to the hours of twilight and darkness (Werner, 1951). Both authors indicate that activity occurs in bouts of about 1 hour duration followed by an hour of rest. Benton (1955) observed from trapping that more activity occurred at night but cautioned that due to the fossorial habits of pine voles activity could occur below ground during the day and bias the data. Continious trapping data from both above and below ground sources indicate that there is activity both above and below ground at night but only below during the day. Activity is restricted to the burrow system. Gettle (1975) radiotelemeted pine voles and found that during any 15 minute period of the day (24 hour period), 50% of the experimental animals were moving actively. He presumed that these animals fed continuously as Boyette (1966) had previously demonstrated that they fed at all times of day or night.

Airoldi (1979) has demonstrated changes in activity patterns of water voles (Arvicola terrestris) which are synchronized by the natural photoperiod. The activity patterns are polyphasic and are distributed throughout the 24 hour period. In winter, activity is principally during the day while it is more equally distributed during other seasons. During all seasons the active cycles are entrained by the current photoperiod and demonstrate a good circadian organization. Seasonal shifts in activity patterns have been reported for red backed voles (Clethrionomys glareolus) (Elbl-Eibesfeldt, 1958) but the influence of ambient temperature could not be determined from these data.

This research will report on activity patterns of pine voles under 5 different photoperiods and two different ambient temperature conditions. The photoperiods (LD) used, except for continious darkness (DD), were comparable to the seasonal changes in day length and the two temperatures were to evaluate the influence of low winter and moderate summer temperatures on activity patterns.

METHOD AND MATERIALS

Adult pine voles from first generation laboratory reared animals were used in all photoperiod experiments. Animals were reared under LD 16:8 at 19 $\pm$ 1^{o}C and were acclimated to the experimental photoperiods and temperatures for 30 days prior to a 30 day activity monitoring period. Activity patterns were recorded on two 8 channel Esterline Angus event recorders from a minimum of 10 pine voles of the same sex individually housed in wheel running cages. Experimental animals had food (Wayne Lab Blocks) and water available ad libitum with fresh apple slices given daily. Data on age, sexual condition and body weight dynamics were recorded weekly over the 60 day acclimation - experimental period.

Experimental photoperiods were LD 18:6, LD 16:8, LD 12:12, LD 8:16 and DD 0:24 with temperatures maintained at a constant 6 $\pm$ 1^{o}C or 18 $\pm$ 1^{o}C in environmental chambers. As the recorders monitored the wheel running activity as single events both circadian pattern and a total distance analysis was performed. Trap revealed activity patterns from field study grids will be compared to laboratory determined activity patterns.

RESULTS

Activity patterns showed no significant differences between sexes but were significantly different between photoperiods. Pine voles under any LD photoperiod demonstrate entrainment to the light-dark transition with activity restricted to the dark phase (Figure 1). In DD (continuous darkness) the pattern is polyphasic with activity distributed throughout the 24 hour circadian day.

The amount of activity distributed in each phase of the active cycle clearly shows changes from unimodal in LD 18:6 to biomodal in LD 12:12 and trimodal under LD 8:16 photoperiods (Figure 2). The DD results (Figure 1) show periods of activity of 1 to 2 hours followed by approximately 1 hour periods of rest. The amount of activity in any 15 minute period changes between all LD photoperiods but in DD the total amount of activity is drastically reduced and redistributed over the 24 hour circadian day (Figure 2). Activity patterns were not significantly different between the experimental temperatures used but did differ significantly in the total amount of activity.

The mean distance traveled by pine voles in running wheels differed between all photoperiods. At 18^{o}C in LD 18:6 they traveled 1512 meters (M) per night while at 6^{o}C they traveled 1280 M per night. At 18^{o}C in LD 12:12 the mean running distance was 755 M and under LD 6:18 it was 376 M but reduced to 267 in the 6^{o}C environment. In the DD environment the voles ran only 89 M at 18^{o}C during a 24 hour day. The amount of activity in each of the photoperiods were significantly different from each other (Wilcoxan rank sum tests) and the reduction of activity in cold environments were significantly different (Duncans Multiple Range Tests) in each of the photoperiod treatments.

