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AGRICULTURAL EXPERIMENT STATION

EXPERIMENTAL FEEDING OF DEER

By A. A. Nichol

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INTRODUCTION

Seventy-five per cent of the big game in the western states[1] live in the national forest. The management of this game in such manner that it will produce the maximum sustained hunting and recreational returns supplementary to the other resources of the forest is one phase of the work of the U.S. Forest Service. Profitable use of the forest range by domestic livestock is one other important phase. Since large game mammals and domestic livestock are foraging animals, the assignment of range and the division of the forage among the many types of occupants is a difficult yet important undertaking. All interested parties recognize the fact that the native wild life should receive a share of this forage. On certain types of ranges it is possible that game might make the best economic use of the forage supply. What constitutes an equitable division must be determined for each given area, and no standardized method of adjustment can be used over the entire forest range.

There are other phases of this problem, however, which are basic throughout the field. Naturally, these are the factors intimately associated with the animals themselves. On any range where there is to be co-operative use by both game and domestic stock, one of the first requisites to proper management is a knowledge of the maintenance requirements of those species occupying the area. Forage requirements for domestic livestock are quite definitely known, and satisfactory practices have been in use for years on forest lands. These practices are based on the class of livestock and the use and palatability of the various types and species of forage plants present.

The feed requirements for the growth and maintenance of big game animals, however, have only been estimated. Any division of the forage wealth of a range, therefore, should be based on the number of species of game animals present and the pounds of forage required to maintain in vigorous health a hundredweight of game animal. The experimental feeding work with deer was initiated at the University of Arizona in an attempt to find and prove these needed figures.

In addition to the maintenance experiments palatability tests on some 168 Arizona native plants were also conducted during the three and one half years this work was carried on. While the palatability experiments are of necessity still incomplete, the re-

[1] A National Plan for American Forestry, U.S.F.S., Vol. I, 1933.

sults obtained have proved fully as valuable as the maintenance work. This is especially true in the phase of seasonal utilization where several highly rated deer-food plants have proved to have a short seasonal use, and other plants overlooked as desirable forage have been discovered to be yearlong mainstays in the diet. While the growth and maintenance figures are closely applicable to deer on any range, naturally the palatability results are concerned only with Arizona ranges or near-by areas with closely similar vegetation.

MECHANICS AND PROCEDURE

Since considerable original work was necessary in the initiation and development of this work, descriptions as concise as possible will be made of the mechanics and procedures used in the experiments.

LOCATION

The corrals are located 40 miles south of Tucson in the Santa Rita Mountains at an elevation of 4,200 feet. On northern exposures of the mountains in southern Arizona this altitude represents the lower edge of the oak belt and the upper edge of the mesquite (Pl. I). Grass is the principal ground cover. Thornbush, such as the acacias, mimosas, and hackberries, follows the washes, and shrubby legumes are common on the rockier ridges. This is typical Arizona whitetail country and is the upper limit of the range of the desert subspecies of the Rocky Mountain mule deer. Snow rarely falls, and some green forage is available the year around.

The original corrals, five in number, were built on the ground plan as illustrated in Figure 1. The average area of the diagonally shaped pens was 300 square feet. As the herd increased, additional pens were built. The plan of the original corrals has been very satisfactory. The wedge-shaped pens facilitate the handling of animals recalcitrant to weighing, treating infections, obtaining blood samples, and so forth. A recommended change would be to increase the area of the wedge-shaped pens, especially in the direction of length. Length rather than area is needed for deer to exercise.

The corral fence was constructed of 4- by 6-inch redwood posts, 9 feet on centers and 8 feet out of the ground. These were strung with No. 9 smooth wire, and the fence was stiffened with a single stay between the posts. Thirty-five wires were used, spaced 2 to 3 inches apart at the bottom, gradually widening to 9 inches apart at a height of 7 feet. A belt of 2- by 6-inch fir topped the wire and held the fence rigid.

Smooth wire was used to reduce the danger of injury. Later additions were built with ordinary woven wire fencing. The smooth wire, however, gave an added insurance against injury to feet, legs, or growing antlers.

The essential equipment for the routine work consisted of scales

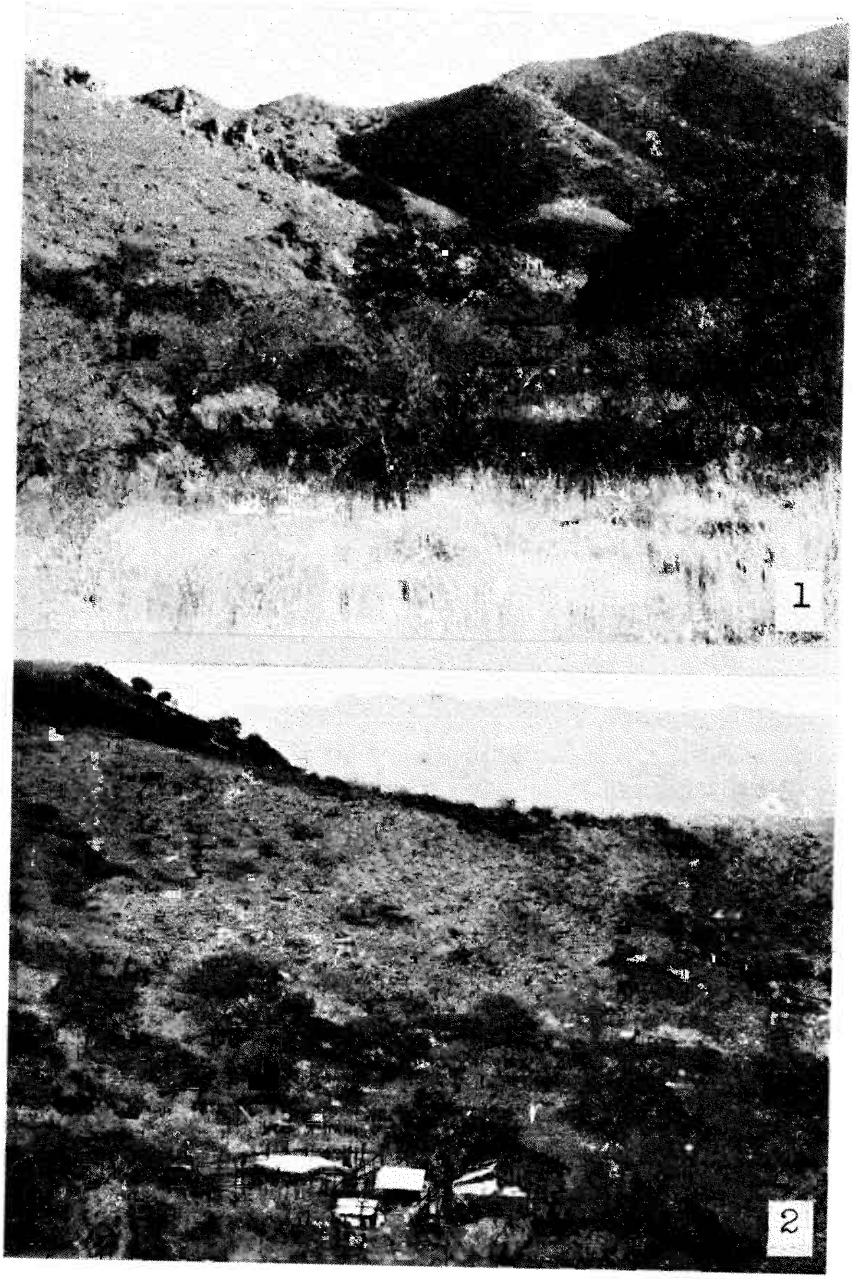


Plate I.—Santa Rita Mountains. *1*, Typical terrain in whitetail range. Mixed grasses foreground, mesquite and oak middle background, oak on hills in distance. *2*, Location of corrals in lower oak belt.

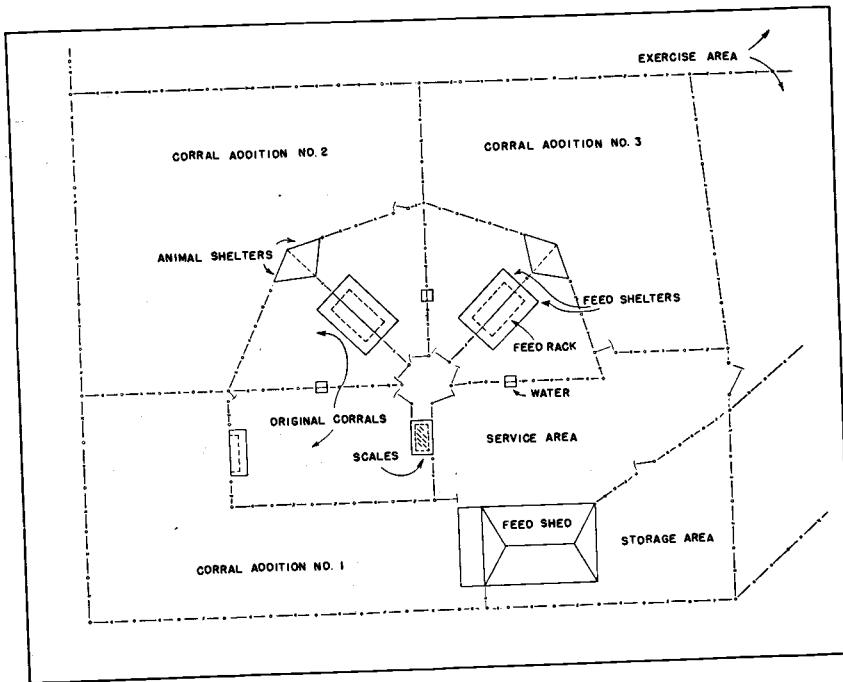


Figure 1.—Ground plan of the experimental feeding corrals.

for weighing the deer; feed racks; watering troughs; salt and bone-meal troughs; balances for weighing the grain, forages, and residues; and equipment for determining the water content of the green feeds.

For weighing the deer a 4- by 6-foot pitless platform scale was used. Its capacity is 4,500 pounds, accurate to 1 pound. This scale was furnished by the American Scale Company. The degree of care with which it is leveled and squared on a good concrete base determines the sensitivity and consistent accuracy. The weighing crate was built directly onto the platform the full 4- by 6-foot size. The narrow V-shaped weighing chutes used for cattle will not work with deer. No matter how tame or accustomed to handling these deer become after years of work, they never could be driven or coaxed into a passageway too narrow to allow them to quickly turn about.

In the feed and record room soil scales were used for weighing out the feed and weighing in the residue and wastes. For accuracy the fawns until they were several months old were weighed on these scales. Chemical balances were used to weigh the bone meal and samples of green forage to obtain the air-dry figures for all feeds.

The watering troughs (Pl. II) were made of galvanized iron on a wooden frame. They have a 16- by 24-inch water surface and

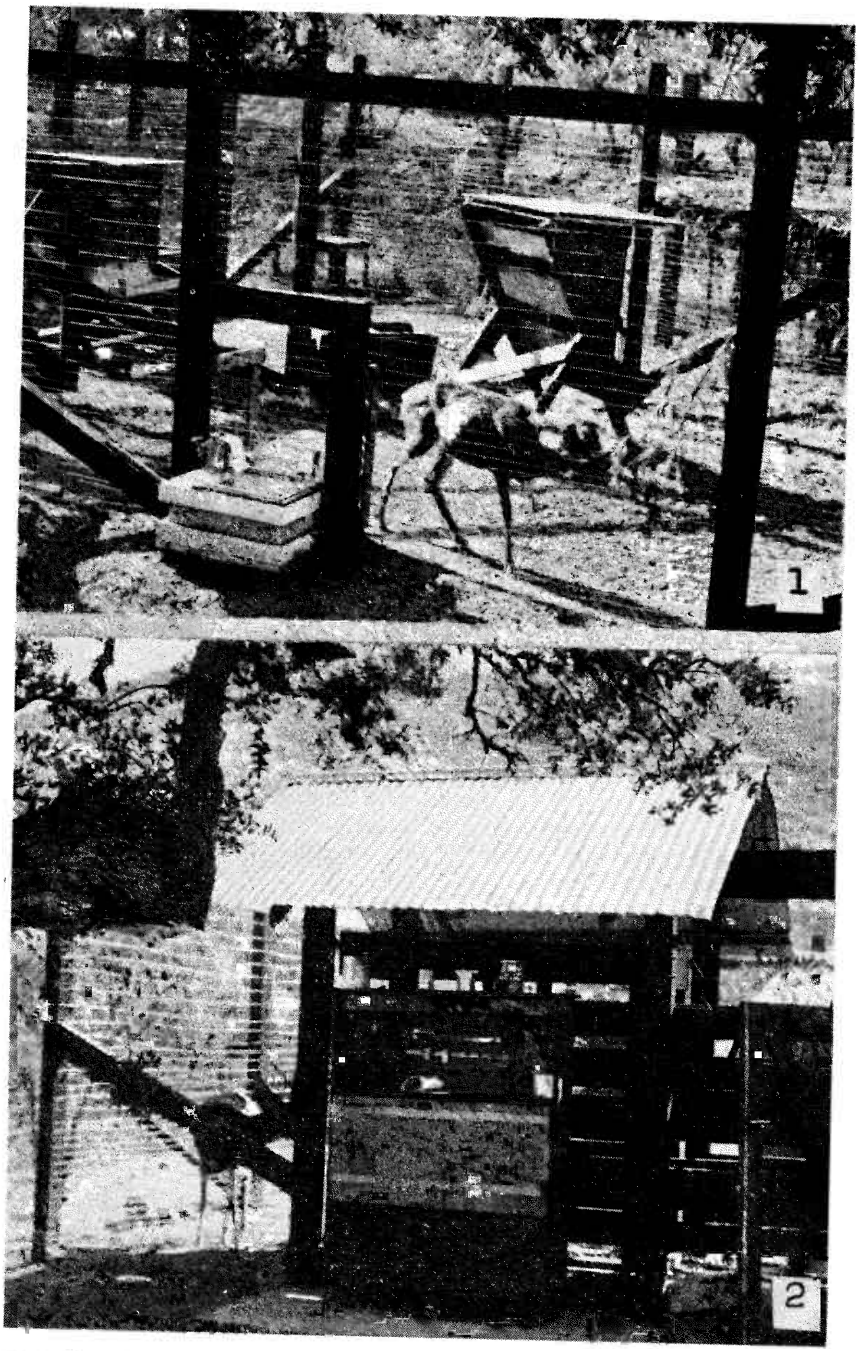


Plate II.—*1*, Water troughs and early feed racks. *2*, Scales and weighing chute.

a depth of 8 inches when filled. An automatic overflow pipe facilitated accurate filling. A float with a graduated scale in quarts gave a direct reading on the amount of water used. A check trough of the same dimensions and in similar exposure was used to find the water loss by evaporation. Daily readings made on the check were used at first, but these accumulated too great an error. In the later work the check was only read once, at the end of the period, and this amount was subtracted from the total consumption of the individual deer.

