Viable Seed Recovered from Fecal Pellets of Sheep and Deer

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THE role of many animals as agents in the dissemination of plants is well established. Not only do animals spread plants by attachment of plant parts to their bodies, but also by ingestion at one location and discharge at another. The purpose of this study was to determine the kinds of seed that were viable after passage through sheep and deer grazing under range conditions on the Hopland Field Station, Mendocino County, California. The Station is owned and operated by the University of California as a range sheep experimental area. The vegetational types on the Station are mostly oak-woodland, annual grass, chamise, and small areas of mixed brush and dense oak. Precipitation is between 40 and 50 inches per year and falls during the winter. There is practically none from June to October.

Literature Review

Are sheep and deer effective agents in the dissemination of seeds? Have they been responsible at least in part for the spread of desirable and undesirable plants? Much has been written on the subject of seed viability after their passage through animals. For example, McAtee (1947) reviews nearly 100 articles on the dispersal of viable seeds by birds. Previous studies have established two points: that seed consumption by animals aids seed dispersal and that some seeds show improved germination by passage through the digestive tract (Burton and Andrews, 1948; Krefting and Roe, 1949). These plants may be desirable forage grasses (Burton and Andrews, 1948), undesirable range pests such as mesquite (Glendening and Paulson, 1950) and Macartney rose (McCully, 1951), or weeds in cultivated crops (Harmon and Keim, 1934). One paper indicates that sheep will pass viable seeds of weeds of cultivation (Harmon and Keim, 1934) and two the seeds of mesquite (Glendening and Paulson, 1950; Fisher, 1947). No papers were found that indicate seed will pass through deer in viable condition. Speculation has been that the proportion of seeds passed depends on the degree of food mastication. Sheep and deer have similar masticating equipment and habits. Nothing was found in the literature to indicate the role sheep and deer might have played in the spread of many plants over California ranges, although a good deal could be inferred from the work with other animals outside the State.

Methods

During 1952, Dr. William Longhurst was autopsying Columbian black-tailed deer and domestic sheep on the Hopland Field Station for studies of food habits, parasites and reproduction. Upon request he saved samples of pellets from the colons of 24 sheep and 34 deer collected. The collections were made at the approximate rate of five sheep and five deer per month between July 1 and December 3, 1952. Rumen samples of all animals, except six of the deer, were taken. The analyses of these were made by Mr. Howard Leach of the California Department of Fish and Game Food Habits Laboratory, Berkeley, California.

Germination of seeds in the pellets was attempted by two methods during the winter and spring of 1952–53. Approximately 2 grams of pellets from each animal were lightly pulverized and planted in flats containing white sand. These were placed in a greenhouse and maintained until positive identification of the plants could be made. This is referred to as trial I. The second trial was with the same amount of fecal material placed in petri dishes for germination at room temperatures for four weeks. The number of seeds which germinated was generally higher in the samples placed in petri dishes than in the greenhouse. However, the correlation coefficient between the number of germinated seeds obtained in the two procedures was very high and significant at the 0.01 level. The high correlation indicates that the data from the two trials show similar trends, even though the different methods prevent consideration of the two trials as replications.

Results

Seeds of ten grasses, two grass-like species and eight broadleaved herbaceous plants were germinated and grown until the species could be positively identified. Ten of the total were found only in sheep pellets, five only in deer pellets and five in both (Table 1). Seeds of woody plants did not germinate and none were found in a cursory examination of the fecal material. Additional ungerminated seeds of the above 20 plants and a few other species were present.

A total of 1,344 seeds germinated in the two trials with sheep pellets for an average of 13.8 seedlings per air-dry gram of material or 56.0 per animal with an average sample of 4.1 grams. Similar data for deer were 234 germinated seeds, 1.8 seedlings per gram and 6.9 per animal with an average sample size of 3.8 grams.

Toad rush (*Juncus bufonius*) was by far the principal species from the

Table 1. Number of viable seed found in pellets from 34 deer and 24 sheep autopsied between July 1 and December 3, 1952

	Deer		Sheep	
	No. of seeds germinated	No. of animals	No. of seeds germinated	No. of animals
Trial I				
Grasses	4	4	221	19
Grass-like plants	65	11	283	18
Broadleaved plants	9	3	30	9
Total	78	12	534	22
Trial II				
Grasses	5	4	9	4
Grass-like plants	128	9	753	20
Broadleaved plants	18	7	48	9
Wheat	5	1		
Total	156	14	810	20
For both trials				
Average number per gram of air dry pellets	1.8		13.8	
Average number per animal (approx. sample 4 grams)	6.9		56.0	

pellets of both animals. For sheep it composed 77 percent of the total number of germinated seeds, and 82 percent for deer. Bermuda grass (*Cynodon dactylon*) was the only grass species that germinated in large numbers, but it was present only in sheep pellets. The other species contributed small numbers of seeds to the total.

The sheep pellets with large numbers of viable seed were collected in September and July from seven animals that had been grazing in areas with a high proportion of brush. For deer about half of the viable seeds were in the July collections; a third, in the October group; and the others were low. The pellets from five animals contained most of the viable seed. These animals were collected where oak-woodland and annual grasses were the largest vegetational types. Regardless of the types, rumen analyses of the seven sheep and five deer indicate that the former were grazing primarily on grasses, and the latter on woody plants.

