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ABSTRACT: In previous studies Norway and roof rats were captured, fitted with radiotransmitter collars, and released into their respective habitats. Detailed observations were made of their locomotor patterns, home ranges, activity phasing, food sources, and general behavior. A summary of micro-ecology, habitat partitioning and other behaviors from those studies which may be of use to persons interested in vertebrate pest control is reported.

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INTRODUCTION

The general biology of the roof rat, Rattus rattus. and the Norway rat, R. norvegicus. is well known. Good baseline data exist for size, weight, appearance, food preferences, reproductive strategies, general ecology, current distribution and historical biogeography for both species. An indispensable tool of the laboratory physiologist, psychologist, and behaviorist, the white morph of R. norvegicus has been especially well studied (Barnett 1967, Calhoun 1962, Howard and Marsh 1976, Ingles 1965, Twigg 1975).

Until recently, however, we knew very little of the details of the fine-structure of the behavior and ecology of free-ranging domestic rats. Because typical rat studies depend on direct visual observation (of animals or sign) and/or live-trapping, they lose accuracy due to their inability to closely monitor the behavior of the rats (Recht 1982b, 1983, and in submission). This inability to closely monitor the behavior of the rats usually results in fragmented non-sequentially recovered data which typically represents less than 1 % of the animals behavior set (Recht 1982b, 1983).

These difficulties with fragmented non-sequentially recovered data are greatly reduced by using continuous radiotelemetric observation. Continuous radiotelemetric observation provides for a more complete data set and thus a more accurate and intimate understanding of rat micro-ecology and behavior (Recht 1982b, 1983). This intimate knowledge of rat movement, foraging, and harborage patterns and response to loss of habitat provides us with some new facts with which to examine our control policies and practices. This paper will present a summary of some new discoveries of the micro-ecology and behavior of domestic rats useful to persons interested in their control.

METHODS AND MATERIALS

The details of the methods and materials used have been reported in my previous studies (Recht 1982b, 1983) and so will be only briefly described here.

Animals were fitted with hand-fabricated radiotransmitters (Shields 1976) which were non-crystal controlled oscillators worn as collars around the necks of the rats. This placement is convenient for both the investigator and the animal: It is easy to attach and, when properly fitted, does not interfere with the behavior of the animals.

Movement of the rat produces subtle changes in the placement of transmitter against the skin. Due to the proximity of the transmitter's pulse rate-setting capacitor on the animal's body, movements affect the capacitive loading results in changes in the audible oscillation (or pulse) rate which is heard on the tracking receiver. Additionally, when the rats move there is a change in the orientation of the transmitter (and the transmitted signal) producing changes in the received level of signal gain at the tracking receiver.

Thus signal changes mean movement; no changes indicate no movement. Therefore, the extent of the changing pulse rate and varying signal gain is an excellent indication of the level of rat activity.

The recovered data were recorded in field notes. Because three of my studies were conducted in urban areas (the Campus of CSU Dominguez Hills, Carson, California, and two individual city blocks in the City of Orange, County of Orange, California) accurate maps of the rats' habitats could be constructed. The data concerning their movements, foraging patterns and use-density were plotted on these maps. Graphs showing the rats' activity level by hour-class were featured (Recht 1982b, 1983, and in submission).

Measurements of rainfall, ambient and vegetation temperatures, and relative humidity were taken.

RESULTS

The home range, use-density, movement pattern, foraging, and activity data have been previously published or submitted for publication (Recht 1982b. 1983.andin submission).

DISCUSSION

The radiotelemetric studies revealed much new information correcting our understanding of the behavior and habitat partitioning of these animals while confirming in greater detail many previously understood concepts. For example, the literature previous to our studies suggests that both roof and Norway rats have circular home ranges that are about 30 meters in diameter (0.18 hectares) with the home burrow or nest in the center. Home range use is said to decrease from the center towards the edge of the home range (Barnett 1967, Davis etal. 1948, Howard and Marsh 1976) and the literature did not report the extensive use of accessory burrows.

In contrast, I found that the rats had home ranges that were different from what the literature described. The size of the home range was about 0.8-2.0 hectares for Norways and about 0.2-0.5 hectares for the roof rats. The home ranges had irregular shapes which were dictated by the micro-structure of the habitat of both species. The home burrow was not centrally located for either species but rather at the edge of their home range. Both animals used accessory burrows or nests.

