Experimental induction of territorial behavior in the deer mouse, Peromyscus maniclatus
by James John Salonen

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Zoology
Montana State University

Abstract:
This study, through experimental induction of territorial behavior in the deer mouse within the laboratory, confirmed initial observations of territorial behavior and determined that territorial behavior was subject to seasonal variation. No relationship between territorial behavior and the reproductive state of male deer mice was discernible.' Deer mice were first habituated to the animal room and then to the interaction complex as described. Tests consisted of three series of seven experiments, each experiment with two pairs of deer mice (one male and one female per pair). Observation and quantification of sequentially related agonistic and nonagonistic behavior patterns, in the context of criteria established for territorial behavior, indicated that males more often than females exhibited agonistic behavior in defense of an area and mutual avoidance of a conspecific's terrain, while females rarely fought each other and were usually submissive to males. Male and female deer mice exhibited territorial behavior most often by attacking a conspecific in defense of a nest box. In some experiments, males utilized threats instead of fighting behavior to defend their territories from intruding conspecifics. Females rarely threatened conspecifics. As a result of compressing the home ranges of deer mice into the narrow confines of the interaction complex, the behavior patterns comprising territorial behavior were transient and usually shifted to a social hierarchy either immediately or shortly after the initial hostile encounter between the subjects of opposing pairs in each series. The failure to detect quantitative differences of spermatozoa present in the epididymides of males is thought to be the main cause for the apparent lack of a relationship between territorial behavior and the reproductive state of the males in this study. Seasonal variation in territorial behavior was determined through observed repetitions of behavior patterns of subjects. During the winter, males exhibited a reduction in agonistic and non-agonistic behavior patterns, while females exhibited an increase in agonistic and non-agonistic behavior patterns.

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Signature James J. Salomon

Date July 28, 1969

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Approved:

Head, Major Department

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ABSTRACT

This study, through experimental induction of territorial behavior in the deer mouse within the laboratory, confirmed initial observations of territorial behavior and determined that territorial behavior was subject to seasonal variation. No relationship between territorial behavior and the reproductive state of male deer mice was discernible. Deer mice were first habituated to the animal room and then to the interaction complex as described. Tests consisted of three series of seven experiments, each experiment with two pairs of deer mice (one male and one female per pair). Observation and quantification of sequentially related agonistic and non-agonistic behavior patterns, in the context of criteria established for territorial behavior, indicated that males more often than females exhibited agonistic behavior in defense of an area and mutual avoidance of a conspecific's terrain, while females rarely fought each other and were usually submissive to males. Male and female deer mice exhibited territorial behavior most often by attacking a conspecific in defense of a nest box. In some experiments, males utilized threats instead of fighting behavior to defend their territories from intruding conspecifics. Females rarely threatened conspecifics. As a result of compressing the home ranges of deer mice into the narrow confines of the interaction complex, the behavior patterns comprising territorial behavior were transient and usually shifted to a social hierarchy either immediately or shortly after the initial hostile encounter between the subjects of opposing pairs in each series. The failure to detect quantitative differences of spermatozoa present in the epididymides of males is thought to be the main cause for the apparent lack of a relationship between territorial behavior and the reproductive state of the males in this study. Seasonal variation in territorial behavior was determined through observed repetitions of behavior patterns of subjects. During the winter, males exhibited a reduction in agonistic and non-agonistic behavior patterns, while females exhibited an increase in agonistic and non-agonistic behavior patterns.

INTRODUCTION

Behavioral studies on cricetid rodents are relatively recent contributions to zoology. For example, species of the genus Peromyscus have been used in studies of paternal behavior (Horner, 1947), habitat selection (Harris, 1952; Wecker, 1963), aggression (Sadlier, 1965), social behavior (Sheppe, 1966; Terman, 1963) and behavior capacities (Foster, 1958, 1959; King, Price and Weber, 1968). Territorial behavior of the deer mouse, Peromyscus maniculatus, has been studied in the context of social behavior in the laboratory by Eisenberg (1962) and in relation to aggression in population size regulation by Healey (1967), using laboratory and field methods. Eisenberg (1962) was the first worker to observe territoriality in the deer mouse, Peromyscus maniculatus gambelii, although others have inferred territorial behavior from field studies (e.g., Burt, 1943; Manville, 1949).

Burt (1943) emphasized two basic types of territories in mammals; one serves for mating and rearing of young, the other food and shelter. Territorial behavior is defined in my study as defense of an area against intrusion by conspecifics with toleration of mate and offspring within that area.

