ACTIVITY OF SMALL MAMMALS AS RECORDED BY A PHOTOGRAPHIC DEVICE

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Donald M. Osterberg

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by

Donald M. Osterberg

AN ABSTRACT OF A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
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Department of Zoology

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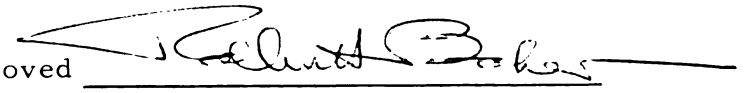
Approved 

ABSTRACT

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The purpose of this study was to analyze activity of small mammals in relation to time of day and various weather conditions. The study was carried on during April, May, October and November of 1960 in a grass vegetation located one mile south of Haslett, Ingham County, Michigan. The recording was accomplished by means of a two-box apparatus. One box, containing a camera with a synchronized flash, was set on one side of the runway. The other box, containing climatological instruments, a millimeter rule, and a clock, was set on the opposite side of the runway. This latter box was arranged in such a way that an animal, by applying its body weight, activated the apparatus by stepping on a treadle, a photograph was then taken of the animal against a background of the dials of the instruments.

The photographic records showed that the shorttail shrew, Blarina brevicauda, and the meadow vole, Microtus pennsylvanicus, were the most common mammals in the habitat studied. The records were analyzed statistically with respect to the environmental conditions that were present when each of these species was active in the runways. Both species were active in runways chiefly at night. In general their

activity showed poor correlation with changes in other environmental factors such as temperature, humidity, barometric pressure, or periods of precipitation. Activity, therefore, was influenced principally by an intricate interplay of all of them combined.

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INTRODUCTION

One of the problems faced by the ecologist when investigating the activity of animals is the extreme difficulty in accurately observing their natural habits without disturbing their environment. In recent years photography has been employed to a progressively greater extent to obtain information concerning the secretive habits of small mammals.

The object of this study was to determine the use made of surface runways by small mammals in relation to time of day and various climatic factors. A photographic device much like that employed by Oliver Pearson (1959) in California was used.

THE STUDY AREA

The study area, located about one mile south of Haslett, Ingham County, Michigan, was a one-acre plot that was bounded on one side by an unpaved road, on another by a driveway and on the other two sides by a garden and lawn (Plate 1). The vegetation on the area was a typical grass-dominated, old field successional type. (The botanical nomenclature used in this paragraph follows that of Fernald, 1950). The dominant grass species were Poa pratensis (Kentucky bluegrass) and P. compressa (Canada bluegrass). Carex spp. (sedges) were also abundant. The more common forbs in the vegetation in order of importance were Monarda fistulosa (wild bergamot), Urtica dioica (stinging nettle), Aster lateriflorus (aster), Cirsium arvense (Canada thistle), Solidago spp. (goldenrod), Asclepias syriaca (common milkweed), and Daucus Carota (wild carrot). The woody vegetation was poorly developed, five or six Prunus serotina (wild cherry) trees averaging six feet in height and clumps of Sambucus canadensis (common elder) were the most conspicuous species. Also present were scattered individuals of Spiraea latifolia (meadow-sweet) and Salix discolor (large pussy-willow). The vegetation had been unburned for at least the last six years according to the owner of the property. The most abundant small mammals living in the area during the study period were the shorttail shrew, Blarina brevicauda (Say), and the meadow vole, Microtus pennsylvanicus (Ord).

Plate 1. The Study Area

The study area was the field in the foreground through which the power lines pass, and was bordered by Tihart road, a driveway, a lawn, and a garden which is to the left of the photograph.

Plate 2. A front view of the camera box showing the camera within and the flash unit mounted above. (Note: the photographs of the apparatus were not taken to show the environmental placement.)

APPARATUS

An electronically actuated photographic apparatus was used to obtain records of movements of small mammals along runways. This apparatus was patterned after that used by Pearson (1959) and consisted of two containers, one placed on either side of a small mammal runway. The first container, the camera box, housed the camera and flash activator. The second container, the instrument box, housed a clock, a millimeter rule and gauges for recording pertinent weather conditions. The purpose was to photograph each animal, that moved along the runway in between the two containers, against the background of gauges housed in the instrument box. Refinements and alterations of the basic apparatus used by Pearson (1959) are included with the descriptions below.