Salt was made available in 4-pound pressed blocks, protected from the weather and weighed at irregular intervals corresponding to the end of a series of days without rain or high humidities. Mineral rations were handled in like manner. Although the deer ate bone meal occasionally, it was never in measurable amounts.

The feeding racks underwent a reverse evolutionary development from the complex to the simple. A desirable feed rack is one which is accessible to the deer, minimizes waste, facilitates removal of the residue, and protects the feed from the weather. To this end the racks were built with a slatted front, hopper back, and rounded residue tray (Pl. II). The slats in front were wide enough to permit the deer to put their muzzles between the bars and nip out the feed. This, however, they would not do. They would eat only that portion of the forage which protruded outside and would go hungry rather than work between the slats as will sheep and cattle. A partial explanation of this was found when later observations showed that whenever possible deer prefer to bite their forage off with the molars rather than use their incisors. The incisor teeth in deer are relatively light and thin. It is a very common occurrence to find one or more broken front teeth in the Arizona whitetail and mule deer. Weeds and succulent grasses are nibbled in a manner similar to sheep, but most browsing is done with the molars.

Since the essentials of the feeding work were to recover all uneaten portions, to prevent scattering, and to minimize wastage, the feed rack was an important item. The hopper feeder, therefore, went through a series of modifications, each time toward a more simplified construction, until it was found that an entirely satisfactory feed rack is a simple, shallow, open tray (Fig. 2). On first inspection this would appear as offering greater opportunity for waste. An observed peculiarity of the deer when feeding, however, suggested a slight change in the location of the trays, which resulted in a great decrease in the amount of feed scattered and lost. Whenever possible, deer are inclined to feed with their front feet elevated above the ground level. Placing the trays on platforms 4 or 5 inches thick and extending beyond the edge of the troughs some 8 inches resulted in the deer's standing much quieter and with a great deal less head turning to drop food fragments to the ground.

Semishelters were built to give as much protection from the weather as the deer might reasonably expect to find for themselves if in the open. Because of the confined quarters, consider-

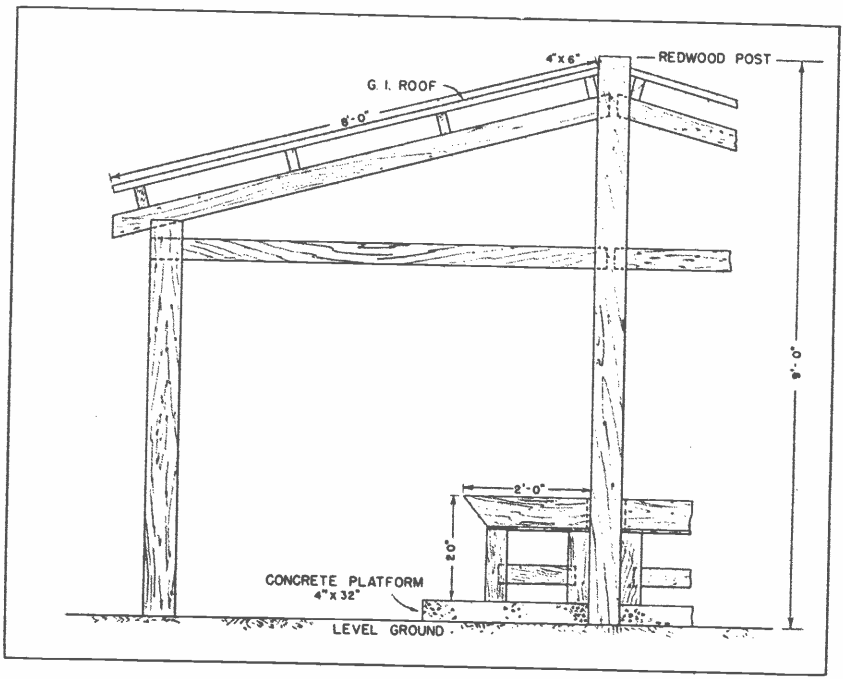


Figure 2.—End view sketch of the feeding trays.

able rock and gravel were scattered in the smaller corrals to prevent excessive growth of hoof.

EXPERIMENTAL ANIMALS

The original stock consisted of seven Rocky Mountain mule deer[2] from the Kaibab National forest. The herd contained three bucks and four does and at the time of their assignment to the University were short yearlings. They were approximately two years old when the experimental work was begun. In the beginning only two Arizona whitetail deer[3] were available. The Santa Rita Mountains are the type locality for the *Coues* or Arizona whitetail, and an ecological study of this species in these mountains is given in a later publication.

The largest number of deer handled at any one time was twenty-four. Of this number fourteen were mule and whitetail fawns bred and born in captivity. A total of thirty-seven individuals were used during the five-year period. Of these, nineteen were

[2] *Odocoileus hemionus* macrotis Say, 1923. Vernon Bailey, "Mammals of the Grand Canyon Region," *Natl. Hist. Bull.* No. 1, June, 1935, pp. 4-5.

[3] *Odocoileus couesi.* H. E. Anthony, *Field Book of North American Mammals* (New York: Putnam, 1928).

Plate III.—*1*, Whitetail doe: age, four years; weight, 70 pounds. 2, Mule-deer doe: age, four years; weight, 120 pounds.

Plate IV.—The original mule deer from the Kaibab forest. (Two bucks not in the picture.)

mule deer, eight were whitetail, one was a form of whitetail,[4] another the desert form of the Rocky Mountain mule deer,[5] and nine were hybrids of reciprocal crosses.

During the experiment several deer were lost from injuries or infections, including seven fawns which died in one summer from a water-borne disease. Two were killed for pathological investigations. The remainder at the termination of the work was liberated in suitable environments in southern Arizona.

METHODS IN MAINTENANCE

Several months were spent in trial and error on the maintenance phase of the study in an attempt to discover and devise practicable methods of procedure which would give proved figures and trustworthy data. The first requisite to successful experimental feeding was the establishment of a basal ration for maintenance. This would furnish a common denominator for factoring or for comparison. Domestic foodstuffs were used because it was necessary to establish this on feeds of known nutri-

[4] Presumably this species was *Odocoileus sinaloae* Allen, 1903. *Bull. Amer. Mus. Natl. Hist.*, XIX (November, 1903), 613.

[5] *Odocoileus hemionus eremicus* (Mearns) 1897. *Proc. U.S. Natl. Mus.*, Rpnt., XX (December, 1892), 470.

tive value. Chemical analyses of forages are very deceptive, and determination of the nutritive value of native forages would be a very long-time problem.

Alfalfa hay was fed for the roughage. Since the deer would under no circumstances eat the stems, only the leaves were fed. Equal parts of whole shelled corn, rolled barley, and whole oats composed the concentrate. The Morrison feeding standards[6] were used. The sheep maintenance ration of 2 pounds per hundredweight per day was arbitrarily taken as a starting point. In the early work each feeding trial extended over a sixty-day period. It was found, however, that deer respond so quickly to changes in diet that twenty-one days proved long enough. A ten-day period followed each feeding trial during which the animals all received the same treatment to bring them back to herd uniformity. Weighings of the animals were made on three successive days at the start of each feeding period and likewise at the end, the averages of which gave, respectively, the beginning and final weights. The deer were also weighed twice weekly. In addition a careful daily inspection of the animals was made which often told as much as or more than the scales.

BASE RATION RESULTS

In the first series of feeding trials the 2 pounds per hundredweight consisted of 1 pound alfalfa leaves and 1 pound concentrate. This was insufficient as testified by the weight and condition of the deer. In the second series the amount was increased 20 per cent or to 2.4 pounds per hundredweight divided equally between roughage and concentrate. This proved more than necessary, and since the weigh back of the unused portions indicated an approximate 10 per cent increase, 2.2 pounds per hundredweight was used in the third series. This appeared to be the correct coefficient. Five deer carried for fifty-six days on this weight ration reached the end of the period in excellent physical condition and vigor.

It is inherent in the work that there were many places where small errors could accumulate to produce incorrect results, but the application of a probable error coefficient would be hard to apply intelligently. To be definitely assured, therefore, that the results were accurate and dependable, the same feeding trials were run repeatedly until minor deviations were removed or explained by the mere weight of the number of experimental trials. Twenty-seven individual feeding tests were run using the 2.2 pound-per-hundredweight ration. In every case this has proved satisfactory, and the animals remained in good flesh and vitality. The dependability of the results is further substantiated by the fact that this was the ration used during holding periods, and all the deer used during three and one half years of study were carried on this amount when they were not being subjected to a specific experiment.

[6] W. A. Henry and F. B. Morrison, *Feeds and Feeding* (19th ed., Madison, 1927), 770 pp. illus.

During the base-ration studies the deer were fed twice daily. At each feeding the residue of the previous feeding was weighed and the net consumption determined. They were fed in the morning as soon after daylight as possible, since the deer, especially in hot weather, will not eat well later than two or three hours after daylight. The evening ration was put in the racks from two to three hours before dark. The animals usually bedded down shortly after dark. Little feeding is done through the night. Ten to 15 per cent more feeding is done at the evening meal. Cool days lengthen the feeding period.

PREGNANCY RATIONS ON DOMESTIC FOODSTUFFS

Three mule-deer fawns were born the first summer. These were dropped approximately two months after the deer were placed in the corrals, and since the animals had far from ideal care previous to this time the fawns were weak. None survived. Two of them, twins, exhibited a superficial condition that in humans would be presumed to be rickets.

A few weeks after the does became pregnant in the second year, they were placed on 20 per cent increase in their ration. This is the figure recommended for domestic sheep and in the case of the deer amounted to 2.64 pounds per hundredweight. This proved entirely too much, and the amount was gradually diminished until it was found that 2.3 pounds was sufficient in the early months of pregnancy with the figure rising in the advanced months to 2.4 pounds. The experimental work at no time explained this "inverse ratio" as compared with domestic sheep. It may be justifiable, however, to assume that the additional 10 per cent needed for maintenance represents the nervous-energy consumption in wild animals over tame; and the smaller increase necessary in pregnancy represents a better utilization by wild animals during this period. Does are quieter when carrying fawns. It is also a natural economy which must work toward the advantage of the females, since the necessity of foraging for 20 per cent more feed each day would considerably increase the duration of their exposure to the weather and their enemies at a time when they are already in the most handicapped condition.

Additional evidence that a pregnancy ration averaging 2.35 pounds per hundredweight was entirely satisfactory was shown in the fact that four mule-deer does produced during the second season eight vigorous, healthy fawns. All pregnant females in subsequent tests were carried on this ration. A total of twenty-three fawns were dropped, and exclusive of a set of hybrid triplets and the first three mentioned above, there was not a weakling fawn in the herd.

MAINTENANCE RATIONS WITH NATIVE FORAGES

After the figures on domestic feeds stood repeated trials without significant change, the study was shifted to native forages. One hundred and sixty-eight different Arizona native plants were

fed during the experiment. Again there was much trial and error. In the early attempts four or five native plants were used, and then if some of these proved unpalatable they were replaced by others. This developed a too complicated system of records and data to allow dependable interpretation. It also created an unnatural usage on any newly introduced forage that was palatable. Furthermore, since we were ignorant of the nutritive value of the native plants, the deer could lose weight and body tone even on forages that were palatable to them.

The procedure finally adopted, which proved satisfactory and dependable, was the placing before the animals of a wide variety of plants from which they made free choice. In the beginning the native plants were fed green. Weights, however, were always figured on an air-dry basis. As the work progressed it was found that plants which were palatable in the succulent stage were usually as much so when properly air cured. This simplification aided the accuracy of the work.

The choice of the ingredients in the native mixed ration was guided by field observations on the plants being seasonally taken by wild deer and also by the tame deer which were periodically liberated for this purpose. Many of the deer became so tame they could be freed on the open range in early morning and would return to the corrals of their own volition at nightfall.

