Some Interrelations of the Merriam Kangaroo Rat to Velvet Mesquite[1]

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THE Merriam kangaroo rat (*Dipodomys merriami merriami*) is one of the important biotic factors disseminating seed of velvet mesquite (*Prosopis juliflora* var. *velutina*) on certain rangelands of southern Arizona. Mesquite, because it dominates and eliminates the more desirable perennial grasses, has been an unwanted invader of many rangelands during the past 50 years and this invasion is still underway. Merriam kangaroo rats increase in numbers as perennial grasses decrease, and, because of their seed-storing habits, contribute to the further spread of mesquite. This paper appraises the relative importance of this means of spread as compared to other possible agencies of mesquite dissemination.

Experimental Area

All experimental work was done on the Santa Rita Experimental Range located about 30 miles south of Tucson, Ariz., and maintained by the Forest Service. This experimental range has been invaded seriously by mesquite during the last 50 years, and inasmuch as it also supports a dense population of Merriam rats, offers an excellent opportunity to study the interrelations of the two species. Moreover, conditions found on the experimental range are believed to be representative of about 20 million acres of rangeland in Arizona, New Mexico and Texas.

Occupying elevations between 3,000 and 4,500 feet, the experimental range exhibits a wide variety of environmental conditions. Average annual rainfall varies from 12 to 20 inches. Average annual rainfall and other environmental influences which are related to elevation result in significant differences in the biota. The vegetational aspect varies from creosotebush at the lower elevations to typical oak woodland-grass at the higher altitudes. The number of plant and animal species living in this transition zone is large. Merriam kangaroo rats are the most abundant rodents, and at the intermediate elevations mesquite is the dominant shrubby plant.

Effect of Merriam Kangaroo Rats on Mesquite

The diet of Merriam kangaroo rats, as measured by pouch collections, averages about 6 percent mesquite beans, and during the period of seed maturation in July beans may exceed 27 percent of the rat diet (Reynolds and Glendening, 1949). All seed collected by kangaroo rats is not consumed. A portion of the seed is stored in the surface soil. Seed caches vary from ½ to 1½ inches in depth and contain 1 to 13 seeds which are in an ideal environment for germination and establishment (Reynolds, 1950*A*). Some seedlings survive in spite of drought or other mortality factors. On some areas, enough seedlings remain to produce potentially not less than 8 mesquiet trees per acre per year (Paulsen, 1950). Because some seedlings survive and produce mature trees, the seed-collecting and surface-caching habits of Merriam kangaroo rats have an important influence on mesquite propagation. Thus, the distance which the seed is moved from the parent tree by Merriam rats has an effect upon the rate of spread of mesquite.

Distance Seed Is Moved by Rats

Merriam kangaroo rats, in common with other small rodents, are known to live in certain spatial units (Blair, 1943). These "home ranges" are known definitely to be occupied during the time of breeding, which includes the period of mesquite seed maturation. In 1942 and 1946, 38 home ranges of kangaroo rats were determined by the live-trapping, marking, and recapturing technique advocated by Blair (1941). Average radius of a home range, considering all sexes and ages, varied from 58 to 80 feet. Hence, on the average, these animals are capable of moving seed to a maximum distance of 160 feet from the parent tree.

In 1950, movement of mesquite seed by the kangaroo rats was actually measured. All seed-eating rodents except Merriam kangaroo rats were removed by live-trapping from selected areas. Just prior to the summer rains, mesquite seed well mixed with sorghum seed was placed at central feeding stations. This mixture of seed was collected by Merriam rats, and some of it was buried in surface caches at variable distances from the central feeding stations. When the surface caches sprouted in response to summer rains, the mesquite seeds transported from the central feeding stations were identified by observing the "marker" sorghum seedlings.

A total of 29 sorghum seed

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Table 1. Percentages of kangaroo rat burrows beneath various shrubs on a 7.5-acre plot in 1946

Shrubs		Burrow Systems	
Name	Number of plants	Percent available shrubs occupied	Percent total number burrows
Mescat acacia (*Acacia constricta*)	1	100	T
Shortleaf baccharis (*Baccharis brachyphylla*)	2	100	T
Velvet mesquite (*Prosopis juliflora* var. *velutina*)	98	99	70
Catclaw acacia (*Acacia greggii*)	33	76	18
Spiny hackberry (*Celtis pallida*)	8	50	3
Cholla and prickly-pear (*Opuntia* spp.)	2	50	T
Wolfberry (*Lycium* spp.)	2	0	1
No shrubs	—	—	7

caches was discovered. Twenty-four percent of the caches contained 1 to 4 mesquite seeds. Average movement of marked mesquite seed was 47 feet although distances ranged from 2 to 105 feet. About 2 percent of the available mesquite seed was recovered in caches. By actual measurement, *Dipodomys venustus*, another species of kangaroo rat, is known to store seed in surface caches at distances as much as 168 feet from the den (Hawbecker, 1940).