A tightly-constructed plywood box, painted with green enamel and having a sliding glass front, housed the camera and the electronic flash activator. The camera, a Bell and Howell, 16mm. movie camera, was synchronized for a flash unit, that was mounted above the camera box (Plate 2). The synchronization was accomplished by having a contact on the shutter of the camera close the flash circuit when the shutter was open.

The camera was set so that only a single frame was exposed when a solenoid attached to the camera release was activated. The electricity for the solenoid was provided by ordinary house current

(110 volts A. C.) which was converted to 12 volts D. C. by a transformer housed in the camera box. The solenoid was activated by a mercury switch that was connected to the counter-weight treadle which was placed in the runway. When the weight of an animal altered the position of the treadle, a taut wire connected from the treadle to the switch was pulled sufficiently hard to close the contact of the solenoid causing the camera and flash attachment to operate.

The flash unit was mounted above the camera box at an angle that would provide maximum illumination of the instruments and the passing animal. The flash was filtered with dark red gelatine to prevent frightening the animal.

The instruments were housed in a wooden box similar in size to that of the camera box but only one-half as deep (Plate 3). This box was open at the front except for a millimeter rule which covered the lower two inches. The instruments, a pocket watch and an Airguide combination barometer, hygrometer and thermometer, were arranged so that their dials were directly above the rule. Thus, all of these measuring devices could be photographed along with the small mammal traversing the runway in front of them.

Once the two boxes and the treadle were arranged so that the camera could photograph clearly the area of the treadle and the instruments in the background, a hood of plywood (Plate 4) was placed over the entire apparatus. This hood protected the instruments and provided shade for uniform exposure of the film, since the lens opening remained

the same for pictures taken both in daylight and at night. To obtain further uniformity of film exposure, especially in daylight, a red filter was placed in front of the camera lens. This necessitated the use of Kodak Tri-X, photo-reversal film that was sensitive to red light.

Plate 3. A front view of the instrument box with the metal treadle in front.

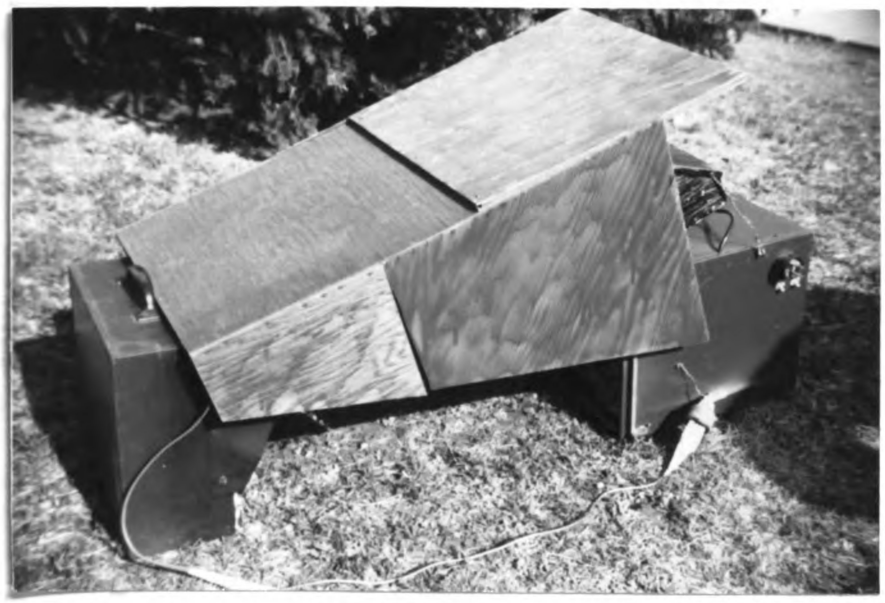


Plate 4. The instrument and camera boxes with the plywood hood in position.

