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Selection of Secondary Growth Areas by Vervet Monkeys (*Cercopithecus aethiops*)

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Habitat selection by a group of vervet monkeys (*Cercopithecus aethiops*) living on the savanna peninsula of St. Kitts was investigated by the intensive sampling of 12 transects. The vervets exhibited nonrandom use of habitats. Examination of 20 ecological variables in each of the habitat types revealed that the vervets preferentially used areas of secondary growth characterized by high density and diversity of tall food plants. It is suggested that the preferential use of secondary growth habitat can be attributed to the fact that these areas have high levels of plant productivity and that they have a large proportion of their productivity available for consumption.

Key words: vervet, secondary growth, habitat selection

INTRODUCTION

Often in scientific literature it is suggested that animals preferentially use areas of secondary growth. The exact characteristics of these areas, however, are generally poorly defined, and the animals' behavior in these areas is rarely described. Clarification of the nature of secondary growth areas is essential to our understanding of regenerating forest and of the influence animals have on the forest. As seed-dispersal agents and plant predators, animals using secondary growth areas may be crucial to the life cycles of many pioneer plants as they influence their dispersal and survival. Animal seed dispersal may be the only means available by which these plants reach suitable newly disturbed sites [Howe & Smallwood, 1982]. To evaluate this dispersal, the use of secondary growth areas must be documented in terms of total habitat use and the animals' behavior in these areas must be described.

In the study reported here, the habitat preferences of a group of vervet monkeys (*Cercopithecus aethiops*) living on the savanna peninsula of St. Kitts was examined with the objective of quantifying the group's habitat use in terms of 20 ecological variables. Secondary growth areas are similarly characterized by these ecological variables, and their use is contrasted to that of other areas. The vervet monkey was selected as a study subject to investigate patterns of range use related to secondary growth because it is widely distributed in habitats ranging from savanna to man-

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grove swamp, and because it has often been described as using areas of secondary growth. For example, studies of habitat use of vervets have found that they are mainly found in areas of regenerating forest [Kavanagh, 1980], that their diet is dominated by secondary growth plants [Moreno-Black & Maples, 1977], and that they flourish in disturbed areas [Basckin & Krige 1973; Henzi & Lucas 1980; McGuire, 1974]. However, descriptions of these secondary growth areas have been largely qualitative.

METHODS

Habitat selection by vervet monkeys was studied from April 1982 until December 1982, during which time approximately 2,500 hours were spent in the field observing the study group. The vervets of St. Kitts are not native to the island. They were introduced from the west coast of Africa in the late 16th century. With subsequent population growth, the vervets have now spread to all habitats on the island not occupied by humans. During the 8 months preceding this investigation, the study group was censused, and its home range was mapped [Fedigan et al, 1984]. The study group consisted of 50 animals, with an age/sex composition of 11 adult males, 2 subadult males, 19 adult females, 3 subadult females, 11 juveniles, and 4 infants. The group slept together at a sleeping site that remained unchanged throughout the study period. During most of the day, however, the group was widely dispersed throughout their home range.

The group's 0.51-km^2 home range was a mosaic of distinct habitats. The majority of the area was a fire-affected community dominated by acacia (*Acacia farnesiana*), but drainage ravines coming from a hill within the group's home range supported stands of large trees (up to 15 m in height), such as *Bursera simaruba*, *Tabebuia pallida*, and *Hippomane mancinella* (mancineel). There was a small saline lake surrounded by an extensive mangrove thicket (*Rhizophora mangle*), a mancineel grove (*Hippomane mancinella*),and a large grassland area. Throughout the group's home range, there were intermittent stands of clammy cherry trees (*Cordia obliqua*), coconut palms (*Cocos nucifera*), and sea grapes (*Coccolobo uvifer*).

One or more transects were placed in each of the seven habitat types defined previously [Chapman, 1985] (Table 1). Observers of equal experience walked along predetermined transect lines, counted the animals observed, and estimated the distance to each animal perpendicular to the transect line. The average perpendicular distance was considered to be one-half of the transect width and was calculated for every transect independently. The density of the vervets on each transect was calculated as the number of animals seen divided by the width of the transect and the number of times it was sampled. By using the average perpendicular distance to determine the width of the transect, any differences in the observability of animals between transects owing to habitat differences in cover were accounted for by changes in the width of the transect (Chapman et al., unpublished manuscript). A sampling regime was established in which the transects were walked equally in all daylight hours so that at the end of every 2 weeks an equal number of transects were sampled.

The ecological characteristics of each habitat were quantified by measuring 20 ecological variables in 10 × 10-m sample plots established within a representative area of each habitat type (Table I). The ecological variables were measured as follows. The density and diversity (based on the Shannon-Weiner Index) of all and only food plants were calculated for three size classes of plants (variables 1–12): small (0.0–0.5 m), medium (0.5–2.0 m), and large (>2.0 m). A measure of cover (variable 13) was obtained by estimating how much of a 10-m pole was visible to an observer seated 10 m from it. The mean and maximum canopy height (variables 14

TABLE I. Description of the 12 Transects Used to Census the Study Group of Vervet Monkeys on St. Kitts