Judging from observations of home range, Merriam kangaroo rats can be expected to move seed less than 200 feet from the borders of a mesquite stand. A tree matures sufficiently to produce seed in about 20 years (Glendening, 1952). Therefore, it would take over 500 years for mesquite to invade a distance of 1 mile. On the Santa Rita Experimental Range mesquite has moved several times this distance in less than 50 years, indicating that other factors contribute more to its spread than the rats.

Effect of Mesquite on Merriam Rats

Mesquite seems to provide a favorite location for kangaroo rat burrows (Table 1). On a 7.5-acre plot, mesquite was favored over any of the other shrubs present, except for shrubs which were too scarce for adequate sampling. Of the total number of burrows on the plot, 70 percent were under mesquite, and 99 percent of the mesquite shrubs were occupied. Presumably a mesquite or other shrub overstory offers easier digging and protection for burrows by preventing trampling by domestic livestock. Also, roots of the trees may discourage burrowing by badgers, coyotes and other digging predators.

Mesquite improves the habitat for the kangaroo rats by decreasing the abundance of perennial grass. Mesquite is known to compete with and to decrease the abundance of perennial grass (Parker and Martin, 1952). The numbers of kangaroo rats tend to increase as the density of perennial grass decreases. The mode of escape used by these rodents is probably a major factor contributing to this relation. Upon being frightened, they run a speedy zigzag course to their burrows. This type of retreat would be progressively hampered as perennial grass density increases (Reynolds, 1950).

Once mesquite becomes established on an area, the habitat improves rapidly for kangaroo rat habitation. The more mesquite, the less grass is available to hinder movement of rats. These rodents can then disseminate more seed to propagate mesquite at a faster rate. Once mesquite and Merriam kangaroo rats become established on the same site, a potent animal agency becomes available for further thickening of a mesquite stand.

Other factors in addition to mesquite increase could be responsible for reducing grass density. For example, perennial grass density fluctuates with changes in annual rainfall. In measurements made on the experimental range, density index changes from 3 to 15 percent have occurred in a period of 7 years as a result of annual rainfall differences (Reynolds, 1950*A*). Other factors being equal, these changes in

Table 2. Relation between Merriam kangaroo rat populations, numbers of mesquite trees and other conditions

Sampling Site	Rats per Acre	Mesquites per Acre		Habitat Evaluation for Rats	Other Conditions
		Over 6′	Total		
I	0	8	10	Poor	Dense annual grass. Coarse sandy loam soil.
II	0	245	294	Poor	Resting area for cattle. Rocky ridge.
III	1.8	48	132	Fair	Corner of cattle drift fence. Rocky soil.
IV	2.0	227	341	Fair	Top of ridge near cattle watering rim. Rocky soil.
V	2.0	12	12	Fair	Artificially cleared of trees, stumps intact. Good perennial grass cover.
VI	3.2	49	78	Good	Little perennial grass. Sandy loam soil.
VII	3.8	65	70	Good	Little perennial grass. Sandy loam soil.
VIII	4.0	34	42	Good	Little perennial grass. Sandy loam soil.
IX	4.2	102	126	Good	Little perennial grass. Sandy loam soil.
X	4.3	10	51	Good	Perennial grass cover depleted. Loam soil.