The Norway rats had home and accessory burrows which were principally located along the edge of their home ranges. These burrows undoubtedly served as territorial marking posts on the periphery of the home range because they were visited on a daily basis as the animals moved throughout their home range. These burrows were also used when successful foraging in that local area warranted remaining overnight. This daily patrolling of the home range and occasional overnight use serves to maintain the social status between neighbors and increases foraging success. It is very clear that use of the periphery of the home range is extensive. Roof rats also extensively used the periphery of their home range. The home range for these rats, however, is the disjunct vegetation, fences, telephone wires, and buildings of a residential neighborhood (as opposed to the rather uniform fields and plantings of a campus), and as such their use of the home range is more dependent on aerial pathways.

Habitat partitioning was determined for both species with a level of detailed understanding not previously documented. With Norway rats, the extent of use of vegetated (ivy) areas for cover, foraging and social behavior with designated use of specific pathways was quantified. Some of the pathways used by the Norway rats were quite long in that it was not unusual to have animals make individual movements of between 100 and 300 meters. Independent simultaneous research by Hardy and Taylor (1980) documents individual movements by Norway rats of up to 500 meters. The speed with which the rats made these movements has also been documented; I was able to time several rats as they moved across open portions of the habitat. It was not uncommon for a rat to cover 100 meters in about 10 seconds.

Quantification of roof rat habitat partitioning was also extensive. While the areas they used were not unexpected, the quantification of their use gave new insight into the ecology of this species. The use of dense ivy, bougainvilla, palm trees, fruit trees, wood piles, garages, attics, and other areas as foraging, social and nest sites was very informative. The discovery of the extent to which these rats construct and use multiple nests in thick vegetation and use telephone wires and trees as pathways was greater than previously known. This detailed understanding of micro-habitat use permitted for the first time a novel test of the concept that habitat reduction reduces rat populations.

By comparing the use of habitat, before and after its vegetation was trimmed in accordance with rat control policies, a first hand understanding of the effects of habitat reduction could be had. Although the details are complex, the behavior of the roof rats following habitat reduction may be summed as follows: After the initial brief exploration of formerly used (and vegetated) areas the rats increased their exploratory behavior of new areas. Setting up new home nest sites, the animals continued to explore new areas while dramatically decreasing use of old ones. Where the vegetation was completely removed so were the rats. Cutting back trees and hedges so that they could not contact buildings or telephone wires prevented them from being used as aerial pathways and dramatically reduced rat movement. Demonstrating a strong site tenacity the rats would occasionally (for very brief periods) return to those old areas where some vegetation remained. Habitat reduction reduced the rats' use of the affected yards but increased their use of the untrimmed ones. The affect of trimmed vegetation on the rats is to reduce their food sources, pathways, and cover. While not diminishing the value of the first two, cover is vitally crucial to the survival of these shy animals (Recht 1982a). Therefore, to be most effective, a comprehensive program of habitat reduction is needed.

Some additional behavioral odds and ends concern new data on the activity phasing, effect of rainfall, trap shyness and food choices of these rats. While both species of rats are known to be nocturnal two new facts emerged: Norways can be completely diurnally phased, and juvenile roof rats were consistently observed actively foraging by 2 pm. These variances in the behavioral schema suggest that in both cases the rats are avoiding competition, the Norways from larger conspecifics and the roof rats from adults. Rainfall affected the two species differently in that the Norways ceased above ground locomotor activity until the rain stopped, whereas the roof rats continued to move about their habitat. This may have been due to the more vertical nature of the roof rat habitat offering more substantial protection from the rainfall.

Trap shyness is of particular interest to persons involved in rodent control. I have observed on several occasions that Norway rats clustered around a baited open wire-mesh trap did not enter the trap; roof rats have been similarly observed. While both animals are notoriously trap shy there are distinct differences between the natures of their shyness. Trapped Norway rats when released did not go back to the areas where they were caught for at least five days and even then maintained a distance of about two meters from the traps. Previously trapped roof rats behaved differently; routinely passing by the traps they would rarely go in. Quickly learning about their habitat has been the key to success for both of these species. Some novel food choices by roof rats were discovered; among them include extensive use of hibiscus flowers, young palm shoots, and young ivy shoots. Additional studies on rat use of landscape plantings would be most useful to allow us to avoid planting additional rat habitat.

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