From fourteen to twenty different species of plants were used in each trial. The lesser number was used in late fall and winter. Twice each day an arbitrary amount of each species far above one day's consumption was weighed in and the unused amount weighed back. Usually some mast or berry species was available, and one or more of these were included in the ration. Frequently some very palatable concentrate was eaten to the exclusion of all the others. In a short time, however, the animal's appetite began to taper off on this item, and his consumption on another one or more increased. When one forage lost in palatability another picked it up, and in the end the figures for native forages were as for domestic feeds, very close to 2.2 pounds per hundredweight of deer.

INDIVIDUAL AND SEASONAL DIFFERENCES

Careful records were made and observations kept on animals that exhibited individual differences. This served as an additional check on the average or mean. Individual departures were found, but the range was very narrow. One very nervous doe needed a slightly larger daily ration to maintain her condition, and on the other hand the two calmest animals made a more economic utilization of the feed and would frequently run through a twenty-one-day period on a 2.1- to 2.2-pound ration.

One whitetail doe, which had been a pet before the feeding trials started, kept in uniformly good condition on 2.1 pounds per hundredweight through three and one half years of experimental feeding. She rarely exhibited any form of nervousness except

anger. This was usually directed against dogs, which she would chase around the corrals or on the open range. In the winter or during cold weather there was the slightest measurable increase in food consumption.

A mule-deer buck whose reproductive organs had atrophied following an accident, developed into a most valuable check animal. Because this deer became very quiet and sedentary he tended to put on a little fat on the 2.2-pound ration. Lightening this by only 6 ounces a day (on a 220-pound animal) kept him in good physical condition without fattening. Undisturbed by any sex stimulus or breeding urge this buck moved through the seasons with a very even tenor and was a dependable and ever-present yardstick against which the oscillations of the rest of the herd could be checked.

Plate V.—*1*, Mule-deer buck in velvet, August 10. *2*, Head of mule-deer doe. Note characteristic white on throat, ear tips, and back bridle.

There are many seasonal stimuli affecting both bucks and does, factors which toss about the deer temperament to such a degree that it was at first difficult to keep up with them and make the necessary adjustments or arrive at satisfactory interpretations. During the breeding season the bucks would eat very little, and that irregularly, yet they raced around expending a great amount of energy resulting in a weight loss. Following the breeding season for a few weeks, while the antlers were still solid and intact, they became much quieter, fed heavily, and regained the weight lost during the rut. Then when the antlers were shed they became timid and retiring, eating little for awhile, but gradually increasing their rations to meet the heavy demands of antler production. Less food was required as the antlers started to harden under the velvet and the blood supply diminished, but consumption immediately jumped again the moment the velvet was shed and the bucks entered their most vigorous physical season of the year.

Plate VI.—Mule-deer bucks shedding, September 13.

The does likewise were subjected to seasonal stimuli and changes of major importance. The gestation period is very close to 200 days in both whitetail and mule deer. Although the pregnant animal is quieter during this period, there is a gradual but steady increase in her food requirements. When the fawns are dropped, with 125-pound mule-deer does, there is a loss in weight of from 8 to 12 pounds. The heavy period of nursing lasts approximately sixty days. This means there is over two thirds of the year in which does are either pregnant or lactating. If unbred the does go through three or four climactic periods a year. These periods, twenty-one to twenty-three days apart, are of such short duration, however, that the animals are rarely off their feed for more than a meal or two.

Apparently any attempt to factor the food requirements of any mixed herd of deer in accurate detail would require unjustified time and labor. It may be stated here, therefore, that the average food requirements for three and one half years of the mixed herd of thirty-eight deer used in this experiment—growing animals of all ages, animals breeding, carrying fawns, or nursing—averaged a daily air-dry food requirement of 2.35 pounds per hundredweight of live animal.

This figure we feel confident will prove dependable for management practices on the open range. In other words, *the daily forage removal of air-dry feed in pounds from a given range by deer of all classes will equal their hundredweight multiplied by the figure 2.35.* Putting it roughly in terms of domestic stock, the forage removal by 500 head of mule deer will approximately equal that of 1,000 sheep; or for the Arizona whitetail, 500 head of deer will approximately remove the same amount of forage as an equal number of sheep.

An important caution should be immediately noted, however, and that is that mere forage removal is far from the complete

picture. In the first place much of the preferred forage species for deer is not utilized by domestic livestock. Grass is the mainstay of the forage cover for cattle and sheep; it is a minor part in the deer diet because they are essentially browsing animals. Other noticeable differences will be found in the palatability charts. In the second place the manner in which deer feed is important in the resulting effects on the forage cover. Unless seriously overcrowded on a range, deer feed with a bite-and-skip type of browsing that makes it difficult to detect the forage removal even on a well-stocked range. Although deer will remove fully as much, or more, forage pounds from a given range as will an equivalent weight of domestic livestock, the plant species given preference and the manner in which they are taken make this forage removal a less serious factor than when taken by domestic livestock. Since deer disturb the grass cover very little, they are of small importance as a causative agent in promoting erosion of the soil.

PALATABILITY OF NATIVE FORAGES

The second phase of the experimental work dealt with palatability and seasonal use of native food plants. One hundred and sixty-eight native Arizona species were run for palatability tests. An attempt was made to determine seasonal utilization on the species which were judged the most important forage plants from the standpoint of palatability, widespread distribution, and availability on southern Arizona ranges.

The procedure was simple. A wide variety of plants was gathered fresh twice daily and placed before the animals. Records were made each morning and evening on the relative preference for the different species. Nonutilized plants were rated at zero and favored concentrates at ninty-nine. The various species were assigned places between these two points according to the degree of use made of them by the deer. This type of feeding was continued steadily through three and one half years. The main evergreen plants were offered continually throughout the year and repeated each year. The deciduous plants, annuals, mast, and berries were made available to the deer when these feeds could be gathered on the range.

The palatability[7] figures derived from this controlled feeding are obviously not comparable to the palatability tables in use by the U.S. Forest Service and other services engaged in range-survey studies. The percentages given in the palatability chart for mule deer and Arizona whitetail are comparative expressions

[7] Palatability as defined by the Inter-agency Range Survey Committee and adopted by the Western Range Survey Conference April 24, 1937, Salt Lake City, mimeographed, is "the percent of the total current year's growth, within reach of stock, to which a species is grazed when the range unit is properly utilized under the best practical range management. The class of stock, the composition of the vegetation, and the proper time of using the range as a whole, etc. must be considered when rating the palatability of individual species."

of food preferences. From fourteen to twenty different species of plants were offered to the deer at one time, all equally available, and each species in sufficient quantity to supply more than the animal could obtain in a day's grazing on the open range. The degree of use they received, therefore, was determined by the individual appetites and physiological needs of the animals. Naturally the deer exhibited individual preferences and individual differences which were independent of the major physiological stimuli of breeding, pregnancy, nursing, and so forth. Over a long time, however, there is a definite group reaction, and the curve for individual palatability follows satisfactorily close to the curve for the herd (Fig. 3).

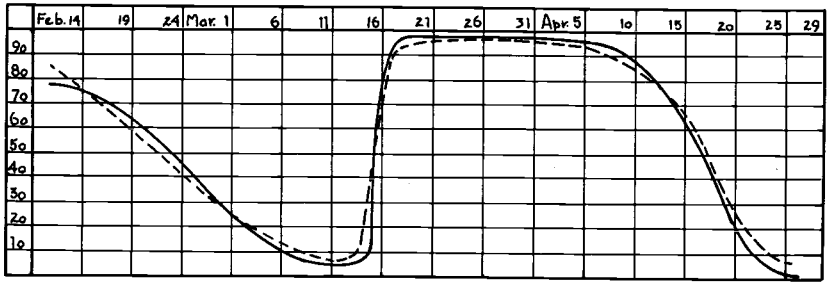
Deer are considered browsing animals, i.e., animals which feed mainly on the tender twigs, leaves, and fruits of shrubs, trees, and woody plants. Dixon[8] in his study of the mule deer of California has shown in convincing detail that the mule deer feed on a far greater proportion of grass, weeds, and succulent annual plants than they are generally thought to do. While our experimental work has been much more limited in this phase than Dixon's observations, nevertheless the data found are conclusive enough to show the more generalized feeding habit for both species of deer.

TREES

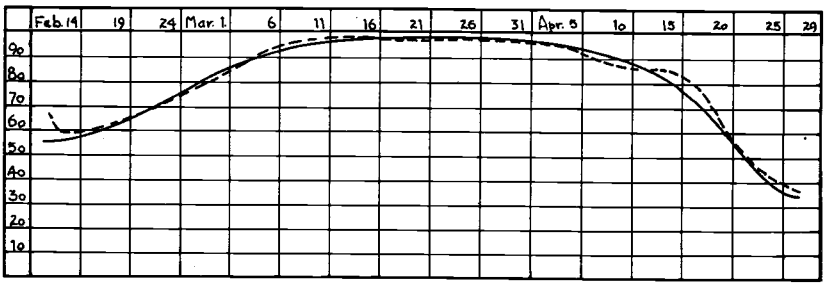
Aspen headed the palatability list of tree forages with 99 per cent. There was one unexplained experience in feeding this plant when four whitetail deer refused to touch a certain meal of young aspen leaves. These leaves had been gathered a few hours before they were placed before the deer, and it is possible some enzymatic change had taken place that influenced the animals to refuse them. It is not known whether aspen produces cyanide in the leaves when conditions such as low temperatures and cutting occur that check the plant processes. Deer appear to readily detect and avoid cyanide in plants. Closely following aspen in palatability were madroña and mountain hackberry. Much less preferred, yet important in the tree forage group, are mulberry, ash, walnut, and cherry.

Although lower in palatability than several other species, the oaks are an important forage group in Arizona because of their widespread occurrence and because most species have persistent foliage and consequently are available as yearlong browse. The Emory oak, a prominent everygreen species found in the state between 4,000- and 5,500-foot elevations, showed a yearlong use of 55 per cent. It is given a marked preference, however, in the spring when new growth is present as illustrated in Figure 3. The Mexican white oak, also evergreen and common to the foothill country in southern Arizona, was only slightly lower in palatability. Gambel's oak, a deciduous tree of the yellow-pine belt also

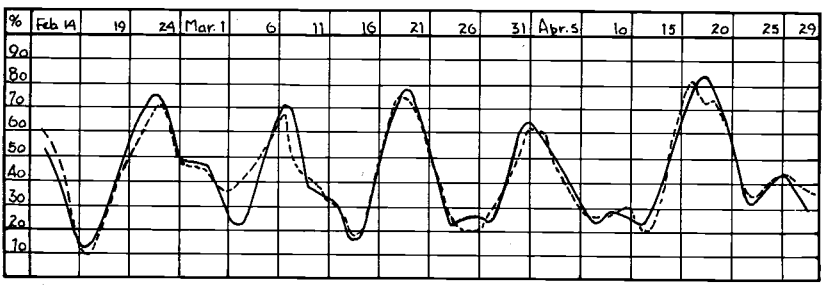
[8] Jos. S. Dixon, "A Study of the Life History and Food Habits of Mule Deer of California," Rpnt. from *Calif. Fish and Game*, Sacramento (Vol. XX), Nos. 3 and 4, July and Oct., 1934.



Emory Oak.



Garrya.



Juniper.

Figure 3.—Graphic examples of the fluctuations in palatability of three evergreen deer forages: solid line, the average of a herd of five Arizona whitetail deer; broken line, one individual. The abrupt mid-April increase in Emory oak marks the time of new spring growth. The *Garrya* curve remains low until the following fall. The ten-day to two-week highs in juniper are characteristic for the year.

had a 50-per-cent-average palatability. The scrubby turbinate oak (*Quercus turbinella*) is a known deer forage, but no figures were obtained on this species.

The alligator-back juniper gave an unexpected figure for white-

tail of 35 per cent, the single-seeded group (*Juniperus monosperma* and *J. utahensis*) rated zero. Utilization by deer of juniper has generally been considered a definite sign of overgrazing. It appears there is a quite consistent and constant use of the alligator-back juniper, and crowded conditions and depleted ranges are indicated only by excess use of this species.

Early in the work it was discovered that the deer reacted to the coniferous group rather as a conditioner or a condiment than a regular food. This reaction held throughout the study. When fir, spruce, pine, or piñon was offered to the deer, they might make an entire meal of any one of these plants, which would be ignored again for ten days or two weeks, and then another meal would be made from either the same species or another one. Within the limits of our work and observation we were led to consider these plants as valuable ingredients in the forage ensemble which furnished needed tonics, enzymes, or vitamins rather than the necessary fats, carbohydrates, and proteins.

GRASSES

Very few grasses were tested because they receive short seasonal use and also because it would have taken a very long time to adequately survey this one forage group alone.

Knotgrass and slim triodia, however, were exceptions to short seasonal use. The first is a grass of the damp or wet canyon bottoms, the second is found typically on the hillsides growing among the rocks. Both species are utilized whenever there is green growth which may obtain throughout most of the year. Although only sixteen different species of grasses were fed, the high utilization and palatability of eleven of these strongly indicate the importance grass may have in the deer-forage picture.