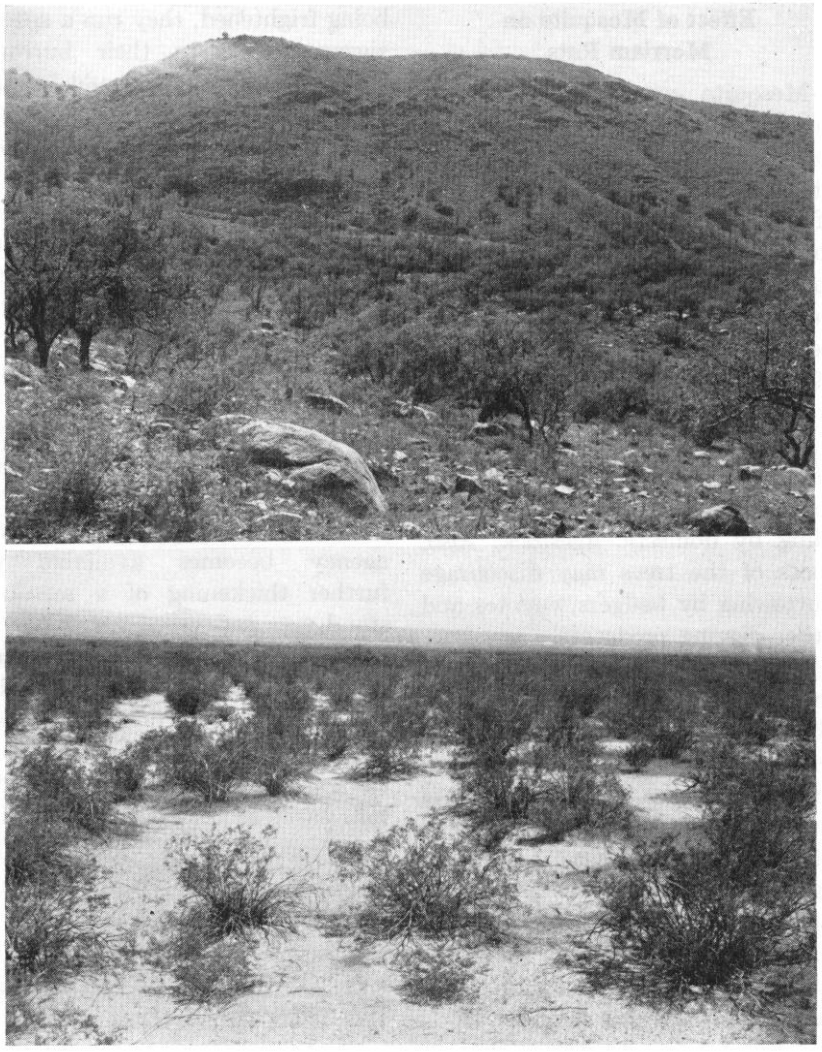

FIGURE 1. Lack of reciprocal dependency between velvet mesquite and Merriam kangaroo rats. *Upper*. Grassland which has been invaded by mesquite but where no rats are present mainly because of a shallow, rocky soil which is unfavorable for burrowing. *Lower*. A high population of rats exists in this creosotebush area, but the site is practically devoid of mesquite.

grass density would have a considerable effect upon rat populations and hence the dissemination of mesquite and other seeds. Heavy, continuous grazing also destroys perennial grass.

Interrelations of Mesquite and Rats

To determine the amount of interdependency of Merriam kangaroo rats and velvet mesquite, locations having different densities of trees were deliberately selected and sampled for animal populations. Rat populations were determined by a modification of the method of Dice (1938). Individual museum break-back traps were equally spaced along lines 450 feet in length and set for three consecutive nights. Border corrections were applied to allow for animal drift, and the results were expressed on a per acre basis. Mesquite numbers were determined by actual counts.

Mesquite-infested areas were found where no kangaroo rats were present. This indicates that other factors in addition to the rats are responsible for the spread of mesquite (Table 2). Rat populations were also discovered on creosotebush areas where there was no mesquite, which shows that rats are not dependent upon mesquite (Fig. 1). In fact, the distributional range of Merriam kangaroo rats has been noted to coincide closely with that of creosotebush (Monson & Kessler, 1940).

Of the factors noted in sampling, grass density and soil appear to be the major factors influencing the choice of a habitat by rats. Soils which are so rocky as to discourage digging, or are so sandy as to result in burrow caving, do not offer a good environment. Any persistent herbaceous vegetation which impedes escape appears to discourage kangaroo rats.

Other Biotic Agencies for Mesquite Seed Dispersal

If Merriam kangaroo rats were entirely responsible for the spread of mesquite, they could have moved mesquite seed to all mutually favorable sites in past geologic time. Paleontological records indicate that the genus *Dipodomys* (Wilson, 1937) and *Prosopis* (Axelrod, 1950) had developed in forms at least closely related to those of the present before early Pleistocene time which was some 1 to 5 million years ago.