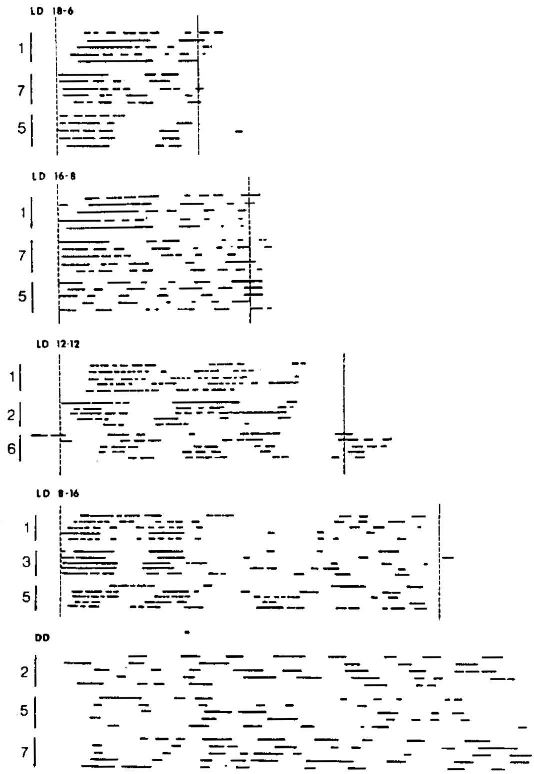

Figure 1. Distribution of activity of 3 individuals in each of the experimental photoperiods. In the LD cycles the area between dashed vertical lines indicate the dark period.

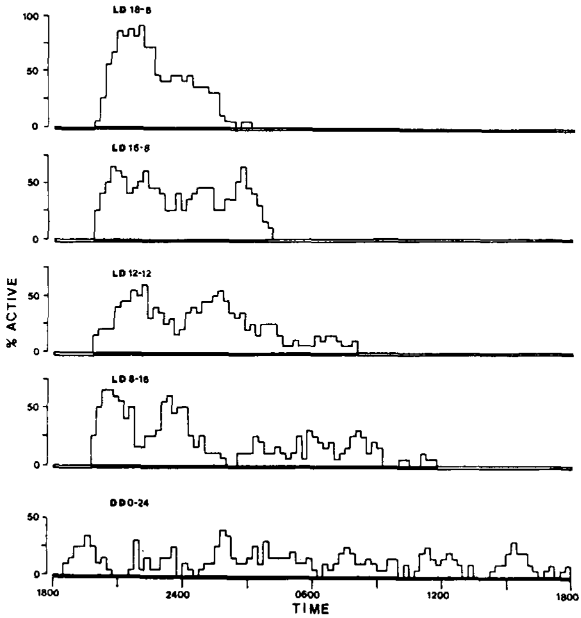

Figure 2. Percent of activity in 15 minute increments across the active cycle under all experimental photoperiods.

DISCUSSION

The overall circadian patterns indicate that pine voles entrain to all experimental photoperiods but lacking a Zeitgeber the activity pattern does not show the typical free running pattern of most rodents. The animals in DD did show a clear pattern going from the entrained to the free running state with a mean T=23.4 hrs. which is typical for a nocturnal rodent. After 5 to 10 days all animals in DD had a polyphasic pattern with periods of activity and rest distributed throughout the 24 hour circadian day. Previous reports have varied in describing activity patterns of pine voles but these data clearly show that pine voles avoid the light but do have activity distributed throughout a 24 hour day. More than 60% of the total activity in DD was distributed in the former dark phase of the previous entrainment (LD 12:12) cycle. This generally agrees with field observation based on trap recapture and telemetry data that more activity occurs at night both above and below ground while day activity is restricted to the burrow system.

All other parameters measured did not show any significant changes from the last 15 days of the acclimation phase through the experimental period. Changes in body weight and food consumption did occur as animals were switched to different photoperiods and temperatures. In general total activity decreased with increasing night length and decreasing temperature. The activity pattern and amount of activity in DD probably represents the best laboratory measure of what pine voles do in an orchard setting. The distribution of activity would permit above and below ground feeding bouts throughout the 24 hour day. The amount of activity would be equivalent to 50-60 trips through a linear home range of 35 meters or from 3-6 foraging bouts per hour within the home range. The decrease in activity with temperature points out perhaps why more subsoil root damage occurs in winter. The overall decrease in activity means energy is conserved and also that roots being available and close by would be foraged on at higher rates.

LITERATURE CITED

Airoldi, J. P. 1979. Etude du rythme d'activite du campagnol terrestre, Arvicola terrestris scherman Shaw. Mammalia, 43:25-52.

Benton, A. H. 1952. Observations on the life history of the northern pine mouse. J. Mammal, 36:52-62.

Boyette, J. G. 1966. A behavioral study of the pine mouse Pitymys pinetorum pinetorum (Conte). Ph.D. Thesis North Carolina State University, 134 pp.

Gettle, A. S. 1975. Activities and movements of pine voles (Microtus pinetorum) in Pennsylvania. M.S. Thesis. Pennsylvania State University. University Park, PA. 66 pp.

Pearson, O. P. 1947. The rate of metabolism of some small mammals. Ecology, 28:127-145.

Werner, W. E. 1951. A report on the activity cycles of New York State voles. Unpublished report N.Y.S. College for Teachers. Albany, Department of Biology. 17 pp.

This research was supported by a Dept. of Interior Fish and Wildlife Service Grant No. 3729491 to J. A. Cranford.