PROCEDURE

Placing the apparatus at the runway

The apparatus was placed on a runway frequently used by small mammals. One indication of recent use was the presence in runways of sign (cuttings and fecal droppings) left by these animals. Fresh green cuttings of grasses and sedges were found along runways being used regularly by meadow voles (Burt, 1957:125-129). The presence of shorttail shrews was indicated by remnants of wings and legs of insects along with shells of snails (Hamilton, 1930).

When a suitable runway was found, a small area on either side was cleared of grass clumps and other plants to provide a level base for the apparatus. The instrument box was placed along one side of the runway in such a way that the dials of the instruments were no more than one inch from the runway. The treadle was set directly in front of the instrument box in a slight depression dug in the runway and then covered over with the soil excavated. The camera box was then placed on the opposite side of the runway from the instruments and back about one and one-half feet. A "fence" of small twigs was stuck in the ground along the camera side of the runway to encourage the passing mammals to stay in the runway and not wander around under the plywood hood.

The camera was then focused by measuring the distance between it and the instrument box. Aiming the camera was accomplished by the use of a cardboard tube which fitted snugly over the end of the lens.

The camera was then moved until the tube pointed to the center of the instrument box.

Daily checking of instruments

Each day between the hours of 12:00 noon and 3:00 p. m. the camera was checked and reset for the next twenty-four hour period. A white card on which was written the time of day and the date was placed in front of the instruments and the camera activated by tripping the treadle. Each recorder day began from the time the camera was checked and ended when it was checked again the following day. If when checking the camera, the mechanism was found to have been jammed during the previous twenty-four hour period, the records from that period were removed from the data.

The weather instruments were checked weekly and corrections were made if necessary. The barometer was checked against the one maintained by the office of the U. S. Weather Bureau at Capital City Airport, Lansing, Michigan (ten miles west of the study area), and the other instruments against accurate portable ones.

Damage to the apparatus was slight. When the temperature changed rapidly, a thin layer of condensation sometimes formed on the lens of the camera. However, condensation was somewhat controlled by the heat generated by the transformer and flash activator housed in the camera box. Occasionally an animal would gnaw on the wooden boxes or on the treadle wire but this action was not frequent enough

to be harmful. Digging up the soil around the treadle seemed to be a characteristic behavior of some shorttail shrews but seldom did this interfere with the records. Occasionally, a shrew was photographed in the process of this digging activity.

When the footage gauge on the camera indicated that no photographs had been taken for three consecutive days, the apparatus was moved to a new location. During the four-month period when the camera was in operation, it recorded photographically the movements of small mammals in six different locations in runways all within an area having a fifteen-foot radius.

RESULTS

For each animal photographed, hereafter called a pass, standard information was obtained as follows: the time the animal passes; the temperature, the barometric pressure and the relative humidity at the time of the pass; the species of animal that passes; the approximate length of the animal; and the direction in which the animal was traveling. The records of the local office of the U. S. Weather Bureau were consulted to approximate the amount of cloud cover and precipitation. The phase of the moon was obtained from the World Almanac, 1960.

Species recorded

The species recorded together with the total number of passes for each during the entire study period (April, May, October and November of 1960) are as follows:

Species	Number of passes photographed
Shorttail shrew, *Blarina brevicauda*	277
Meadow vole, *Microtus pennsylvanicus*	161
Mouse, *Peromyscus* sp.	2
Least weasel, *Mustela rixosa*	2
Eastern mole, *Scalopus aquaticus*	1
Eastern cottontail, *Sylvilagus floridanus*	1
Eastern garter snake, *Thamnophis sirtalis*	1
Song sparrow, *Melospiza melodia*	1
total	446

