Alfilaria, *Erodium cicutarium*, as a Forage Plant in Arizona.

BY J. J. THORNBER.

Tucson, Arizona, May 21, 1906.
UNIVERSITY OF ARIZONA
AGRICULTURAL EXPERIMENT STATION.

GOVERNING BOARD
(Regents of the University)

Ex-Officio,

HON. JOSEPH H. KIEBBY, . . . . Governor of the Territory
R. L. LONG, . . . . Superintendent of Public Instruction

Appointed by the Governor of the Territory:

WALTER TALBOT, . . . . . . Chancellor
GEORGE J. ROSEBUSH, . . . . Secretary
MERRILL P. FERKAN, . . . . . . Treasurer
CHARLES H. BAYLESS, A. M., . . . . Regent

KENDRIC C. BARRACK, Ph. D., . . . . President of the University

STATION STAFF.

ROBERT H. FORBES, M. S., . . . . . . . Director and Chemist
JOHN J. THORNBER, A. M., . . . . . . . Botanist
VINCENT A. CLARK, M. S., . . . . Agriculturist and Horticulturist
ALBERT E. VINSON, Ph. D., . . . . . . . . Associate Chemist
FREDERICK W. WILSON, B. S., . . . . . . . Animal Husbandman
T. D. A. COCKERELL, . . . . . . Consulting Entomologist
G. E. P. SMITH, C. E. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ..
## CONTENTS

**Introduction** ................................. 57  
**The introduction of alfilaria into Arizona** ................................. 29  
**Botanical characters of alfilaria** ................................. 34  
**Other species of alfilaria** ................................. 34  
**Factors favoring growth of alfilaria** ................................. 36  
**Characters of the plant adapting it to the Southwest** ................................. 38  
**Qualities of the seeds** ................................. 40  
**Alfilaria as a forage plant** ................................. 43  
**Alfilaria as a hay plant** ................................. 44  
**Chemical analyses of alfilaria hay** ................................. 45  
**Circular letter and list of questions** ................................. 49  
**Possibility of the general introduction of alfilaria** ................................. 54  
**By sheep** ................................. 64  
**By sowing seed** ................................. 56  
**The collection of alfilaria seed** ................................. 57  
**Summary** ................................. 58
Young plants of Alliaria reduced to one-third size. Most of the leaves and the root portions are cut away. The small rosette below is seven weeks old.
ALFILARIA, ERODIUM CICUTARIUM, AS A FORAGE PLANT IN ARIZONA.

By J. F. Thornber.

INTRODUCTION.

The economic study of the native and introduced plants of Arizona, together with the introduction of other plants more or less promising to the Southwest, has been given an important place among the various lines of range work that have been pursued during the last five years by the Arizona Experiment Station, singly, or in cooperation with the United States Department of Agriculture. Of the introduced plants of our flora that merit especial consideration on account of great economic value, and also that have shown themselves admirably adapted to our peculiar climatic conditions, alfilaria, also widely known as filaree, pin-clover, pin-grass and herod's-bill, easily ranks first.

Alfilaria is a native of the Mediterranean region of the Old World, where it is commonly regarded as a weed. From there it has been spread through the agency of man, over considerable portions of Europe, Asia, Africa, and especially North and South America. Its present distribution may be said to be world-wide, which is an indication of its capacity for adapting itself to the many and varied conditions with which it must come in contact over so great a range.Little mention is made of alfilaria in European works, which may be due partly to the lesser importance it assumes there as a forage plant, especially when growing in the rather permanently green meadows, and partly to the presence of other and more nutritious food plants.

Alfilaria was undoubtedly introduced into the New World by the early Spanish explorers, perhaps as early as the sixteenth century, at points in South America and Mexico and some time later in California. From these centers it has spread, often with remarkable uniformity, to parts far removed from the coasts. Its
abundance and general distribution in the above mentioned regions, together with the numerous and well verified statements that it was as common in California during the early part of the last century as at the present time has caused it to be regarded, proverbially, as a native of the Pacific coast region, which is not at all likely. "Gay, (Historia de Chili, Botanica, tom. prim. p. 388), speaks of Erodium chunterium and E. moschatum as among the best natural forage plants of Chile, and believes them to be indigenous."

Without entering into a detailed discussion here as to the improbability of alfilaria being a native of the Pacific coast region, in addition to being indigenous to the Mediterranean basin of the Old World, the writer quotes from a recent publication by Professor Joseph Burtt Davy, formerly assistant botanist of the University of California, the following:

"Wild oats and alfilaria were not, however, the primitive forage plants, for they also are aliens, natives of the Mediterranean region, their introduction into California probably dating from the Spanish occupation. Being adventive, they, too, must have replaced other plants which were probably native in the sense of not having been introduced through the agency of man or his domestic animals, since we have no records of immigration earlier than that of the Mission Fathers.

"On account of their wide distribution in the State, and their abundance and prevalence in the fifties, many persons have refused to believe that wild oats and alfilaria could be other than native to the soil; even Bolander, writing in the early sixties, was inclined to believe that they must be native alike in southern Europe and California. To anyone who has watched the spread of alien weeds in the rich soil and favorable climate of this State, and has observed one alien gradually giving place to others, the century and a quarter which has elapsed since the Spanish occupation will appear none too short to witness the occupation of the whole State by such prolific plants as wild oats and alfilaria, and the later disappearance of one of both of them by overstocking.