One hundred and sixty-eight plants are a small number of the total species found in any mountain range in southern Arizona. These probably represent a propportionate percentage of the species utilized by deer for food. Since no plant is too small for the attention of a deer, it is reasonable to presume that among the herbs, weeds, and annuals; the great variety of grasses; the flowering parts of otherwise unpalatable plants; small vines, berries, and fruits that the utilized list of native species would be increased manyfold. After extensive field observations, however, and the testing of every plant that had any prominence whatsoever on the range, it is safe to assume that the far greater bulk of the forage consumed annually by deer in southern Arizona is represented in the species which have been experimentally fed and described.

Provided adequate water and cover are present, the size of the permanent deer herd in the grassland-oak type of vegetation could be determined by a reconnaissance on the amount of *Eriogonum wrightii*, mesquitillo, mountain mahogany, *Rhus trilobata*, the browsable parts of Emory, Arizona, and Mexican white oak with their mistletoes, and either cliff rose or *Garrya*, *Amorpha* or

TABLE 1.—SEASONAL AVAILABILITY AND PALATABILITY OF TREES AND GRASSES.

	TREES	Seasonal availability												Palatability (per cent)						
														Whitetail			Mule deer			
		J	F	M	A	M	J	J	A	S	O	N	D	Av.	G*	M*	Av.	G	M	
1	*Arbutus arizonica*, madroña	G	G	G	G	G	G	G	G	G	G	G	G	95	95	95				1
2	*Celtis pallida*, desert hackberry				G	G	G	G	G	G	G	G	G	60	95	25	90	99	90	2
3	*C. reticulata*, mountain hackberry				G	G	G	G	G	G	G	M	M	90	99	80	90	99	80	3
4	*Cercidium torreyana*, blue paloverde				G	G	G	G	G	G	G	G					20	35	5	4
5	*Chilopsis linearis*, desert willow				G	G	G	G	G	G	G	G			60			20		5
6	*Fraxinus velutina*, Arizona ash					G	G	G	G	G	G	M	M	50	80	20	10	20	0	6
7	*Juglans major*, walnut				G	G	G	G	G	G	G	M			50		10	20	0	7
8	*Juniperus pachyphloea*, alligator bark	G	G	G	G	G	G	G	G	G	G	G	G	35	35	35	20	20	20	8
9	*Morus microphylla*, mulberry				G	G	G	G	G	G	G			25	40	10	30	50	10	9
10	*Padus* sp., cherry				G	G	G	G	G	G	G			40	70	10		60		10
11	*Pinus edulis*, piñon pine	G	G	G	G	G	G	G	G	G	G	G	G	5			5			11
12	*P. ponderosa*, yellow pine	G	G	G	G	G	G	G	G	G	G	G	G	10	10	10	15	15	15	12
13	*P. strobiformis*, white pine	G	G	G	G	G	G	G	G	G	G	G	G	5			5			13
14	*Plantanus wrightii*, sycamore					G	G	G	G	G	M	M			85			40		14
15	*Populus aurea*, aspen	M	M	M	M	G	G	G	G	G	M	M	M	99	99	99	99	99	99	15
16	*P. fremontii*, cottonwood			G	G	G	G	G	G	G	G	M		5						16
17	*Prosopis juliflora*, mesquite				G	G	G	G	G	G	G	G	G	30	50	10	20	35	5	17
18	*Ptelea* sp., skunk trefoil				G	G	G	G	G	G	G	G		0	0	0	0	0	0	18
19	*Pseudotsuga taxifolia*, Douglas fir	G	G	G	G	G	G	G	G	G	G	G	G	5			5			19
20	*Quercus arizonica*, Arizona oak	G	G	G	G	G	G	G	G	G	G	G	G	40	70	10				20
21	*Q. emoryi*, Emory or black oak	G	G	G	G	G	G	G	G	G	G	G	G	55	99	10	50	90	10	21
22	*Q. gambelii*, Gambel's oak					G	G	G	G	G	M	M		50	90	10	45	80	10	22
23	*Q. hypoleuca*, white-leaf oak	G	G	G	G	G	G	G	G	G	G	G	G	25	50	0				23
24	*Q. oblongifolia*, Mexican white oak	G	G	G	G	G	G	G	G	G	G	G	G	50	90	10	45	80	10	24
25	*Robinia neomexicana*, locust				G	G	G	G	G	G					60					25
26	*Salix amygdaloides*, willow		G	G	G	G	G	G	G	G	G							45		26
	GRASSES																			
1	*Andropogon furcatus*, big feathergrass	M	M	M	M	M	M	G	G	G	M	M	M		0			0		1
2	*Aristida californica*, Calif. three awn†	M	G	G	G	M	M	G	G	G	M	M	M		0			0		2
3	*Boutelona curtipendula*, side oats grama†	M	G	G	G	M	M	G	G	G	M	M	M		60			60		3
4	*B. rothrockii*, crowfoot grama†	M	M	M	M	M	M	G	G	G	M	M	M		45			45		4
5	*Bromus carthartious*, rescue grass	M	G	G	G	G	M	M	M	M	M	M	M		40			40		5
6	*Eragrostis lugens*, lovegrass†	M	G	G	G	M	M	G	G	G	M	M	M					60		6
7	*Festuca arizonica*, Arizona fescue	M	G	G	G	G	G	G	G	G	M	M	M					50		7
8	*F. octoflora*, winter fescue	M	M	G	G	G	M	M	M	M	M	M	M		0			0		8
9	*Heteropogon contortus*, tangletop†	M	G	G	G	M	M	G	G	G	M	M	M		0			0		9
10	*Muhlenbergia montana*, mountain muhly†	M	M	M	M	G	G	G	G	G	M	M	M					40		10
11	*Paspalum distichum*, knotgrass	M	M	G	G	G	G	G	G	G	M	M	M	45	85	5				11
12	*Poa fendleriana*, blue grass	M	M	G	G	G	G	G	G	G	G	M	M		40			40		12
13	*Sitanion hystrix*, squirrel tail	M	M	G	G	G	G	G	M	M	M	M	M		35			35		13
14	*Trichachne californica*, cotton grass†	M	G	G	G	M	M	G	G	G	M	M	M		35			35		14
15	*Triodia mutica*, slim triodia	M	M	G	G	G	G	G	G	M	M	M	M	40	75	5	50	85	15	15
16	*T. pulchella*, burro grass	M	M	M	M	M	G	G	G	G	M	M	M		0			0		16

*G, green; M, mature.

†These species are generally considered as starting their growth with the midsummer rains. Dependant on climatic conditions, however, approximately one year in three, early spring growth takes place.

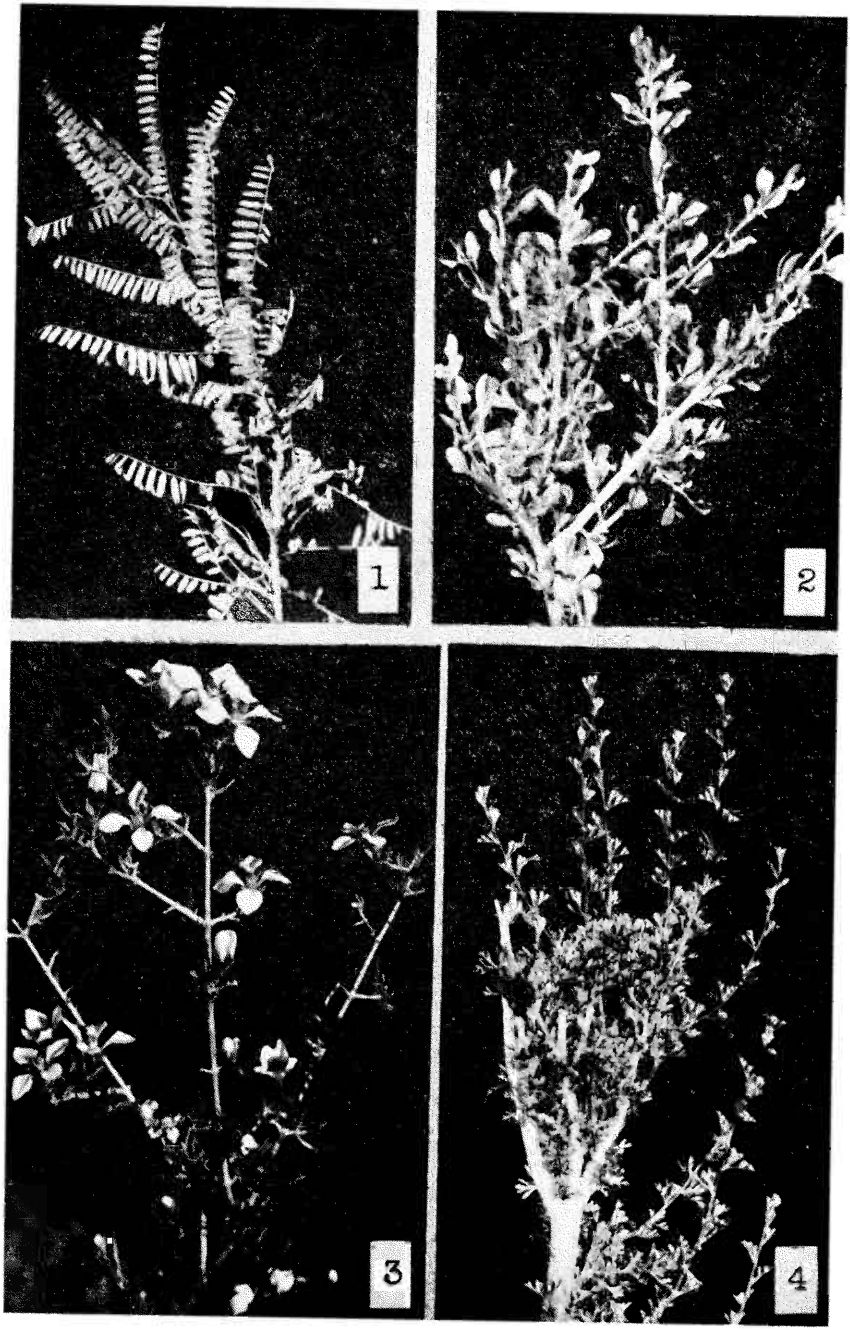


Plate VII.—Shrub forages: *1*, false mesquite or *Eysenhardtia*; *2*, mountain mahogany; *3*, *Fendlera*; *4*, cliff rose or *Cowania*.

Eysenhardtia, grape or fendlera, and cat's-claw or mimosa. Above the grassland-oak type, through and including the yellow pine, spruce, and fir the key species would be *Ceanothus*, *Eriogonum wrightii*, madroña, aspen, mountain mahogany, Gambel's and other oaks (excepting *Quercus hypoleuca*), lotus, and the amount and variety of perennial grasses. The grassland-oak type of range carries by far the greatest weight of the whitetail deer population in Arizona, and as will be shown in a later publication, when water is not a factor there is a direct correlation between the deer density and the variety of forage and type of cover.

SHRUBS

The shrub element in the forage cover has usually been given the greatest attention in game reconnaissance work. This may be because deer are known to browse on shrubs and because shrubs are compact units, each visible in its entirety, with the woody stems carrying the browsing record for a long time. Grass and annuals on the other hand make rapid and obliterating regrowth and are difficult to observe except in limited areas. Trees, which also furnish considerable food, are large units, and on a normally stocked range the annual tonnage collected by the deer easily goes undetected. The importance of shrubs is not minimized, but trees, grass, and weeds do not generally receive the full importance they deserve in the food supply of deer.

A noticeable fact about the shrub contribution to the deer diet is the very uniform utilization made of this group. Shrubs are either not used at all, or if they are, they appear to have a steady usage of a high degree of uniformity. This may be an expression of forage dependability and availability. Drouth years may see no annuals or weeds produced, but the shrubs are present and usually put on some growth increment. Deer acquire a habit of feeding over a certain area and other things being equal will return periodically to feed where there is a known food supply.

Outstanding of southern Arizona shrubs are the mistletoe, false mesquite, *Ceanothus*, cat's-claw, *Mimosa*, mesquitillo, *Bouvardia*, fendlera, false indigo, grape, and *Eriogonum wrightii*. All of these shrubs with the exception of *Eriogonum wrightii*, *Ceanothus*, and mistletoe are deciduous or partially so and are usually unavailable in the three winter months. This is definitely true of grape and fendlera. The leguminous shrubs on the other hand often have persistent foliage if they are growing in warm, south-facing niches. This is especially true of mesquitillo, and deer seek the mesquitillo or *Calliandra* slopes in midwinter. Because of its yearlong use, availability, and widespread occurrence in the state *Eriogonum wrightii* might well be considered the most important single shrub in the deer forage supply. This plant occurs in all the low desert ranges to the Colorado River and continues upward into the yellow-pine belt. Midwinter analyses of deer stomachs have been made which showed *Eriogonum wrightii* to make up 94 per cent of the contents.

TABLE 2.—SEASONAL AVAILABILITY AND PALATABILITY OF SHRUBS, VINES, AND OTHERS.