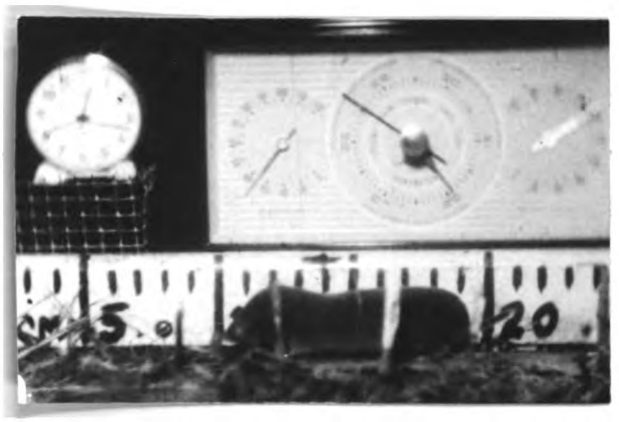


Plate 5. A shorttail shrew,

Blarina brevicauda

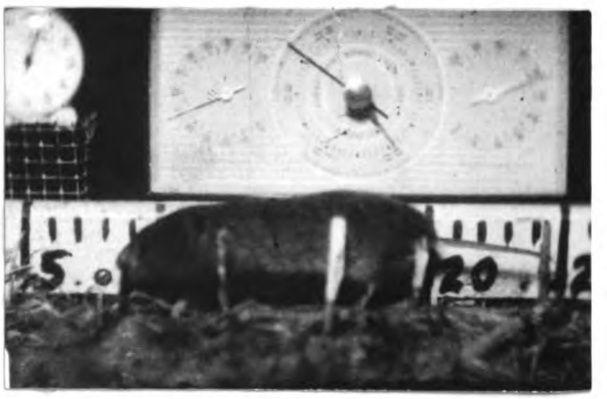


Plate 6. A meadow vole,

Microtus pennsylvanicus

(Note: the plates on this page were enlarged from the 16 mm. film used for this study.)