Toad rush germinated from pellets of both sheep and deer collected throughout the July to December period. Bermuda grass was only in the pellets of sheep collected after the first of September. Other species were scattered with no apparent seasonal pattern for either deer or sheep. In fact, correlations of number of germinated seeds with age, sex, and condition of the animals were not evident.

All of the species found to germinate in the pellets are very common on or near moist soil surrounding springs on the Hopland Field Station. Aside from the grass-like plants, Bermuda grass is the most common of the moisture-loving species, and it often forms dense sod on moist soil. These areas are grazed very severely, especially after the annual vegetation of drier sites has matured, because the plants remain green throughout the summer dry period.

Of the 20 species found to germinate, 13 were introduced into California and seven are native. Since these seeds were voided in viable condition, it seems reasonable to conclude that sheep and deer have contributed to the spread of the many introduced plants on California ranges.

These animals can be important in the continuous movement of weeds into cultivated fields. The case with Bermuda grass illustrates the point. It was introduced into California prior to 1860 and has become very widely spread in regions with mild winters (Robbins, 1940). In cultivated areas the vehicles of its spread are many—by machinery, in livestock feed, with seed of cultivated plants, etc. On range land its overall distribution is wide but it is confined locally to wet areas and in a discontinuous manner. Man's activity with machinery and seeding has been slight on most ranges. The spread of Bermuda grass, then, can probably be attributed to animals for the most part. Bermuda grass is listed as a minor noxious plant in California, and it is a troublesome weed in cultivated fields. However, on the Hopland Field Station it is a desirable forage plant. California law prohibits the sale of grass seed that is contaminated with more than nine Bermuda grass seeds per pound. Many farmers and ranchers move livestock from ranges and pastures to utilize the crop aftermath. If these animals have been grazing on Bermuda grass with mature seed, they can be expected to carry that seed to the cultivated field, along with many other kinds of seed. On the basis of these data and other published reports, animals should be held on a weed free diet for a minimum of 72 hours if they are suspected of carrying the seed of noxious plants in their digestive tracts. This will reduce the possibility of their contaminating clean fields or clean ranges.

On the other hand, animals undoubtedly have aided in the spread of desirable forage plants. Burton and Andrews (1948) mention cattle as a factor in the spread of carpetgrass in the South and suggest this method as an aid to reseeding in the piney woods. At least one rancher in

Lake County, California has fed bur clover to sheep in order to spread it over his range land. Jones and Carroll in California (1953) have found that establishment of smilo, and in a few cases rose clover, was attained by feeding seed to cattle. Hardinggrass, ryegrass and yellow blossom sweet clover failed in the same experiment. They determined that these seeds will pass through cattle in viable condition, but there is a marked percentage difference between germination and establishment. The practicality of this method of reseeding range lands is yet to be determined.

Examination of the rumen contents of the same animals from which the pellets were obtained indicated that seeds of many species were consumed. Fifteen grasses, eight woody plants, and ten broadleaved herbs were found. Of these, at least 26 were not found to germinate in the pellets. All seeds except wheat and acorns contributed a very small amount to the diet of the animals studied. On the other hand, the seed of several species had a high frequency of occurrence which indicates that they were eaten more or less continuously. Differences between the kinds of seed in the rumen and in the pellets are to be expected for several reasons. Many of the seeds consumed would be destroyed by the mastication and digestion processes. For example, seeds of soft chess (*Bromus mollis*) were not found in the pellets, but yet they occurred in the rumen of 20 animals. Animals do not choose the same forages each day. Wheat seeds were found in the rumen of one sheep, but not in the pellets, and vice versa, with one deer. A major number of the viable seeds were very tiny and could have been overlooked in the rumen analysis. On the other hand, tiny seeds with hard coats are the most likely to go through the digestive tract unharmed and these may not have germinated because of dormancy.

Seeds of grasses and herbs germinated in approximately 91 percent of the samples from sheep, but only 41 percent from deer. The number of non-woody species of seed in the rumen was 23 for sheep and 8 for deer, only 2 of which were not present in sheep rumen. Seeds of eight woody species were found in deer rumen while only one (acorns) was also present in sheep.

The general concept that sheep show greater preference for grasses and herbs than deer is substantiated, although considerable seasonal variation exists. The average diet of the sheep in this study as determined by stomach analyses was approximately 90 percent grass, 8.5 percent browse, and 1.5 percent forbs. For deer, the portions were 7 percent grass, 91 percent browse, and 2 percent forbs. Green grass composed as much as 70 percent of the deer's diet in January, February, and March, coincident with the growing season. Browse reached a high of 25 percent in the sheep's diet during the summer months.

Conclusions

Throughout the study the inconsistencies from one individual animal to another were striking. One animal had numerous viable seeds in the pellets; another had none. Seeds in the rumen and seeds in the pellets were almost totally different. Rumen contents were different for animals collected on the same date. Sheep and deer gave different results. In view of these wide variations from pellet samples of 58 animals, for which rumen analysis was also available for 52, the sample seems small to draw detailed conclusions. However, the data and their possible interpretation would indicate the following:

1. Sheep and deer consume the leafage and seeds of many native plants in amounts varying by individual preferences, season, availability, and probably other reasons.
2. A portion of the seeds consumed pass through these animals in viable condition; the portion being dependent on the nature of the seed and characteristics of the animal and being impossible to determine with uncontrolled animals on native ranges.
3. Sheep and deer have contributed to the spread of plants introduced onto California ranges.
4. Sheep, in particular, and deer may carry seeds of noxious plants to cultivated fields and possibly could be utilized to spread desirable forage species.

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