	SHRUBS AND VINES	Seasonal availability												Palatability (per cent)						
														Whitetail			Mule deer			
		J	F	M	A	M	J	J	A	S	O	N	D	Av.	G*	M*	Av.	G	M	
1	*Acacia greggii*, cat's-claw				G	G	G	G	G	G	G	G	G		95					1
2	*Amorpha californica*, false indigo			G	G	G	G	G	G	G	G	G		85	99	70	65	80	50	2
3	*Anisacanthus thurberi*, false honeysuckle				G	G	G	G	G	G	G	G	G	25	40	10				3
4	*Aplopappus hartwegi*, burroweed	G	G	G	G	G	G	G	G	G	G	G	G				0	0	0	4
5	*Aralia bicrenata*, elk clover				G	G	G	G	G	G	M			95	95	95				5
6	*Arctostaphylos pungens*, manzanita	G	G	G	G	G	G	G	G	G	G	G	G	20	35	5	20	35	5	6
7	*Atriplex canescens*, chamiso	G	G	G	G	G	G	G	G	G	G	G	G	20	35	5	40	60	20	7
8	*Baccharis glutinosa*	G	G	G	G	G	G	G	G	G	G	G	G	5			0	0	0	8
9	*B. pteronioides*	G	G	G	G	G	G	G	G	G	G	G	G	20	35	5				9
10	*B. sarothroides*, desert broom	G	G	G	G	G	G	G	G	G	G	G	G				0	0	0	10
11	*Bouvardia glaberrima*				G	G	G	G	G	G	G	G	M	85	95	70				11
12	*Brickellia californica*, brickellia			G	G	G	G	G	G	G	G	G	M	60	85	35	35	65	5	12
13	*Calliandra eriophylla*, mesquitillo	M	M	M	G	G	G	G	G	G	G	G	M	90	99	80	80	99	60	13
14	*C. humilis*	M	M	M	G	G	G	G	G	G	G	G	M	90	99	80				14
15	*Ceanothus fendleri*, buckbrush	G	G	G	G	G	G	G	G	G	G	G	G				60	90	30	15
16	*Cercocarpus paucidentatus*, mountain mahogany	G	G	G	G	G	G	G	G	G	G	G	G	70	85	55	70	85	55	16
17	*Condalia lycioides*, greythorn				G	G	G	G	G	G	G	G	G		60		0	0	0	17
18	*Cowania stansburiana*, cliff rose, quinine bush	G	G	G	G	G	G	G	G	G	G	G	G	60	90	30	55	85	25	18
19	*Eriogonum wrightii*, buckwheat	G	G	G	G	G	G	G	G	G	G	G	G	85	99	70	80	99	60	19
20	*Erythrina flabelliformis*, chilicotte					G	G	G	G	G				25	50	0	0	0	0	20
21	*Eysenhardtia orthocarpa*, false mesquite				G	G	G	G	G	G	G	G	M	90	99	80	80	99	60	21
22	*Fendlera rupicola*, fendlera				G	G	G	G	G	G	G	G		90	99	80	90	99	80	22
23	*Garrya wrightii*, silk tassel	G	G	G	G	G	G	G	G	G	G	G	G	40	70	10	25	40	10	23
24	*Gossypium thurberi*, wild cotton			G	G	G	G	G	G	G	G	G	M	40	60	20	0	0	0	24
25	*Gutierrezia sarothrae*, snakeweed	G	G	G	G	G	G	G	G	G	G	G	G	0	0	0	0	0	0	25
26	*Hymenoclea monogyra*, ramirio	G	G	G	G	G	G	G	G	G	G	G	G	0	0	0	0	0	0	26
27	*Janusia gracilis*, janusia			G	G	G	G	G	G	G	G	G						70		27
28	*Krameria parvifolia*, cosahui	M	M	M	G	G	G	G	G	G	G	G	M	45	80	10	40	75	5	28
29	*Mimosa biuncifera*, mimosa	M			G	G	G	G	G	G	G	G	M	90	90	90				29
30	*Phoradendron californicum*, mistletoe	G	G	G	G	G	G	G	G	G	G	G	G				70	80	60	30
31	*P. flavescens*, mistletoe	G	G	G	G	G	G	G	G	G	G	G	G	95	99	90	95	99	90	31
32	*P. macrophyllum*, mistletoe	G	G	G	G	G	G	G	G	G	G	G	G	99	99	99	99	99	99	32
33	*P. juniperum*, mistletoe	G	G	G	G	G	G	G	G	G	G	G	G	99	99	99				33
34	*Pteridium aquilinum*, bracken fern			G	G	G	G	G	G	G	G	M	M	25	50	0	15	30	0	34
35	*Rhamus californica*, buckbrush	G	G	G	G	G	G	G	G	G	G	G	G	0	0	0	0	0	0	35
36	*Rhus trilobata*, lemon bush				G	G	G	G	G	G	G	G	M	60	60	60	50	50	50	36
37	*Rubus strigosus*, raspberry				G	G	G	G	G	G	G	M	M		95					37
38	*Senecio douglassii*, grey snakeweed	G	G	G	G	G	G	G	G	G	G	G	G	0	0	0	0	0	0	38
39	*Vitis arizonica*, grape				G	G	G	G	G	G	G	M	M	80	99	60	80	99	60	39
	MISCELLANEOUS																			
1	*Agave palmeri* (leaves) mescal	G	G	G	G	G	G	G	G	G	G	G	G		15			0		1
2	*Arctostaphylos pungens* (berries) manzanita				G	G	M	M	M	M				50	50	50	25	25	25	2
3	*Argemone platyceras* (flowers) prickly poppy			G	G	G	G	G	G	G	G				35					3
4	*Celtis reticulata* (berries) mountain hackberry	M								G	G	M	M		0		10	10	10	4
5	*Chilopsis linearis* (flowers) desert willow				G	G									95					5
6	*Fendlera rupicola* (seed pods)	M			G	G	G	M	M	M	M	M	M	60	90	30	50	80	20	6
7	*Ferocactus wislizeni* (fruit) bisnaga		M	M						G	G	M	M			85			25	7
8	*Fouquieria splendens* (flowers) ocotillo			G	M	M								85	85	85				8
9	*Juniperus pachyphloea* (berries) juniper				G	M	G	M	G	M	M	M	M			50			20	9
10	*Morus microphylla* (fruit) mulberry						G	M								5				10
11	*Nothalaena* sp. fern		G	G	G	M	M	G	G	G	M	M	G			60				11
12	*Physalis crassifolia* (berries) ground cherry						G	G	G	M	M	M				80				12
13	*Prosopis juliflora* (beans) mesquite						G	M	M	M	M	M				90			35	13
14	*Quercus emoryi* (acorns) oak						G	M	M							99			99	14
15	*Q. oblongifolia* (acorns) oak	M										G	M			99			99	15
16	*Quercus* sp. (galls) oak	M	M	G	M	G	M	G	M	G	M	M	M			55				16
17	*Rhus trilobata* (berries) lemon bush				G	M	M	M								5			10	17
18	*Solanum elaeagnifolium* (berries)						G	M	G	M	M	M	M			90				18
19	*Vitis arizonica* (fruit) grape								G	G	M	M				90			90	19

*G, green; M, mature.

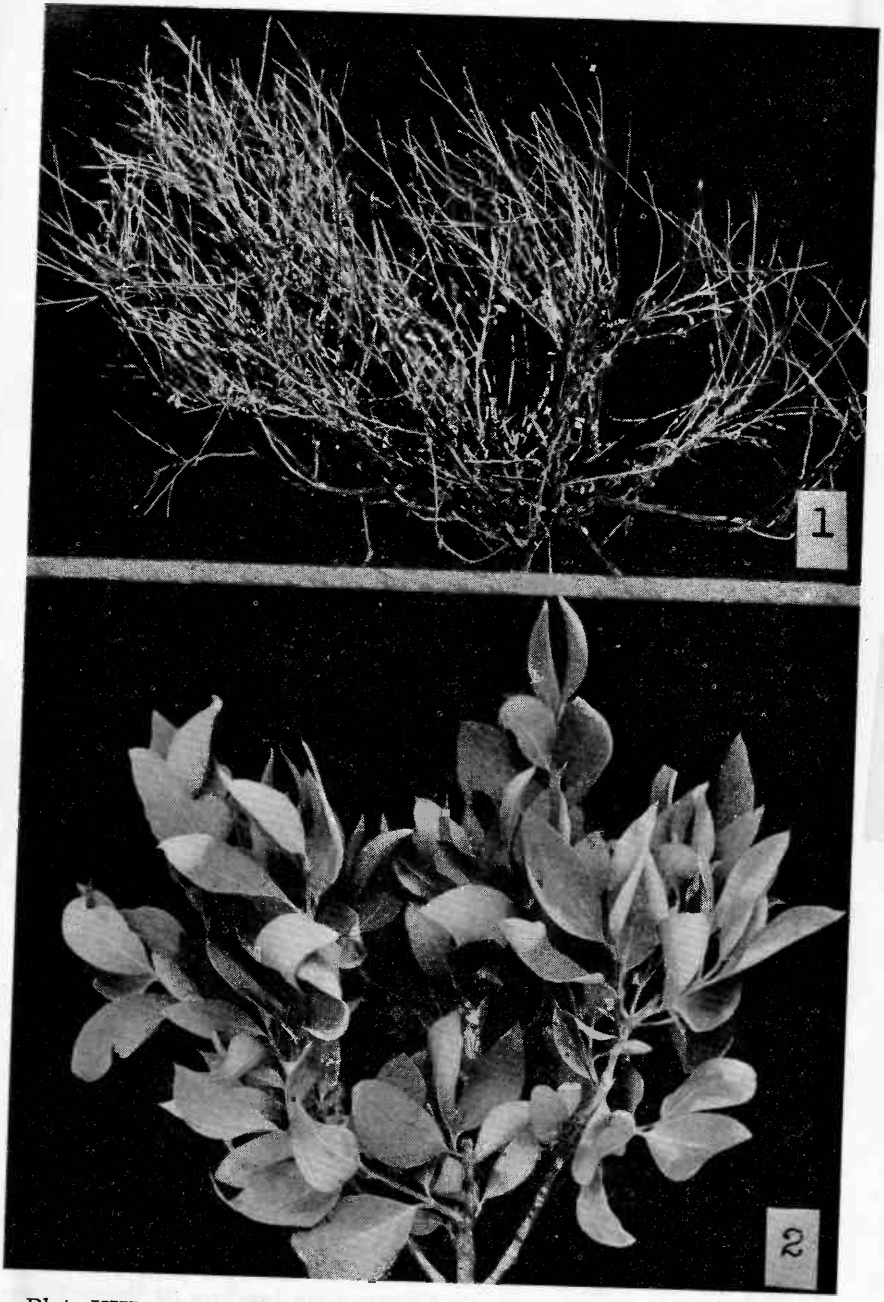


Plate VIII.—Shrub forages: *1, Eriogonum wrightii; 2, Garrya wrightii.*

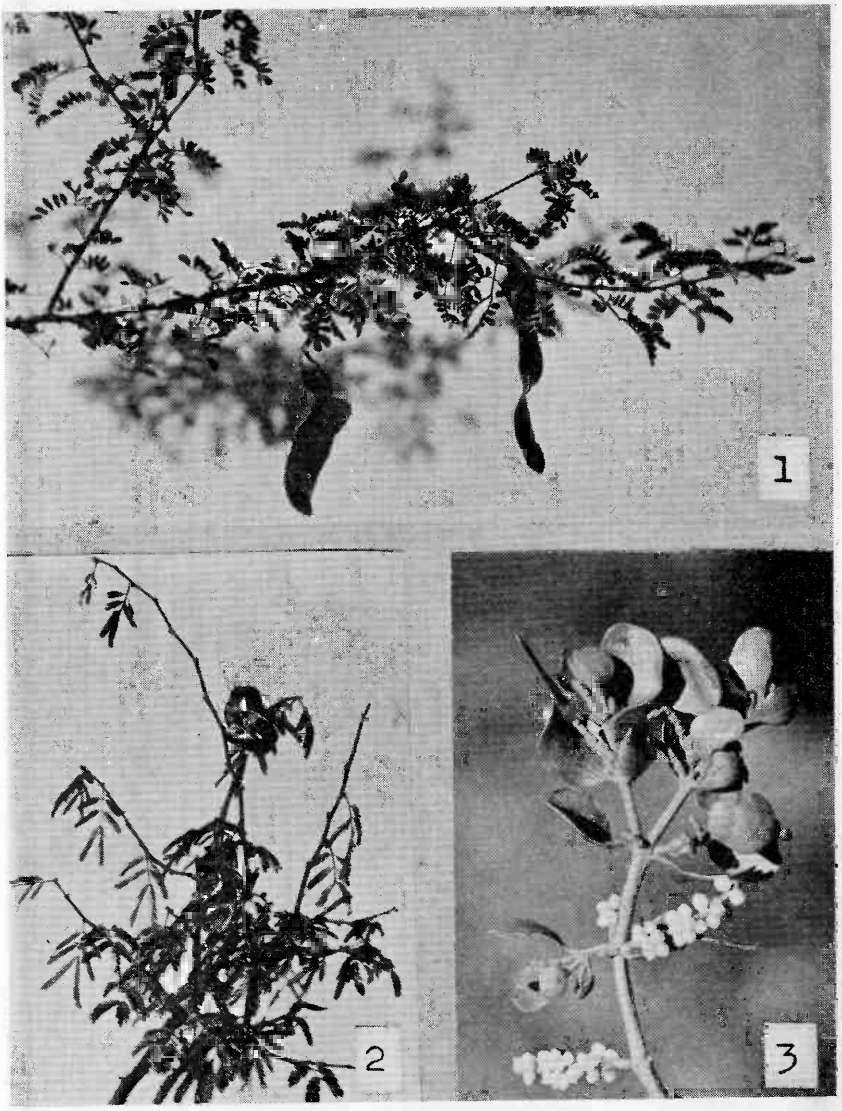


Plate IX.—Shrub forages: *1*, cat's-claw; *2*, mesquitillo (*Calliandra*); *3*, mistletoe.