Domestic livestock and several other species of native animals are probably as important as kangaroo rats in disseminating mesquite on the Santa Rita Experimental Range. Mesquite seeds pass through the digestive tract of domestic livestock in a viable condition, and many seedlings are produced in the dung. Feeding trials with mesquite seed showed that many seeds were potentially viable after passage through the alimentary tract, amounting to 27 percent for sheep (Glendening & Paulsen, 1950), and 45 percent for cattle (Fisher, 1947). In their normal grazing habits, cattle move distances of 2½ to more than 5 miles. Hence, cattle are perhaps a more important

biotic factor for dissemination of mesquite seeds than kangaroo rats which move seeds less than 200 feet. Among the native animals known to be spreaders of mesquite seed are deer, peccary, cottontail rabbit, jackrabbit and coyote (Allred, 1949). All of these animals, even though they may not be as abundant as Merriam kangaroo rats, have much larger home ranges and thus potentially could spread seed much greater distances.

Conclusions

Ecological—Merriam kangaroo rats appear to be favored by mesquite invasion because of the resulting lowered density of perennial grass, but they are not dependent upon mesquite for production of a favorable habitat (Fig. 2). However, they may extend their range and increase their numbers because of mesquite spread. Cattle are a more important factor contributing to mesquite spread than are kangaroo rats. Cattle disseminate seed to greater distances. Also, cattle grazing pressure can be so heavy as to reduce perennial grass density. The habitat is then improved for mesquite seedling establishment, and becomes more favorable for the kangaroo rats. Once mesquite is established and the habitat is favorable for kangaroo rats, these rodents can, however, assist in effecting a rapid thickening of a mesquite stand. Once mesquite and rats exist on the same site, mesquite can be expected to increase rapidly until competition for space or some other factor limits populations. In this regard, wild range fires which are now mostly controlled are believed to have contributed considerably to mesquite suppression (Humphrey, 1949).

Economic—The Merriam kangaroo rat is not the primary, and is only one of several agencies for dispersal of mesquite seed. Mesquite, because of its effect in reducing grass density, is probably