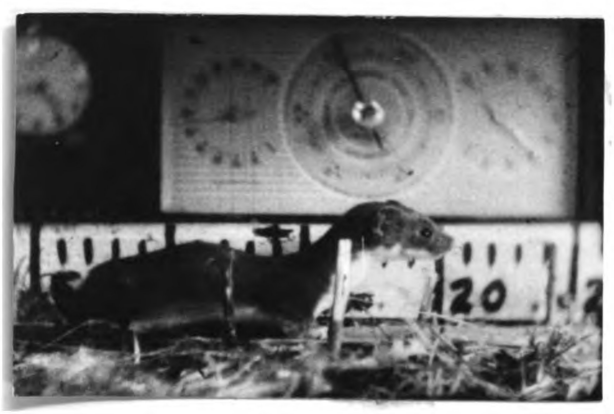


Plate 7. A least weasel,

Mustela rixosa

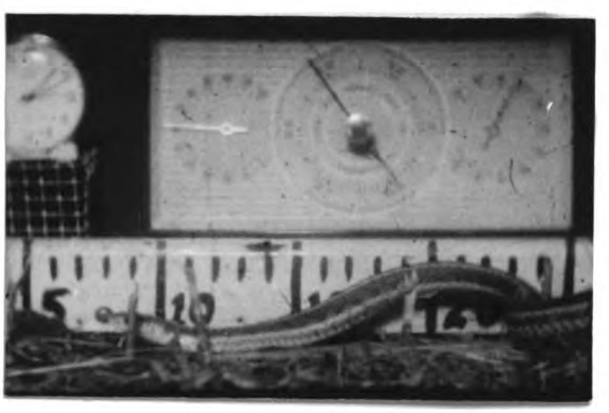


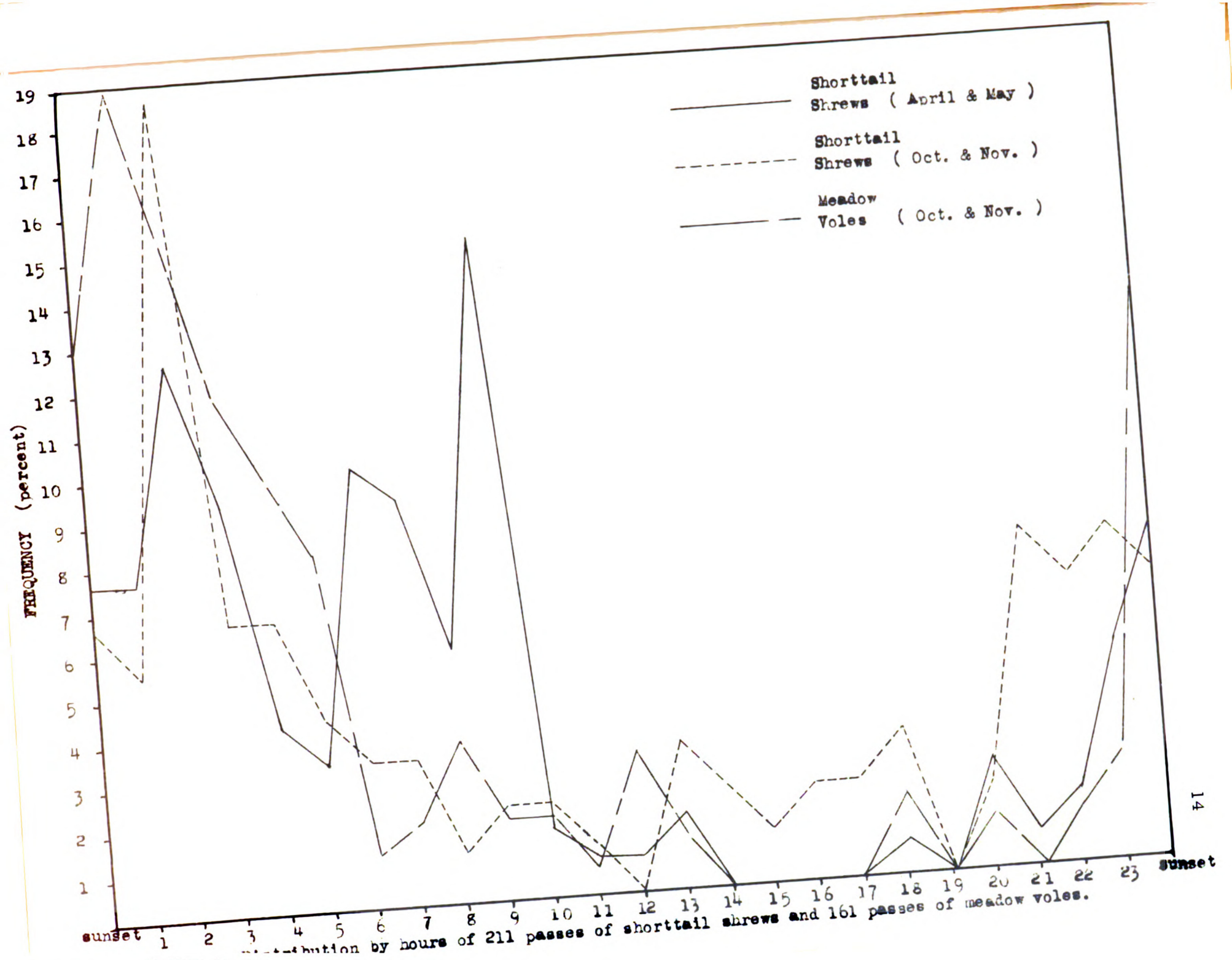
Plate 8. A garter snake,

Thamnophis sirtalis

Animals were easily identified to species from their photographs except for two Peromyscus which passed the camera at such a speed that their specific characteristics were blurred.

Two separate bursts of activity by shorttail shrews were recorded. The first occurred in mid-afternoon on October 17, when twenty-five passes were photographed within a two-hour period. The second occurred in mid-afternoon on October 22, when forty-one passes were photographed within a two and one-half hour period.

A few of the photographs showed only the instruments and no traces of a passing animal. In these cases the treadle may have been tipped by a burrowing earthworm or insect or even possibly an animal moving too rapidly to be photographed by the camera (shutter speed, 1/24 of a second). Another possible explanation might be that condensation on the mercury switch short-circuited the mechanism.



Distribution by hours of 211 passes of shorttail shrews and 161 passes of meadow voles.

TABLE I

EVALUATION OF PASSES BY THE SHORTTAIL SHREW

AND THE MEADOW VOLE

	Number days recorded	Number of passes	Passes per day	Percent of passes at night	Percent of passes on rainy days
Shorttailed shrews					
April	17	75	4.4	91.	
May	14	45	3.2	80.	
April and May	31	120	3.9	87.	49.
October	23	82*	3.6	59.	
November	21	9	.4	89.	
October and November	44	91	2.1	62.	38.
April, May, Oct. & Nov.	75	211	2.8	76.	45
Meadow voles					
October	23	118	5.1	95.	
November	21	43	2.0	86.	
October and November	44	161	3.7	93.	37.