In the past in Arizona the value of deer range has been often judged on the amount of silk tassel or *Garrya*, cliff rose, and mountain mahogany present. Continuous feeding of these three throughout the entire study has given these plants a palatability rating that is well below the first ten, although their evergreen

TABLE 3.—SEASONAL AVAILABILITY AND PALATABILITY OF HERBS AND ANNUALS.

	HERBS AND ANNUALS	Seasonal availability												Palatability (per cent)						
														Whitetail			Mule deer			
		J	F	M	A	M	J	J	A	S	O	N	D	Av.	G*	M*	Av.	G	M	
1	*Amaranthus palmeri*, careless weed						G	G	G	G	M				99			99		1
2	*Anemone tuberosa*, anemone		G	G	G	G	M								50			35		2
3	*Arabis perennans*, rock cress			G	G	G	G	M							90					3
4	*Argemone platyceras*, prickly poppy		G	G	G	G	G	G	G	G	G	G		0	0	0	0	0	0	4
5	*Artemisia mexicana*, sage	M	M	M	G	G	G	G	G	G	G	G	M	55	95	15	45	80	10	5
6	*Atriplex wrightii*, salt weed				G	G	G	G	M	M					90			75		6
7	*Astragalus nothoxys*, locoweed	G	G	G	G	G									90			80		7
8	*Baileya multiradiata*	M	G	G	G	G	G	G	G	G	G	G	M	0	0	0	0	0	0	8
9	*Bidens heterophylla*			G	G	G	G	G	G	G	G	G	M		95					9
10	*Boerhaavia* sp.							G	G	G	M				15					10
11	*Brodiaea capitata*, covena		G	G	G										95					11
12	*Calandrina caulescens*			G	G	G									95			95		12
13	*Calochortus aureus*, mariposa lily		G	G	G	G									99					13
14	*Carex* sp., sedge				G	G	G	G	G	G	G	G	M	0	0	0				14
15	*Castilleja austromontana*, paintbrush				G	G	G	G							40					15
16	*Chaemactis stevioides*			G	G	G	M								80					16
17	*Chenopodium fremontii*, lamb's-quarters			G	G	G	G	G	G	G					99			99		17
18	*Cryptantha barbigera*, burr comb		G	G	G	G	M								85					18
19	*Echinocystis gilensis*			G	G	G	M								85					19
20	*Erigeron commixtus*				G	G	G	G	M						50					20
21	*Eriogonum abertianum*				G	G	G	G	G	M					80					21
22	*E. pinetorum*	M	M	M	G	G	G	G	G	M	M	M	M	0	0	0	0	0	0	22
23	*Erodium cicutarium*, filarec	G	G	G	G	G									99			99		23
24	*Eschscholtzia parvula*, poppy			G	G	G									99			99		24
25	*Euphorbia albomarginata*				G	G	G	G	G	G	G	M	M		75			55		25
26	*Evolvulus linifolius*						G	G	G	G	G	G		60	95	25	60	95	25	26
27	*Franseria tenuifolia*	G	G	G	G	G	G	G	G	G	G	G	G	50	85	15				27
28	*Funastrum lineare*							G	G	G	G	M		0	0	0				28
29	*Galium aparine*, bedstraw			G	G	G	G								90					29
30	*Gilia aurea*, golden gilia			G	G										85					30
31	*G. candida*, gilia			G	G										85					31
32	*Gymnolomia annua*			G	G	G	G	G	G	G	M				70					32
33	*Ipomoea barbatisepala*, morning glory						G	G	G	G	M				80			60		33
34	*I. cordifolia*						G	G	G	G	M				80			75		34
35	*Juncus arizonicus*			G	G	G	M								35					35
36	*Kallstroemia grandiflora*, Mexican poppy							G	G	G	M				90			40		36
37	*Lepidium lasiocarpus*, peppergrass			G	G	G	M								75			60		37
38	*Lesquerella gordonii*, bladderpod			G	G	M									60			50		38
39	*Lotus mollis*, birdsfoot trefoil		G	G	G	G	G								90			95		39
40	*L. wrightii*			G	G	G									90			85		40
41	*Lupinus* sp., lupine		G	G	G	G	G								10			0		41
42	*Marrubium vulgare*, horehound	M	M	G	G	G	G	G	G	G	G	G	M		0			0		42
43	*Mentzelia albicaulis*, blazing star			G	G	G									80					43
44	*Microseris linearifolia*			G	G	G	M								99			95		44
45	*Oenothera* sp., primrose		G	G	G	G	M								95			95		45
46	*Oxalis* sp.		G	G	G	G									85					46
47	*Parietaria obtusa*			G	G	G	M								85					47
48	*Pectocarya recurvula*, combseed			G	G	G	M								50					48
49	*Pentstemon wrightii*, San Jose			G	G	G	G	M	M					10	20	0		0		49
50	*Phacelia alba*			G	G	G	M								45					50
51	*P. crenulata*			G	G	G	M								50					51
52	*Plagiobothrys arizonicus*, paintweed			G	G	G	M								95					52
53	*Plantago insularis (fastigata)*, trigo			G	G	G									65			50		53
54	*Portulaca lanceolate*, purslane						G	G	G	G					99			99		54
55	*Rafinesquia neomexicana*			G	G	G	M								99					55
56	*Roripa* sp., watercress	G	G	G	G	G	G	G	G	G	G	G	G		55					56
57	*Senecio riddellii*			G	G	G									0					57
58	*Sisymbrium irio*, mustard			G	G	G									75					58
59	*Solanum elaeagnifolium*	M				G	G	G	G	G	G	M	M		0			0		59
60	*Sonchus oleraceus*, sowthistle			G	G	G									99			99		60
61	*Spermolepis echinatus*			G	G	G	M								55					61
62	*Stephanomeria pauciflora*			G	G	G	M								75					62
63	*Streptanthus arizonicus*			G	G	G	M								65					63
64	*Talinum patens*							G	G	G					99			99		64
65	*Tetramerium hispidum*	G	G	G	G	G	G	G	G	G	G	G	G		80					65
66	*Thysanocarpus laciniatus*, lacepod			G	G	G	M								80					66
67	*Vicia exigua*, vetch			G	G	G	G	G	G	G	G	M					50	85	15	67
68	*Viquiera helianthoides*, sunflower	M	M	M	G	G	G	G	G	G	G	M		15	30	0		0		68

*G, green; M, mature.

nature and yearlong use raises their importance above the actual palatability rating given them in Table 2.

The mistletoes far outrank in palatability all the shrub forages which were tried. These parasitic plants can be grouped roughly into three types in Arizona: the leafless form commonly found on mesquite and the acacias; the broad-leafed type represented by *Phoradendron macrophyllum* on the oaks, with closely related species growing on hackberry, ash, and cottonwood; and the yellow forms of the genus *Arcenthobium* which occurs on pines and firs. All are eaten, but the broad-leafed forms are much preferred and reach a palatability figure from 95 to 99 per cent. Only on the oaks is this feed easily available. The oaks which carry these shrubs are widely distributed in the foothill country in southern Arizona. Many of the trees are low branching and occupy hillsides so that a good portion of this forage is in a position accessible to deer.

MISCELLANEOUS

Mast, berries, fruits, flowers, and so forth have been listed under miscellaneous forages. Probably the most important of these are acorns. Arizona has approximately twenty species of oaks, maturing acorns from midsummer to early winter. The Emory, turbinate, and dumosa (*Q. dumosa*) are important early maturing species, while the Mexican white oak, Arizona, and Gambel's oak are equally important late maturing species. During a fall of acorns deer may eat little else, and because they respond so quickly to changes in diet, deer have been recorded which have gone from a thin, dry-haired condition to sleekness and good flesh in fifteen days when there was a plentiful supply of acorns.[9]

Other important concentrates on southern Arizona ranges are cacti fruits; wild grapes; mesquite beans; flowers of cacti, desert willow, and ocotillo; fendlera pods; and the ripe berries of *Physalis* and *Solanum elaeagnifolium*. A rather unique food record is the use of oak galls. These are only eaten in the dry stage. They appear to be only a spidery mass of dry cellulose with a small insect larva in the center. They have a light, sweet taste which is probably what makes them attractive to the deer.

HERBS AND ANNUALS

Twenty-three herbs or annuals, of some sixty-eight that were fed, had a palatability figure when green of 90 per cent or more. These were careless weed, lamb's-quarters, bedstraw, primrose (an abundant plant in southern Arizona), *Bidens*, loco, lotus, mariposa lily, covena, poppy, portulaca, *Talinum*, sage (*Artemisia mexicana*), saltbush, rock cress, *Evolvulus*, paintweed, *Rafines-*

[9] Hunters who record the taking of really fat deer are simply obtaining animals which had previously found an abundant supply of some very accessible food high in fats and sugars. Also, in many cases they would be animals which for some reason of age, impotence, or barrenness were escaping the physical strain that accompanies the breeding phenomena.

quia, sowthistle, *Microseris*, filaree, calandrina, and Mexican poppy (*Kallstroemia*). Many of these have a very short season, and again it should be noted that their high palatability is an expression of the heavy utilization they receive when they are green and available and not an expression of the plant's comparative value on the open range on a yearlong basis. Exceptions to short-season availability are sage, which has almost yearlong use, and *Evolvulus* and *Bidens*.

Important because of widespread distribution in the state are sage, bedstraw, filaree, careless weed, and lamb's-quarters. There are two distinct growing seasons in Arizona when new green feeds are produced. Inspection of Table 1 will show the distribution of these herbs and annuals throughout the year.

PARASITES AND DISEASE

None of the parasitic arthropods common to deer caused any trouble with the exception of the wood tick (*Dermacentor nigroliniatus*) and the screw-worm flies. The ticks persisting through the spring and summer required continual removal and subsequent watching to prevent the screw worms from becoming established in the irritated areas. Several proprietary remedies were used in attempting to control the ticks. Most of them were coal-tar derivatives, and the remedy often proved more irritating than the parasites. Largely by accident it was found that a cheap, light hair oil removed the ticks much more effectively, besides being very soothing to the deer.

Two species of lice, the biting louse (*Tricholipeurus virginianus*) and the sucking louse (*Cervophthirus binipilosus*), were occasionally found on the deer but never occurred in such abundance as to require control methods.

Screw worms caused by far the greatest amount of trouble. During the spring and summer months a constant fight of prevention and removal took place. The smallest scratch on head, flank, or rump would mean an infection if not immediately covered. Despite constant vigilance several serious infections took place. One three-year-old mule-deer buck was lost because an infection in his head due to flies could not be properly treated. By the time the animal was finally killed all the softer septa in his nares and frontal region had been consumed. Vulnerable periods for the does were during fawn birth, and for the bucks when they were shedding the velvet from their antlers. While the fundamental technique in screw-worm control is to ignore the worms already present but prevent additional egg depositing, this is difficult to do with animals as hard to handle as deer, and occasionally almost surgical methods were required to control the worst infections. In severe cases the worms were "boiled out" with chloroform and the wound packed with a sticky oil. This was then covered with aseptic powder to dry the region as much as possible to discourage further oviposition by the flies. Carbolated ointments were tried, but as in the case of the tick remedies the deer appeared to be

somewhat allergic to coal-tar derivatives. Both species, the primary screw-worm fly (*Cochliomyia americana*) and the secondary fly (*C. macellaria*), appeared to be involved in every case.

While bot and warble flies were observed annoying the deer, no trouble was ever found from these insects. When the adult flies were attempting to lay eggs they caused the deer much concern, and when the flies were particularly persistent the deer would protect its nose in its flank until the fly withdrew.

In the summer of 1935 a bacterial disease attacked the fawns. Only one survived. One lived nearly three months after it became infected, but the other six died between three and six weeks after they had contracted the disease. No peculiarly distinct outward symptoms developed until the disease was in the advanced stage. Following a period of general lassitude and lack of appetite, the fawn's head would begin to lower and the neck would assume a rigid and stretched condition (Pl. X). This arose from the heavy impaction of hardened pus in the sublingual glands. When the carcasses were examined, it was found that the entire alimentary tract was ulcerated. In many cases the lesions perforated the rumen and the intestines. Usually the kidneys were enlarged and surrounded by hardened pus. The livers contained large, caseous areas, many larger than hickory nuts. The heart was partially or entirely covered with pus within the heart sac, and various-sized masses of apparently pure cultures were found in the larger blood vessels. In one specimen a piece of hardened pus the size of a lima bean was found in the heart and was probably the immediate cause of death. The lymphatic glands were several times normal size and suppurative.

Laboratory analyses determined this organism as one of the blue-green pus-forming group, genus *Pseudomonas*. It was impossible to obtain healthy fawns for inoculation, and it could not be proved that the bacillus was the primary causative agent in the disease. Since the organism has a very wide distribution and has been isolated from water, milk, ice cream, wine, etc.,[10] it would be necessary to satisfy Koch's postulates before definite statements could be made of its primary pathogenic importance. Analysis of the water supply for the corrals showed that at this time it was heavily charged with *Pseudomonas*. Serum from the adult deer agglutinated the bacillus (in high dilutions) which was recovered from the fawns.