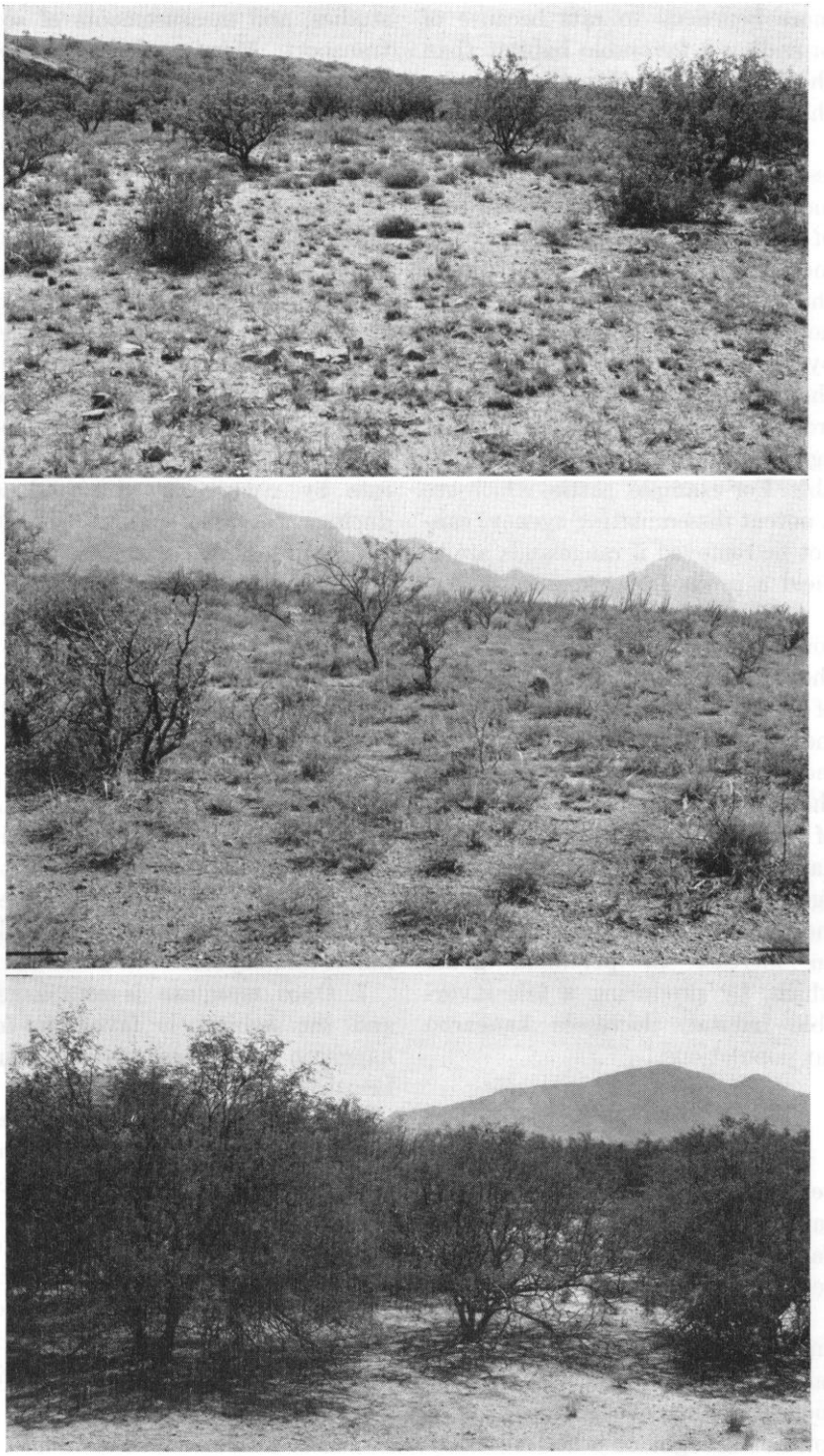

FIGURE 2. Interrelations of velvet mesquite, perennial grass, livestock grazing and Merriam kangaroo rats. *Upper*. Perennial grass density is being reduced as a result of mesquite invasion and heavy livestock grazing use. Rat population is moderate, but the environment is becoming increasingly favorable for rats. *Center*. Perennial grass virtually depleted as a result of heavy livestock grazing. Rat population is high. Increase of mesquite is being favored by rats. *Lower*. Site completely occupied by mesquite to the exclusion of perennial grass. Rat population is high but the site is fully occupied by mesquite and these animals are having little effect upon mesquite increase.

more beneficial to rats because of providing a favorable habitat than the rat is beneficial to the mesquite through seed dissemination.

Once the cycle: more mesquite→ less perennial grass→more rats→ more mesquite, is initiated because of the increase or suppression of modifying environmental factors, the rate of increase of mesquite is not likely to be slowed appreciably by removing kangaroo rats. Even though these rodents are removed from a mesquite-grass area, other agencies for dispersal are still available. For example, cattle, which are a potent disseminating agency, cannot be removed if rangelands are to yield a profit from grazing.

An approach which seems sounder than concentrating upon the disseminating agencies is that of preventing further invasion of mesquite by direct chemical or mechanical attack on the trees themselves. This destroys the source of seed and automatically eliminates the effect of disseminating agencies. Moreover, destruction of mesquite trees usually brings about an increase in perennial grass which, by producing a less favorable habitat, decreases kangaroo rat populations.

Summary

1. Some of the interrelations of velvet mesquite and Merriam kangaroo rats were investigated on the Santa Rita Experimental Range near Tucson, Arizona.

2. Velvet mesquite seeds are known to be buried in surface caches by kangaroo rats. These caches produce enough seedlings in spite of drought or other mortality factors to effect mesquite spread and increase.

3. By inference from home range studies, and measurements of seed transport, Merriam kangaroo rats were found to be capable of moving mesquite seed less than 200 feet on the average. On this basis and accounting for time required for mesquite trees to fruit, kangaroo rats could spread a mesquite border about 1 mile in about 500 years.

4. On a sample plot, 70 percent of the kangaroo rat burrows were located beneath mesquite trees and 99 percent of the trees were occupied by burrows. The trees further improve the habitat for rats by competing with and reducing perennial grass density which interferes with escape of rats from predators.

5. Mesquite and rats apparently have no dependency relation. Heavy populations of mesquite were found where there were no rats, and vice versa.

6. Cattle apparently are a more important biotic agency than kangaroo rats for mesquite seed dissemination. Among other biotic agencies of dispersal are deer, peccary, cottontail rabbit, jackrabbit and coyote.

7. Once mesquite is established and the habitat is favorable for kangaroo rats, these rodents may help to thicken the stand.

8. Once the cycle: more mesquite→less perennial grass→more rats→more mesquite, is initiated because of the effect of other dispersal agencies or the suppression of factors which may prevent the increase of mesquite, the rate of mesquite increase is not likely to be retarded appreciably by removing Merriam kangaroo rats.

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