My study involves experimental induction of territorial behavior in the deer mouse within the laboratory, attempts to confirm and expand upon the initial observations of territorial behavior made by Eisenberg (1962), to relate territorial behavior with reproductive state and to ascertain whether or not territorial behavior is subject to seasonal variation. Observations in this study were made from 28 July 1968 to 11 March 1969.

MATERIALS AND METHODS

Deer mice used in this study were caught using Sherman live-traps baited with rolled oats. All deer mice were collected from a low man-made ridge forming the west boundary of the Gallatin Sand and Gravel Pit 10 miles northwest of Bozeman, Montana.

Predominant vegetation on the ridge consisted of the following species: downy chess brome (Bromus tectorum L.), june grass (Koeleria cristata (L.) Pers.), sweet clover (Meliotus officinalis (L.) Lam.), Russian thistle (Salsola kali L.), clasping pepper weed (Lepidium perfoliatum L.) and tumblemustard (Sisymbrium altissimum L.).

Collected deer mice were taken to an animal room, ear-punched for identification, paired male with female and placed in 29 cm x 18 cm x 13 cm cages containing sawdust, cotton nesting material and food and water ad libitum. Light and dark periods were controlled and were the same as natural light and dark periods. In all cases, subjects spent a minimum of seven days in the animal room before being habituated to and tested in the apparatus.

Deer mice utilized in this study were at least 50 days of age as evidenced by adult pelage (Cockrum, 1962). Adult males, in most cases, had testes lowered into their scrotal sacs as determined by direct observation and palpation. Adult females which had perforate vaginae, were pregnant, or were rearing litters were considered sexually mature. During the winter months of the study, subjects exhibited vaginae filled with mucous material and testes retracted into the body cavity.

Three series of experiments were conducted, each series consisting of seven experiments with two pairs of deer mice per experiment (Table I). In the first series consisting of experiments 5 through 11, the two pairs of subjects in each experiment were habituated to the animal room ranging from a minimum exposure of seven days for Experiment 5 to a maximum of 46 days for Experiment 11. The mice were kept after completion of the experiments in Series I for use in the experiments of Series II.

In an attempt to simulate winter conditions, the mice to be used in Series II were placed in an unheated, unlighted Quonset hut on a storage rack. Each cage was arranged to receive illumination from two adjacent vinyl and screen covered windows. Holding cages were prepared with a layer of sawdust, abundant cotton and food and potato ad libitum. Quartered potato slices served as a source of moisture and as additional food. Food, bedding and moisture were maintained daily. Daily temperature fluctuations were recorded by a maximum-minimum thermometer starting 28 October 1968 (Fig. 1).

During the period of winter simulation for experiments of Series II, one male of Experiment 6 escaped as cages were being cleaned. Therefore, Experiment 6 had to be dropped from the study. Consequently, Series II consisted of subjects from Experiments 5 and 7 through 11 of Series I with the mice of Experiment 3 substituted for the mice of Experiment 6.

For experiments in Series III, deer mice trapped during January and February were habituated to the animal room ranging from a minimum of nine days for Experiment 12 to a maximum of 35 days for Experiment 18. Pairs of

TABLE I. Collection of Subjects and Experiments Performed in the Study

Series	Dates of Collection	Designation of Experiments	Dates of Experiments	Number of Experiments	Mouse Groups in each Experiment
I	4 August 1968- 9 August 1968	Breeding Season	27 August 1968- 23 September 1968	7	5 through 11
II	29 June 1968- 9 August 1968	Winter-Simulation	18 November 1968- 21 December 1968	7	3, 5 and 7 through 11
III	11 January 1969- 14 January 1969	Winter	20 January 1969- 17 February 1969	7	12 through 18