There is a very close connection existing in the field between fawn mortality and the amount and condition of the water supply. The summer of 1935 was very dry and the rains late. When the rains did come and the canyons were flushed the disease immediately abated, and fawns born after the rains started were never sick. Field observations have shown that in several southern Arizona deer ranges there is a high fawn mortality definitely correlated with summer drouth periods and a low, stagnant water supply.

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[10] W. B. West, manuscript.

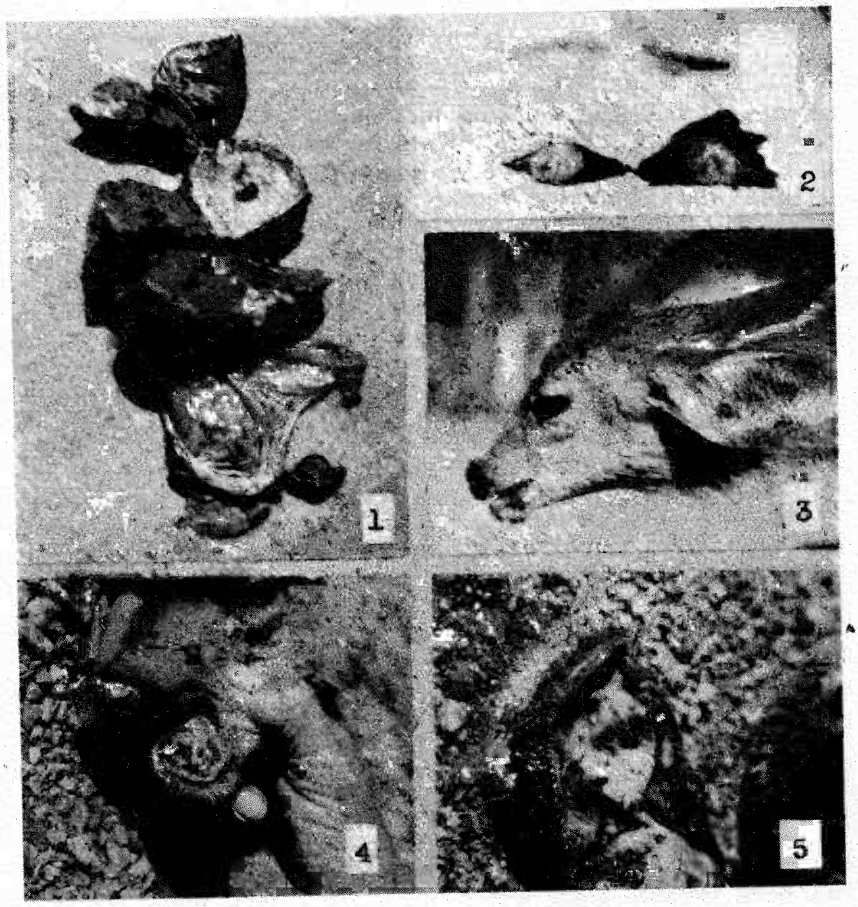

Plate X.—Diseased fawns: *1*, heart; note thickening of chamber walls (field specimen); *2*, infected liver; the light areas are pus; *3*, characteristic attitude of animal in last stages; note swollen sublingual region; *4* and *5*, condition of mouth and lips in advanced stages of disease. (Photos 4 and 5 by J. F. Arnold.)

WATER AND SALT CONSUMPTION

Naturally the temperature, evaporation, water content of the feed, and exercise all influence the amount of water a deer drinks each day. The following figures are for a mule-deer doe weighing approximately 100 pounds and are typical of the entire herd.

Month	Type of feed	Daily consumption
January	air-dry	1.5 quarts
January	semisucculent	1.2 quarts
July	air-dry	3.8 quarts
July	succulent	2.3 quarts

Since green feed makes up the greater part of forage taken on the open range, the seasonal averages found for the herd show that a water consumption allowance per hundredweight of 1 to 1½ quarts per day for the winter, and 2 to 3 quarts for the summer would meet the needs of deer.

Salt requirements are also influenced to a large extent by type of feed, temperature, and exercise. In addition there are certain types of digestive disturbances in which the deer will eat unusual amounts of salt. At such times an animal may lick salt as many as ten or fifteen times during the day, often alternating with small sips of water. Since the daily consumption of salt per deer is recorded in such minute amounts, a better idea can be had by stating that ten deer will consume a pound of salt per month in the summer and approximately one half this amount in the winter. Although definite proof is lacking, there were many indications that a diet heavily weighted with leguminous forages tended to increase the salt consumption.

POISONOUS PLANTS

The mule deer which were removed from the Kaibab Plateau to southern Arizona found in their new environment more than 200 plants which were unfamiliar to them. Many of these were known to be poisonous to cattle and sheep, but the deer appeared able to detect and avoid the harmful ones. When an animal species has occupied the same range for unnumbered generations this would be a natural expectation. The ability, however, appeared to extend beyond the single avoidance response or objective stimulus furnished by any particular injurious plant. Especially noticeable in the earlier periods of the work was the distinct tasting process that the mule deer went through when they were offered a new forage. They would take a leaf or twig of the new plant between their lips, move it about until it was moistened, and then discard it. In some cases this was final; otherwise they would return in a minute or two and repeat the action. This might be repeated three or four times after which the plant would be accepted or rejected. While this procedure was more frequently observed with the mule deer, it occassionally was recorded for the whitetail. The whitetails were on their native range. With this species the trial testing occurred most frequently with plants which were known under certain conditions to develop hydrocyanic acid. While there are a few plants poisonous to domestic livestock which deer eat with immunity as regular forage, it is extremely unlikely that deer have any tolerance for cyanide. On southern Arizona ranges there are several plants, which while excellent forage much of the year, may unpredictably produce lethal amounts of hydrocyanic acid. Livestock losses are periodically quite severe from this cause, and the ability of the deer to detect and avoid these plants when they are poisonous is an important racial safeguard. It is conceivable that tolerance can be developed for any poison, but considering the nature and

speed with which cyanide acts, it would be almost analogous to expect deer to become tolerant to death by mountain lions.

Poisonous plants on southern Arizona ranges may be roughly grouped into two classes: those which produce cyanide and those which carry some toxic property usually specific for the particular plant. Associated with a distinct soil type, quickly dropping temperatures and other causes adversely affecting the plant's metabolism are apparently the influencing factors in the production of cyanide in certain forages.[11] Plants which were fed to the deer and which they found highly palatable but which are also known as cyanide producers were mountain mahogany, cat's-claw, mimosa, lamb's-quarters, *Amorpha*, and mesquite.

In the second group are those plants in which a toxic principle is definitely associated with the plant and characteristic of it. Locoweed with its alkaloid, locoine,[12] is illustrative of this group. Locoweed, bracken fern (*Baccharis pterionoides*), and elk's clover (*Aralia*) are plants known to be toxic to domestic livestock but which are very palatable to deer and never at any time appeared to promote any harmful results. All parts of the locoweed were fed and in all stages. While they would not normally obtain it in the wild, they were particularly fond of the fleshy root.

Mistletoe which is high in tannin has been reported as injurious and thought to cause abortion in deer. This forage was often a prominent part of the diet for pregnant does, and no harmful results were ever noticed. Careless weed (*Amaranthus*) has also been reported as poisonous, although much liked and used by both livestock and deer when it is succulent.

BREEDING AND GESTATION

The corralled mule deer bred when they were approximately eighteen months old. Breeding began after the first week in December. The earliest record on four does for three breeding seasons was December 10. There was a spread of approximately ten days during which the animals came into their first heat. The length of time between the climactic periods is from twenty-one to twenty-three days; if unbred the does pass through three or four periods and then remain quiescent until the next breeding season. During these periods the does are receptive from a few hours to less than a day. There is little outward sign when they are approaching the heat and very little congestion of the tissues. Records were very rarely missed, however, since the bucks in adjoining pens would become unmanageable with the peculiar type of excitement they exhibit at the time of the rut.

The gestation period is approximately 200 days. The following record on four animals would indicate a high degree of regularity for the individual animal.

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[11] W. J. Pistor, Poisonous Plants on Limestone Areas in Arizona. Manuscript.

[12] G. S. Fraps, Texas Agr. Exp. Sta. Bull. 537, November, 1936.

Animal	1st year	2nd year	3rd year
No. 1	194	193	196
No. 2	204	205	.....
No. 3	200	.....	.....
No. 4	202	201	202

Although Arizona whitetails average about one half the weight of mule deer, the vital-statistic figures on the whitetail are essentially the same as for the larger animal. Only in the time of breeding is there a marked difference. Arizona whitetail deer breed fully a month later than the mule deer. The earliest record was January 10. The second earliest, which more nearly starts the general breeding season, was January 18. If the bulk of the fawn crop is conceived at the first one third of a forty-day-rut period for the whitetail species, it will be seen that the majority of the fawn births will appear the last week in August and the first week in September. If the mule deer were figured on this same basis the bulk of the mule-deer fawns would appear the first two weeks in July. This is not far from right.

There is a difference in breeding between the two species, however, that tends in actuality to produce a wider spread, and the majority of the mule-deer fawns are produced slightly earlier. The reason is found in the fact that a mule deer serves more does during the first period the females are in heat than does a whitetail buck. A mule-deer buck will herd six to a dozen females in his harem, whereas a whitetail will rarely be found with more than three. This naturally means that more whitetail does pass their first climactic period and run to their second and third before they are discovered by the buck. Since only bucks are allowed to be killed in Arizona during the hunting season the bulk of the fawn crop is steadily appearing later in the season. As will be discussed in a later publication,[13] this might even prove beneficial to the species from the standpoint of improved water and food conditions, provided the hunting season on this species was also moved late enough to take it past the time when the majority of fawns are nursing.

For several weeks the does show no measurable increase in the amount of forage they consume. By the end of three months, however, they will utilize a 5- to 7-per-cent increase, and from six months on a 10- to 12-per-cent increase is needed. As pregnancy advances the animals become quieter until a day or two before the fawns are due. They then are exceedingly restless (in the corrals) and upon occasion it has been necessary to liberate certain does from the pens to prevent them injuring themselves. The animals that were given their freedom never went far from the pens. They sought some near-by cat's-claw thicket or grapevine cover and had no objection to returning to the pens with their offspring.

[13] A. A. Nichol and T. Knipe, "Ecology of the Arizona Whitetail Deer," Manuscript of Ariz. Agr. Exp. Sta.

FAWNS

During the time the experimental feeding was being conducted, there were produced by the corralled animals twenty-three fawns. Eleven of these were mule deer, three were whitetails, and nine were hybrids. Of this number, there were nine pair of twins. Of these nine pair, seven pair were buck and doe twins; the other four animals were females. There were two single births: one a mule-deer male, the other a whitetail female. The one set of triplets was hybrid, the buck fawn stillborn, and the two doe fawns weak and sickly. They lived less than a week.

The sexes and the weights (in pounds) of these animals are given in Table 4.

TABLE 4.

Mule deer =	8.1 ♂ 7.4 ♀	7.4 ♂ 7.3 ♀	7.3 ♂ 7.1 ♀	7.4 ♂ 8.2 ♀	7.1 ♀ 7.4 ♀	7.4 ♂
Whitetail =	4.2 ♀ 4.2 ♀	5.6 ♀				
Hybrids: ♂ whitetail + ♀ mule =	? ♂ 7.0 ♀	9.0 ♂ 6.5 ♀	4.9 ♂ 4.5 ♀ 2.9 ♀			
♂ mule + ♀ whitetail =	6.2 ♂ 7.3 ♀	♂ = male ♀ = female				

The single mule-deer fawn was produced by a female that was in very poor physical condition during the breeding season. On the other hand, the single whitetail fawn was out of a doe that was in excellent physical condition and vigor. The male parentage was unknown, however, as the doe had been released on the open range to breed, as there was no whitetail buck available in the corrals.

Fawns of both species approximately double their weight in the first fifteen days. If in good health they will quadruple it in from thirty to forty days. After this the mule deer begin to leave the lighter whitetail behind. As yearlings the mule-deer bucks weighed from 115 to 130 pounds, the whitetail from 60 to 70 pounds.

The fawns exhibited many instinctive reactions. The most noticeable of which were dropping instantly to the ground when frightened, seeking the coolest, darkest place in which to lie down, and placing their noses in the dirt when a fly passed near their head. When only a few days old they also attempted to rub their heel or tarsal glands together (see p. 34). The mothers watched for this action very closely and encouraged it by vigorously licking the glands whenever the young started rubbing them together. As far as the human nose could detect, the fawns did not have any

Plate XI.—Fawns: *1*, whitetail doe, five weeks old; *2*, mule-deer twins, three weeks old; left, buck; right, doe.

body odor, although this condition obviously ceased as soon as the fawns began urinating on their tarsal glands, which they did when a little over a month old.

When the fawns are newborn or very young there appears no dependable way to tell the sexes apart. Often there is a marked difference in coloring, but where the buck may be the darker in one set of twins, the doe may be the darker in the next set. Frequently the buck may be the more robust and vigorous, but the converse may occasionally be true. The only generalization that appeared dependable in the corral-raised animals, and the hybrids were no exception to this, was that the buck fawns showed a decided resemblance to the male parent while the doe fawns could be picked out by their resemblance to their mothers.