*This figure does not include the two bursts of shrew activity.

TABLE II

RESULTS OF THREE STATISTICAL ANALYSES

	Shorttail shrews (April and May)	Shorttail shrews (October and November)	Meadow voles (October and November)
Correlation coefficients			
Barometric pressure	.0051	-.2599	-.2145
Temperature	-.2205	-.1693	.1546
Humidity	.1354	-.2019	.1516
Precipitation	.1960	-.1557	-.0391
Multiple correlations (R^2)	.6295*	.1837	.1059
Partial regression coefficients			
Barometric pressure	.0023*	-.3619	-.2363
Temperature	-1.625**	-.2255	.1078
Humidity	-.6775*	-.1247	.2059
Precipitation	1.852**	-.1690	-.1859

*These figures are significant at the 1% level.

**These figures are significant at the 5% level.

DISCUSSION

Activity

Figure 1. shows all passes by meadow voles and shorttail shrews (except for the two bursts of shrew activity in October, as mentioned previously) for all 24-hour periods, corrected to an average sunset. In all an average of 3.7 animals were photographed per 24-hour period in the runways studied. Animals used the runways more per 24-hour period in autumn (5.7) than in spring (3.9). An average of 2.8 passes per day was recorded for the shorttail shrew (75 recorder days) and 3.7 passes per day for the meadow vole (44 recorder days) (Table I). In both spring and autumn the highest percentage of activity in surface runways under observation was at night. Only 18.7% of all recorded passes by both mammals were during daylight hours.

The shorttail shrew (Plate 5) was photographed both in spring and autumn; only a few records were obtained in November. In spring two periods of nocturnal activity seemed evident. One period was early (from sunset to approximately four hours after); another was late and extended to near dawn (from six to nine hours after sunset). In autumn the shrew was most active only from approximately three hours before sunset to four hours after. Also, shrews were photographed more frequently in daytime during autumn than in spring. Their diurnal activity surpassed that of the meadow vole. Manville (1949:62) also emphasized the diurnal activity for the shorttail shrew.

A possible explanation for longer nocturnal activity in April and May is that the food supply may have been less abundant than in October. More diurnal activity in autumn may be correlated with a greater amount of grass and other protective ground cover present than in spring.

There were no passes by meadow voles recorded during the spring months. This might be attributed, following the findings of Linduska (1950:40-43), to a low population density of these animals which may have not recovered from the winter fatalities in the habitat studied, or possibly to a disturbance in the natural habitat which caused the voles to avoid the apparatus. The greatest amount of activity in surface runways by meadow voles (Plate 6) was from one hour before sunset to five hours after. Diurnal activity was limited, which contrasts markedly with the greater daytime activity found by Pearson (1959:175-176) for Microtus californicus. Photographs taken in autumn showed various sizes of Microtus, ranging from young to adults (no attempt to determine age-ratios was made because the posture of many animals photographed was such that total length was obscured). Shrews in both spring and autumn all seemed to be of the same general size. Possibly, young shrews may not use surface runways as much as do adults.

Statistical analysis

The mammalian activity as shown by the number of passes photographed was analyzed with respect to the three major groupings:

shorttail shrews in April and May, shorttail shrews in October and November, and meadow voles in October and November. Correlation coefficients were calculated for the passes of each of these three groupings with respect to barometric pressure, temperature, humidity and precipitation (Table II). These coefficients were found not significantly different from zero at the 5% level, indicating little or no correlation between activity in runways and the various weather factors considered separately. However, the correlation coefficients do suggest that activity varies under certain weather conditions and not others. This will be discussed later in relation to the partial regression coefficients.

The multiple correlation coefficient of activity with the four weather factors simultaneously considered was significant at the 1% level for shorttail shrews in spring (Table II). This suggests that the weather factors considered in this test operated jointly to effect shrew activity in the spring. The multiple correlation coefficients for autumn activity of both the voles and shrews were not significantly different from zero.