Transect No.	Habitat type	Length (m)	Population density (individuals/sq km)
1a	Grassland bordered by forest	180	217
1b	Grassland bordered by forest	200	400
1c	Grassland bordered by forest	190	98
2a	Coccolobo/Acacia dominated forest	100	38
2b	Coccolobo/Acacia dominated forest	95	5
3	Mangrove (Rhizophora mangle)	110	1
4a	Grass dominated slope	540	0
4b	Grass dominated slope	425	0
5	Shrub dominated slope	275	9
6	Tall tree plateau	135	2
7a	Tall tree drainage ravine	210	5
7b	Tall tree drainage ravine	260	150

and 15), the percentage of the quadrant that was open ground, the percentage of the quadrant covered by plants, and the percentage covered by food plants (variables 16–18) were determined. Disturbance and the structural complexity of the area (variables 19 and 20) were estimated through qualitative ranking procedures. The structural complexity variable was scored so that open areas were assigned the lowest rank, and areas with a canopy overstory and a dense understory received the highest rank.

RESULTS

The 12 transects were sampled at least ten times in each daylight hour, resulting in a total sample of 1,462 transects. The density of individuals on the transects varied from 400 individuals per km^2 in one of the transects crossing a glassland area to 0 individuals per km^2 in the transect sampling a grass-dominated slope (Table I). The distribution of vervets between transects was significantly different from what would be expected if they were selecting habitats at random ($X^2 = 2{,}200$, df = 11, $P < .001$). Nonrandom use of habitats is further demonstrated by the fact that 57% of all animals seen were observed on three of the 12 transects. Two of these three transects were located in narrow grasslands, which were being encroached upon from the neighboring treed areas. Along the edge of these grasslands, trees, such as *Cordia obliqua* and *Acacia farnesiana*, were abundant, as well as a variety of small shrubs. The third preferred area was a ravine habitat which was bordered by grassland. This area was the group's sleeping site throughout the duration of the study. The ravine was dominated by *Bursera simaruba*, a common early succession plant, and was bordered by stands of *Acacia farnesiana*. Both of these plants were favored foods of the monkeys.

This strong selection of habitats was consistent throughout the study period. In none of the 2-week sampling periods was the distribution of monkeys seen on the transects random. In fact, throughout the entire study there was no change in the order in which habitats were selected.

It is possible to provide insight into why the vervets selected the areas they did by determining which of the 20 ecological variables measured related to the animal density of the transects. Of the 20 ecological variables examined, the population density of the vervets was related to both plant diversity and density variables. In particular, vervet population densities were related to density (Pearsons r = 0.445, $P = .05$), and diversity (r = 0.489, $P = .04$) of tall food plants, the diversity of tall

plants ($r = 0.579$, $P = .03$), and the diversity of small plants ($r = 0.542$, $P = .05$). To evaluate the relative importance of ecological variables in predicting population density of the vervets, a multiple regression was performed. Tall plant density entered the equation first and accounted for 39% of the variation in vervet density. Second to enter the equation was small plant diversity, which accounted for 37% of the remaining variation. These two variables together accounted for 76% of the variation between transect population density. No other variable significantly entered the equation.

The fact that diversity and density of tall food plants were strongly related to habitat selection suggests that a major factor influencing habitat choice is the availability of food resources. This speculation is strengthened by the fact that areas with high population density and high density and diversity of food plants were areas where monkeys tended to feed [Chapman, 1985]. Selection of habitat was not solely caused by animals choosing areas in which to feed; the high-density areas were also areas where the monkeys preferentially chose to rest and socialize. In contrast, the vervets spent proportionally more time locomoting in areas where the population density was low, than where it was high.

DISCUSSION

It is evident from this investigation that vervets select habitats and that plant diversity is an important determinant of their habitat selection. Those areas characterized by high levels of plant and food plant diversity were typically areas of secondary growth, such as on the edge of grassland areas [Chapman, 1985]. Hartshorn [1978], who studied a tree fall as an area of secondary growth, demonstrated that these areas are characterized by a tremendous increase in the diversity of plant species. Secondary growth areas are typified by a number of features that may be attractive to vervet monkeys: high levels of both leaf and fruit production [Webb et al, 1972]; an overall greater availability of the areas' primary production, caused by the plant's reduced investment in predator defense [Janzen, 1979]; and the actual increased level of plant diversity [Hartshorn, 1978].

Kavanagh [1980], who studied vervet monkeys in West Africa, found monkeys mainly in areas where cultivated land was bordered by fallow areas. Moreno-Black and Maples [1977] found that the diets of vervets they studied in East Africa were dominated by secondary growth plants. These studies are in agreement with the results found here, demonstrating that vervets select secondary growth areas. These studies similarly suggest that the attraction of vervet monkeys to areas of secondary growth could be due to an attraction to the food resources. However, the possibility that the monkeys may have been attracted to these areas because of some other favorable condition associated with these areas cannot be ruled out. When more information is gathered on the nature of these secondary growth plants and on the monkey's behavior in these areas, the motivating factors behind this attraction can be more fully understood.

CONCLUSIONS

1. Vervets exhibited a nonrandom use of habitats.

2. Areas characterized by high density and diversity of tall food plants and high small-plant diversity were preferentially used.

3. The preferentially used areas were often areas of secondary growth.

4. Behaviors expressed in secondary growth areas suggest that these habitats were used to take advantage of high level of plant productivity and the large proportion of their productivity that is available for consumption.

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