Although the young nurse heavily for sixty days, they will begin to forage on grass tips and browse when two or three weeks old. By the end of a month they will manage hard foods such as whole shelled corn, acorns, seedy fruits, and similar foods. Provided the mothers do not object, the fawns will nurse occasionally up to the next breeding season, or approximately five months. The fawn bucks grow small nipples of antlers which do not appear above the hair and which are shed in the spring at the natural time, or when the little animals are around nine months old. They exhibit a strong sex instinct and persistently try to cover the doe fawns when they are only a few weeks old.

The spots disappear from the mule-deer fawns in approximately seventy-five days, and they have an entire new coat by 100 days. With the whitetail the spots disappear more rapidly (in about 60 days), and the new coat is present in eighty days. This difference may be largely a function of temperature as the whitetail fawns do not appear until the heat of summer is past and the temperatures, especially the minima, are much lower than those experienced by the same-aged mule-deer fawns.

HYBRIDS

Seven hybrid fawns were produced from a whitetail male and a mule-deer female cross. The male parent weighed 69 pounds and the females averaged 110 pounds apiece. Of the seven fawns only two survived. In addition to the triplets, which were mentioned, two other fawns were lost because it was necessary to kill the mother at the time of their birth. Hand raising was unsuccessful, as several different methods failed to start any intestinal activity.

The reciprocal cross, a mule-deer buck with whitetail doe, produced two healthy fawns, one male and one female. It was hoped these could be kept and information obtained on sterility, segregation of characters, etc. However, it was necessary to bring the work to an end, and the four hybrids were released on the range. Since they are semitame and may remain in the vicinity, it is hoped additional data may be gathered on them. The offspring of the mule-deer male and whitetail female cross were only a few months old when they were liberated and so did not show plainly what the adult features were to be like. The metatarsal (cannon bone) gland, however, was in size just half way between the two species. This gland on adult mule deer is about 5 to 6 inches long and on Arizona whitetail, much less than an inch. The ears also were in size and contour as near midway between the two parents as it was possible to judge. The tails were whitetail in size, color, and pelage.

On the reciprocal cross (whitetail buck plus mule-deer doe) the metatarsal glands and ears were also a blend of the parentage rather than any segregation. The tails, however, on both fawns were typical whitetail but perhaps a little larger than a true whitetail. The antlers of the buck were true whitetail antlers and in no way resembled the forked processess of a mule deer. In both hybrids the summer coat had the distinctive red color of the mule deer, but the winter coat more nearly resembled the steel-gray of the whitetail. In general conformation the buck fawn showed a likeness to his whitetail sire, while the female could easily be identified by her resemblance to her mule-deer mother.

GLANDULAR ACTIVITY

The time and labor connected with the feeding work did not give as much opportunity to study deer behavior as was desired. Particularly interesting was the phenomena associated with the activity of the external glands of the legs and feet. There are three sets of glands on the limbs of mule and whitetail deer. They are all cutaneous and epidermal in origin. These are the interdigital glands between the toes, the metatarsal gland on the outside of the leg along the cannon bone, and the tarsal or heel gland on the inside and near the joint of the hock.

The interdigital glands are present on all feet. This glandular area forms an oblong sac between the toes. On the little white-

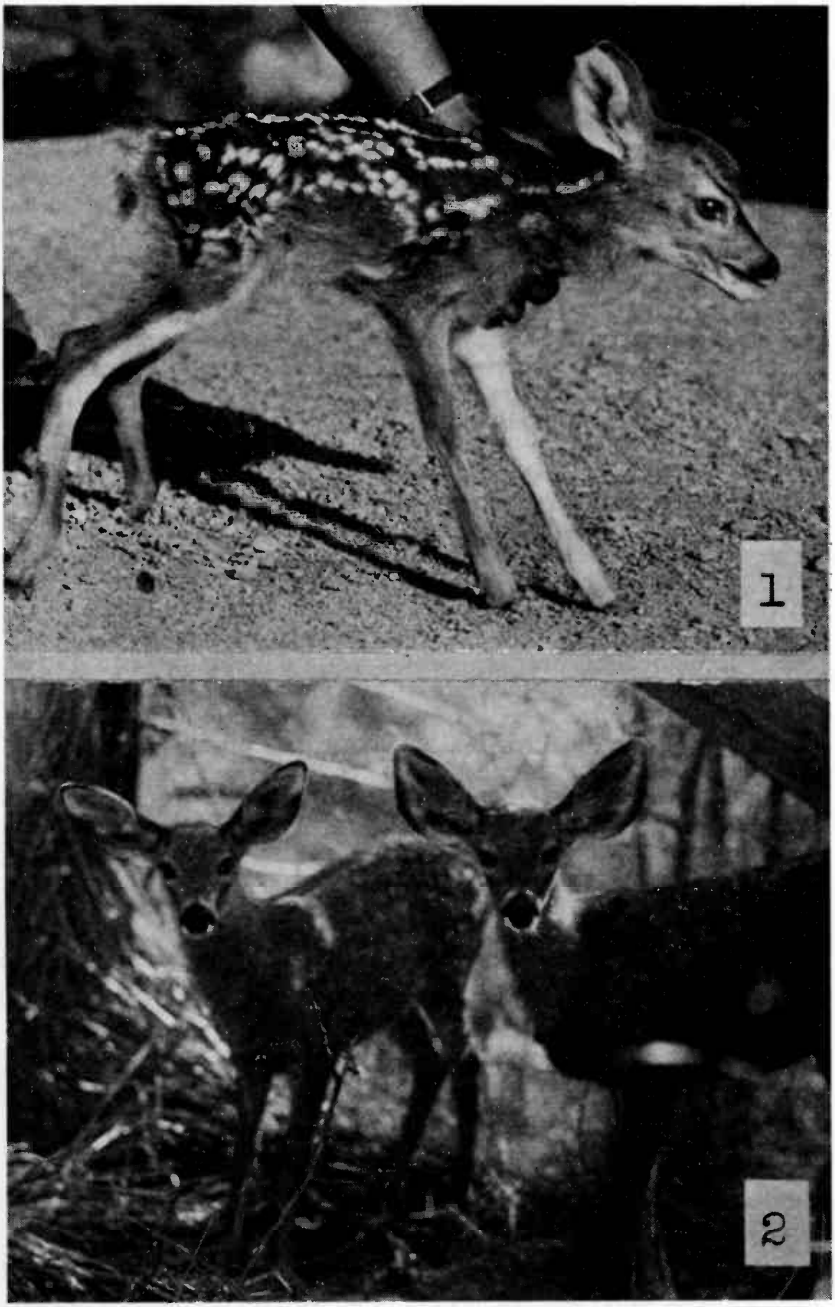

Plate XII.—Hybrids from a whitetail buck and a mule-deer doe: *1*, doe fawn, two days old; *2*, twin hybrids, seventy days old; doe, left; buck, right.

tail it is fully an inch long, while it is approximately one half that size on the larger mule deer. This sac, made by the glandular surface being folded upon itself, contains a few scattering hairs and pellets of a yellow waxy material which has an extremely strong and offensive odor. The opening on the gland lies along the inner edges of both toes. Since it would be impossible for the deer to place its foot on the ground without leaving some of this scent, it appears likely that their function has to do with locating themselves or other members of their species. Since mule deer are much more gregarious than the Arizona whitetail, it is possible that this larger gland on the more solitary animal is significant. Deer liberated from the corrals were invariably observed to find their return way by back trailing themselves. At times they crossed a road which carried considerable automobile traffic. If several cars had been over this road to obliterate their scent, they would become ridiculously lost even though a short way from the corrals. If they could wind the deer in the pens they would cross the road without hesitation, if not it was very difficult to get them away from their last recognized track.

It is argued that marking a trail with this strong and distinctive scent would be detrimental to the individual and the species because of the advantage it gives its enemies. The enemies of deer, however, which depend on scent to locate their quarry are able to follow a trail of animals not intensified by any glandular secretions. Deer depend first on scent, second on hearing, and last on sight. It is, therefore, possible and even likely that the characteristic scent left by the deer is simply a function of the species *for the species* and is a method whereby the communal life of the animals themselves is facilitated.

No information or observations were obtained that would indicate the use or function of the metatarsal glands. Some writers have called attention to the fact that this gland reaches its largest size on species which are gregarious in nature and is very small or absent on species which tend to be solitary. While this correlation exists, it does not yet indicate any theory to the function of the gland. At no time was any observation made on the reactions or behavior of the deer which might lead one to believe the activity of the metatarsal gland was involved.

The heel or tarsal gland on the other hand played a prominent part in the actions and behavior of the deer. Although the outward activity of this structure was readily observed, the fundamental physiology and the stimuli that induced this activity are unexplained. It is also a cutaneous structure, pear-shaped in outline, and covered when quiescent with a dense circle of coarse, stiff hairs. When the deer activate the gland, the surrounding hairs are raised vertically to the surface in a prominent rosette of white, and the glands emit a penetrating odor of musk. Certain people and certain dogs are very allergic to it. An extreme case was one individual who took hold of an animal which had shortly before charged the air with the musk. In the matter of a few minutes his face had become swollen and inflamed, his eyes closed,

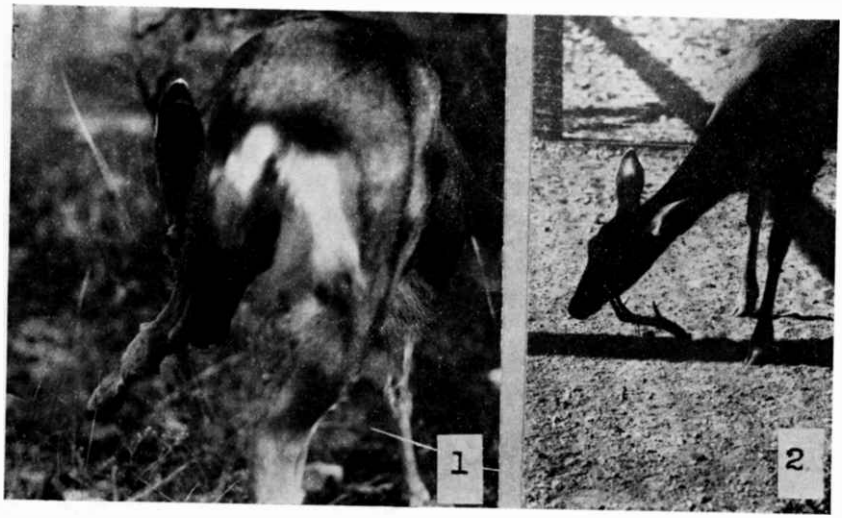

Plate XIII.—*1*, Doe licking tarsal gland. *2*, Whitetail eating old antlers. This is a rare occurrence and only noted with whitetail.

and breathing became difficult. Thirty-six hours passed before the discomfort finally abated.

Does discharge the scent to warn and call fawns, bucks continually do it when in the rut, and all deer do it when dogs are near by or other frightening disturbances take place. Deer lost from the corrals and trying to return called to the herd by this manner, and when the scent reached the pen animals, they would respond. There appears to be individual recognition made by the animals through this medium. A little Mexican red deer (the only individual in the pens of this species) frequently got out and frequently got lost in the early days of the work. He was disliked by both mule deer and whitetail, and although he would signal from outside the pens, and it was observed that the other deer detected the odor, they would not respond as they did when one of their own number discharged the musk.

While this outward activity was readily observed and found to be associated with definite behavior items, there were phases of the activity which are not yet explained. The most striking of these was the phenomenon of urinating on their tarsal glands. While it was always the most nervous animals which would emit the musk odor, it was the least nervous which most frequently urinated on these structures. One hundred and eighty observations were recorded on ten deer during fifteen months. A mule-deer doe and a castrated mule-deer buck were by far the quietest of the herd. This action was recorded for these two forty-two and thirty-three times respectively. During the same period a very excitable mule-deer doe was only observed to do likewise

four times. This doe on the other hand discharged her musk very many times oftener than the others. Mule deer urinate on their glands more frequently than whitetails, but like the mule deer it was the most nervous animals that were the most infrequent.

This action consists in holding the hocks together, then when they are wet with urine they are rubbed against each other, and finally licked with the tongue. Although the fawns start rubbing their glands together when only a few days old, they do not urinate on them for a month or more after birth.

It is evident that there is a direct association between the nervous system and this habit and the activity of the gland. At times the more phlegmatic animals would attempt to wet the glands without success. This apparently upset them considerably because they would repeat the attempt every few minutes until successful. No feasible theory could be advanced, but it was very evident from the behavior of the individual animals that this phenomenon played a very important part in their life and well-being.

SUMMARY

During a three and one half year period thirty-eight deer, native species to Arizona, were fed experimentally to determine the food requirements necessary for growth, maintenance, and reproduction.

It was found that the coefficient 2.35 multiplied by the hundredweight of deer will give in pounds the amount of air-dry forage removed daily by the deer from the range.

Palatability tests were run on 168 different native plants. These tests showed that shrubs make a dependable and substantial part of the deer diet, but that the tree forages, grasses, weeds, and annuals are also very important.

The gestation period for Arizona whitetail and mule deer was found to closely approximate 200 days.

The length of time between climactic periods is from twenty-one to twenty-three days, and there are three to four periods a year.

The Rocky Mountain mule deer in Arizona starts breeding after the first week in December, and the Arizona whitetail starts about the middle of January.

Hybridization under captive conditions is not difficult to effect.

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