Partial regression coefficients (Table II) were used to test the importance of the four weather factors relative to each other. By using this analysis, the relationship of activity in runways with each of the individual weather factors was tested for significance, while the remaining weather factors, in effect, were held constant. Although not all the partial regression coefficients were significant (Table II),

they still indicate a pattern of activity under certain weather conditions. The shorttail shrew in spring became more active as the barometric pressure increased and the humidity decreased. This trend in activity was found to be significant at the 5% level, whereas a tendency for these shrews to be more active as the temperature dropped and the precipitation increased was almost significant at the 5% level. This was in contrast to activity during October, when shrew activity seemed to increase with a decline in all four weather factors. The meadow vole, on the other hand, during autumn was more active with the rise in both temperature and humidity and was less active during increased precipitation. However, the relationship of passes to weather factors recorded in the autumn was not significant at the 5% level for either shorttail shrews or meadow voles. The partial regression coefficient suggests that the individual weather factors did effect the activity of the mammals studied, although the affect of any one factor may be difficult to discern because of the variability of the other weather factors.

Activity during moonlight

Pearson (1960) observed a tendency for Microtus californicus to be less active on nights of full moon with little or no cloud cover than on moonless nights. It was impossible to subject my data to such a test since a malfunction of the apparatus resulted in a lack of photographs during periods when the moon was full. However, since the photographic records indicate that both voles and shrews showed

distinct preference for nocturnal activity, there is evidence that both species generally avoid daylight and may, as well, be more active on dark nights than in moonlight.

Effects of temperature and humidity

As previously mentioned, only passes of shrews in spring showed a significant correlation with relationship to the weather conditions. However, it might be noted that except for the month of November, passes were recorded during all ranges of temperature and humidity that occurred during the study. In November, only nine passes by shrews were recorded. Shrews may have been more active in underground tunnels than surface runways, because of the colder temperatures in November and reduced surface food.

Specific runway incidents

Two bursts of activity by shrews, as previously mentioned, were recorded in October. There was no evidence found in the photographs to indicate that this activity resulted from such actions as nest building, the gathering of food, or escape from predators, even though a back and forth pattern of travel was observed. Consequently, the cause of these two unusual events remains unknown. Pearson (1960:248) noted three such bursts of activity in Microtus californicus, in two of which animals were carrying food or nesting material.

In most cases traffic showed an overall decline from the time the apparatus was placed in the runway until it was moved to another location.

This also was noted by Pearson (1959:171), and he attributed the decline to one of three possibilities: either the animals abandoned the runway; or they were killed during the recording period; or the apparatus disturbed them such that they subsequently avoided the runway.

On a number of occasions a meadow vole and a shorttail shrew passed the camera only minutes apart, indicating a frequent use of the same runway at approximately the same time by two species. Although the animals were not marked for identification, some individuals could be recognized by physical characteristics, but not sufficiently well to obtain details on total runway activity of a single mammal.

Other species photographed

Species photographed other than the shorttail shrew and the meadow vole have been listed previously. The song sparrow and the shorttail shrew were the only species recorded in spring. The song sparrow appeared on a series of forty frames of film but since they were within a five-minute period they were collectively considered as one record. The Peromyscus, least weasel (Plate 7), mole, cottontail, and garter snake (Plate 8), were recorded either in October or in the first week of November.

SUMMARY AND CONCLUSIONS

By means of an automatic photographic apparatus, pictures of small animals using runways in a grassy area in Ingham County, Michigan, were obtained during April, May, October and November, 1960. Certain weather data and the time of day were recorded along with each animal on the same photograph. Of the 446 photographs taken, 277 were of the shorttail shrew (Blarina brevicauda) and 161 were of the meadow vole (Microtus pennsylvanicus). Four other mammals, one bird and one snake were photographed either once or twice. No meadow voles were recorded during April and May and only nine shorttail shrews were recorded in November. An average of 3.7 animals were photographed by the apparatus per day.