"If the destruction of the most palatable forage plants by selection is constantly going on, how could such palatable species as wild oats and alfilaria ever have become so abundantly naturalized as to be the prevailing plants on the ranges in the relatively short time since the Spanish occupation of California? And if they had at one time been able to estab-

---

lish themselves as aliens, would not the same factor which enabled them to establish themselves prevent their being killed out by pasturing at a later date? Is it not more probable that they are indigenous species which have suffered numerical diminution in the same way as have the wild clovers? Such are the questions asked in this connection. We are not at present prepared to answer them decisively, but to anyone who has watched the spread of introduced weeds in California, especially those of the Mediterranean region, the exotic origin and rapid increase of wild oats and alfilaria will not appear improbable, even in the face of general range deterioration. Usually European weeds find themselves quite at home on the soil of this State, new to them and comparatively unimpoverished. Annual species, especially, spread with great rapidity. If the wild oats and alfilaria were introduced at the time of the Spanish occupation, when cattle were comparatively few in the land, they would have abundant opportunity to 'take' the country in spite of being relished by stock."

While alfilaria is occasionally met with throughout the greater portion of North America, it has become permanently established only in the general territory lying west and south of a line drawn through central Washington and central Texas, embracing portions of these two States and Idaho; besides all of Oregon, California, Nevada, Arizona, New Mexico and Utah; and also Mexico and Central America. This general area is characterized by rather mild winters, combined with more or less fall and winter rains. East and north of the above mentioned line alfilaria occurs, for the most part, about towns, farms, along public roads and on ballast, and plays the part of a very secondary species.

THE INTRODUCTION OF ALFILARIA INTO ARIZONA AND ITS SUBSEQUENT SPREAD.

Alfilaria was introduced into Arizona from California perhaps somewhat before, or at least as early as, the sixties. Col. H. C. Hooker of the upper Sulphur Springs valley writes: "It was here when I came in 1866." Mr. H. S. Gray of Mammoth says, with reference to its occurrence in this same portion of Arizona: "It is to be found in abundance about Old Camp Thomas, thirty miles east of San Carlos. This was the first filaree in Arizona, and remains the farthest east of any importance." The above, from two reliable sources, constitutes the earliest record of alfilaria in Arizona, though it may have been growing in other parts...

previous to this. In the case of its introduction about Old Camp Thomas, it is to be presumed that the seeds were carried there in the coats of animals, especially sheep, or perhaps in feed, from which place it was almost certain to spread over the surrounding mesas.

Alfilaria was observed in small quantity in the northwestern part of Arizona in the vicinity of Hackberry by Mr. William F. Grounds, Sr., as early as 1870, at which date he moved to that place. Mr. Grounds states that this was before any sheep had been driven into that country from California. Previous to moving to Hackberry Mr. Grounds had had experience with alfilaria in California, in the San Joaquin valley, where he writes it was very abundant, being much grazed by stock and also occasionally put up for hay. This latter statement would seem to remove any doubt as to the possibility of his being mistaken in the species in question.

It was about 1870, also, that alfilaria seed found its way into Arizona from California on a considerable scale, principally through the agency of herds. During the early sixties, which preceded by about twenty years the day of the southwestern interstate railroads, a flourishing overland trade was carried on between Arizona and California by means of freighters; hay, food and other necessary supplies, including live stock, being brought in to the frontier mining camps, ranches and forts, and valuable mineral products hauled out. One of the most noted of these freight and stage roads, which is still in existence, though little used now, and which was at that time the principal thoroughfare between California and Arizona, began at Dos Palmas, now on the Southern Pacific railroad, and proceeded eastward into Arizona, crossing the Colorado river at Ehrenberg, then a freight station and steamboat landing of importance. From Ehrenberg it continued in an easterly direction by way of Tyson's Wells, Cullin's Wells and Harrisburg to Wickenburg, from which place roads led directly or indirectly to Congress, Date Creek, Prescott, Phoenix, Florence, Tucson and other territorial centers, in addition to numerous military posts.* It was along this remarkable

---

highway, during the years 1870 to 1872, that alfilaria appeared in noteworthy quantities in western Arizona. The feeding of freighting and stage teams along the road from day to day, either at the relay stations or in open country wherever overtaken by nightfall, undoubtedly played a part in this remarkable plant introduction.

Fig. 1. Map of Arizona showing introduction and spread of Alfilaria as indicated by old freighting routes, and arrows.

By far the most important factor, however, though an indirect one, was the disastrous drought which continued to pre-
vall over southern California during 1870 and 1871, and which necessitated the driving out, at the point of starvation, of many large herds of sheep and other animals. The virgin mesas of the young and promising Territory lying to the east afforded timely relief, and in addition, offered large areas for ever increasing flocks; thus droves of sheep, carrying in their wool a supply of alfilaria seed from southern California mesas, over which the plant had been growing for more than a half-century, found their way first to adjacent districts, as Date Creek, Wickenburg, Prescott and Phoenix, and later to Kingman, Dripping Springs valley, Oracle, Cave Creek and other farther removed points to the north and east. Accordingly, the appearance of the plant in considerable quantity along these well traveled highways, or in their vicinities in so short a time, is not to be wondered at.