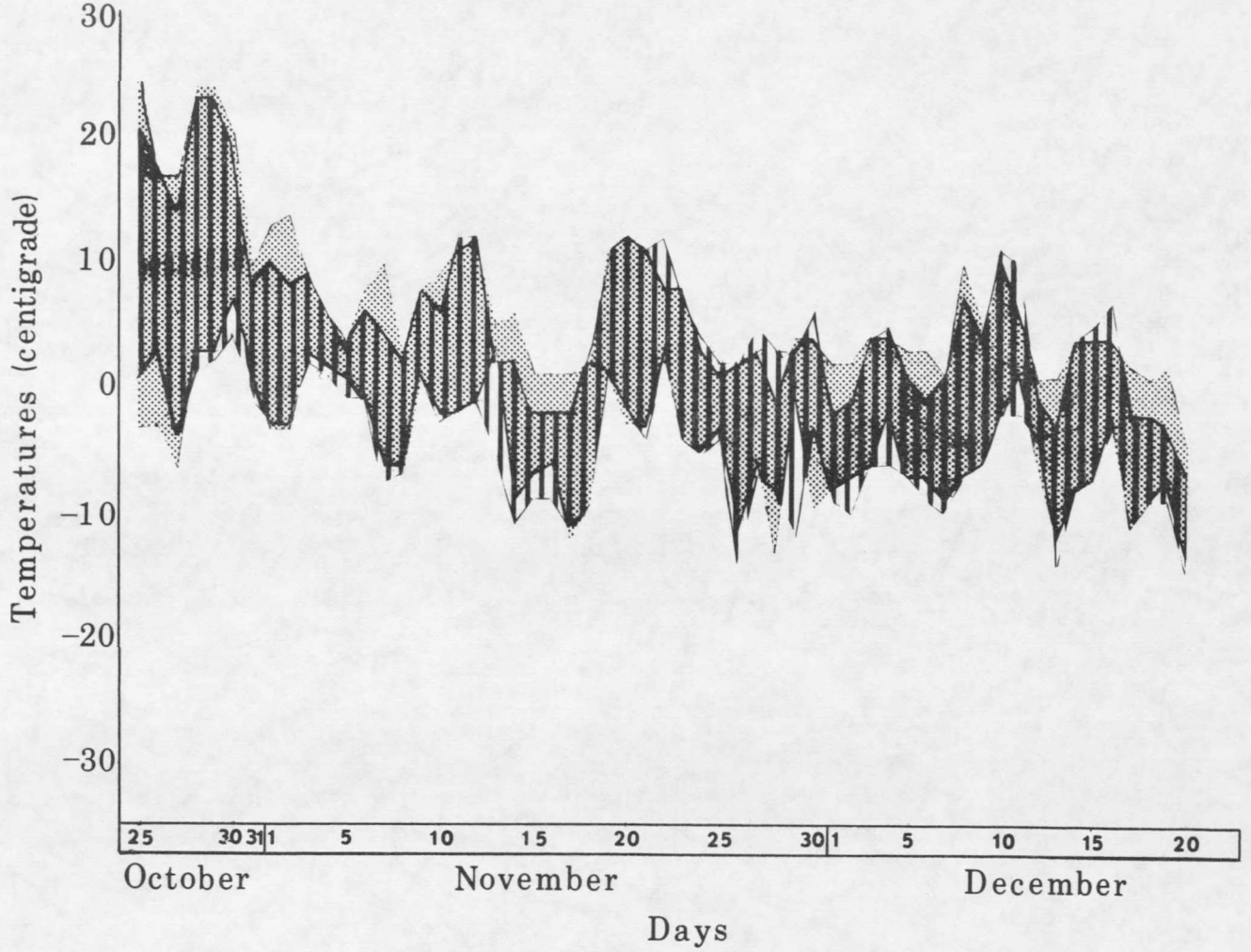

Fig. 1. Maximum-minimum temperatures recorded during the winter-simulation procedure for subjects in Series II. Quonset temperatures, dotted areas; Montana State University Weather Station temperatures, vertical bars.

deer mice used in Series I, II and III were transferred either from the animal room or the Quonset hut to the apparatus just prior to their habituation to the apparatus.

Description of Apparatus

The apparatus used in this study was a modified version of the "Multiple Escape Pens" used by Scott (1944). The interaction complex, or apparatus, was constructed of quarter-inch plywood, quarter-inch hardware cloth and aluminum metal stripping (Fig. 2). The interaction complex consisted of five compartments. Four outer compartments with dimensions of 91 cm x 30 cm were connected with adjacent compartments by runways 23 cm x 11 cm. The center compartment measuring 61 cm x 30 cm was connected with each of the outer four compartments by runways 31 cm x 14 cm. The walls of the interaction complex were 25 cm high and roofed over with hardware cloth. The hardware cloth cover was fastened to the plywood walls using paper clips and rubber bands to form clamps. Access to certain compartments was controlled by closing off compartment entrances with metal slides (Anderson and Hill, 1965). Nest boxes in each outer compartment consisted of modified 1 1/2 quart polyethylene food storage containers. Except for the hardware cloth, the entire apparatus including nest boxes was painted with a polyurethane-base flat medium-gray paint.

Representatives of the six previously described species of plants obtained from the collection area were placed in each compartment. Each compartment floor was covered with a thin layer of plant material, food, cotton nesting material and gravel. A single rock with approximate