It was found from the photographic records that activity of small mammals along surface runways was influenced by time of day and by an interplay of all the recorded weather factors (temperature, barometric pressure, humidity and rainfall) acting together, although the effect of any one factor was difficult to discern because of the variability of the other weather factors. However, the shorttail shrew showed a significant increase of activity with reductions in either temperature or humidity whereas the meadow vole was more active during rising temperature or humidity. Both shrews and voles were chiefly nocturnal although some daylight traffic was recorded. Shorttail shrews used runways mostly from one hour

before to approximately four hours after sunset, although in spring this species also was active between six and nine hours after sunset to near dawn and in autumn as early as three hours prior to sunset. Meadow voles were most active in runways in autumn from sunset to five hours after sunset. In autumn shorttail shrews were more active during daylight hours than meadow voles.

Shrews and voles were active throughout the range of temperatures and humidities in both spring and autumn, showing no definite preference to any specific condition. Movement in runways decreased only slightly during periods of rain.

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APPENDIX

APPENDIX 1

PASSES IN RUNWAYS OF SHORTTAIL SHREWS
(Spring, 1960)

Date		Number of passes	Mean barometric pressure	Mean temperature	Mean humidity	Precipitation*
April	14	4	29.0	60	88	1
	15	13	28.9	57	93	1
	16	14	28.7	60	82	1
	17	11	28.9	45	28	1
	18	12	29.4	35	50	0
	19	5	29.2	50	34	0
	20	6	28.8	60	60	1
	21	2	29.0	60	70	0
	22	0	29.1	70	60	0
	23	0	28.9	70	65	0
	24	1	28.7	70	65	1
	25	0	28.9	42	95	1
	26	3	29.1	44	90	0
	27	0	29.2	48	65	0
	28	0	29.1	49	50	0
	29	0	28.9	56	75	1
	30	4	28.7	45	88	0
May	13	0	28.8	48	75	1
	14	6	28.9	53	60	0
	15	0	28.9	59	51	0
	16	5	28.8	60	75	1
	17	5	28.9	55	91	1
	18	1	29.0	65	72	0
	19	1	28.9	65	90	1
	20	4	28.8	64	90	1
	21	1	28.7	70	85	1
	22	7	28.8	69	92	1
	23	6	28.9	53	85	0
	24	2	28.9	50	75	0
	25	7	29.0	60	75	0

*Yes = 1, no = 0.

APPENDIX 2
PASSES IN RUNWAYS OF SHORTTAIL SHREWS AND MEADOW VOLES
(Autumn, 1960)

Date		No. of passes		Mean barometric pressure	Mean temperature	Mean humidity	Precipitation (yes=1, no=0)
		Shrews	Voles				
Oct.	8	0	0	29.0	50	75	0
	9	5	0	29.1	48	75	0
	10	2	7	29.1	65	65	0
	11	2	6	29.0	55	80	0
	12	8	11	29.0	58	67	0
	13	0	0	28.9	65	65	0
	14	6	9	29.0	60	95	1
	15	1	0	29.2	50	90	1
	16	7	19	29.0	54	60	0
	17	2	3	29.1	50	57	0
	18	4	5	29.1	48	63	1
	19	4	4	29.1	37	85	1
	20	0	0	29.2	43	70	0
	21	2	6	29.0	44	64	0
	22	10	13	28.6	54	58	1
	23	8	12	28.8	37	67	0
	24	10	12	29.1	33	66	0
	25	3	0	29.0	45	59	1
	26	6	4	28.9	50	90	0
	27	1	3	29.0	50	86	0
	28	1	4	29.0	49	96	1
	29	0	0	29.1	53	91	0
Nov.	2	0	0	28.9	45	74	1
	3	4	4	29.1	44	70	0
	4	2	5	29.2	43	79	1
	5	0	6	29.0	33	81	1
	6	0	7	29.2	31	76	1
	7	0	0	29.2	36	67	0
	8	0	2	29.1	43	92	1
	9	1	5	29.2	36	89	1
	10	0	1	29.3	30	64	0
	11	0	0	29.2	38	68	0
	12	0	0	29.1	43	61	0
	13	0	0	29.1	44	72	0
	14	0	6	29.0	55	77	1
	15	0	1	28.6	53	87	1
	16	2	3	28.7	37	71	1
	17	0	0	29.0	38	62	1
	21	0	1	29.0	41	64	1
	28	0	2	28.7	39	79	1