Mr. H. S. Gray of Mammoth, mention of whom has already been made, says that alfilaria was abundant at Ehrenberg twenty-five or twenty-six years ago, and also at Wickenburg as early as 1874 or 1875. Mr. J. I. Bachtiger, an old time resident of Wickenburg, writes that it appeared at Date Creek, where sheep were first driven in from California, during the period 1870 to 1872, and at Wickenburg two or three years later, which fully confirms Mr. Gray's statements. Mr. Bachtiger further states that from the Date Creek country it spread, by the agency of sheep, throughout Yavapai and Maricopa counties and the northeastern portion of Yuma county. Mr. Wm. L. Griffiths, of Tucson, formerly of the Dripping Springs valley, which is on the north side of the Gila river, and about twenty-five miles south of Globe, writes that he first noticed alfilaria there during the years 1876 to 1878. It was about 1878, also, that it appeared in the neighborhood of Kingman, notably in the Sacramento valley lying to the west; and near Prescott and Phoenix,—three widely separated localities. From Kingman and Hackberry it was spread over considerable portions of northwestern Arizona, where it was noted as more or less abundant in 1880 by Mr. M. E. Jones, of Salt Lake City, Utah. From the points of introduction already mentioned, and in all probability others, alfilaria was carried north and east throughout the entire Tonto Basin country and portions of the San Carlos Indian reservation, where sooner
or later it would meet with the alfilaria invasion from Old Camp Thomas. About this time, also, it was noted in the vicinities of Oracle, Florence, Dudleyville and Mammoth. The appearance of alfilaria about Oracle may be cited as a typical case of its introduction and spread under favorable conditions. Two Frenchmen, in 1873, drove a herd of sheep from California into a small canyon known as Canada del Oro, a few miles south of Oracle. Some years later, after the sheep had been taken away, alfilaria was observed to be quite abundant in this little canyon and in its immediate vicinity, where the herd had been grazed. From this beginning the seeds have been spread by other flocks of sheep, especially those belonging to the Bayless and Berkalew Company, so that the entire country about Oracle has come to be a veritable alfilaria patch and one of the best sheep ranges in the Territory. Just recently alfilaria has been reported abundant on the mesas in the vicinity of Safford, which appears to be an invasion of the plant from Old Camp Thomas lying thirty miles to the northwest.

According to Mr. Hugh Anderson of Flagstaff, alfilaria occurs in considerable abundance on the north side of the Verde valley, which has, naturally, a southern exposure. It also occurs sparingly about sheep ranches in the vicinity of Flagstaff, where, on account of the rather severe winters, occasioned by higher altitudes, it grows principally during the summer season. Mr. C. E. Howard of the Howard Sheep Company at Ashfork, writes as follows: "We have no alfilaria here to speak of ... I suppose the altitude is too high for it." Mr. M. E. Jones, of Salt Lake City, writes also: "It occurs sparingly from the Little Colorado river to Utah, and in the Moqui Indian region."

Alfilaria is by no means confining itself to its present distribution. Mr. S. A. Howe, of Tonto Basin, states that it is gradually moving north across the Mogollon mountains, in the direction of the Little Colorado river; and from almost every other locality in the Territory where it has secured a reasonable hold, it is reported as becoming not only more abundant, but also as spreading over larger areas from year to year. Scattered patches, of a few hundred acres in extent, have been noted in other parts of the Territory, especially where sheep have ranged, which, as will be seen later, is wholly in accord with its means
of introduction. Of these sporadic patches one has been observed south of Bowie, one between Tucson and Vails, one north of Pantano station in Happy valley, and one or more in the Arivaca country where the seed was introduced by Mr. N. W. Bernard of Tucson. Finally, it may be said that there is scarcely a locality in the country where at least occasional plants are not to be found, which are increasing in numbers from season to season.

BOTANICAL CHARACTERS OF ALFILARIA.

Alfilaria is known, botanically, as *Erodium cicutarium* (L.) *L’Her.*, being a member of the geranium family, *Geraniaceae*, a group of plants which finds its maximum development in Western Africa. The genus *Erodium* consists of fifty or more species of plants, nearly all of which are herbs, indigenous to the Mediterranean region of the Old World, though a few occur in temperate and tropical America and in widely separated parts of Asia. At least one species, also, occurs in Western Australia. Alfilaria, or *Erodium cicutarium*, is a hairy, slightly viscid, erect or ascending herbaceous winter annual, six to eighteen inches in height. During the winter period it forms a relatively large, compact, many-leaved rosette which commonly attains a diameter of ten to twelve inches. Its leaves are opposite, or alternate, and pinnate, the divisions being finely dissected nearly to the mid-vein. Its lilac or purple flowers, with parts arranged in fives, are produced in axillary, stalked, several-flowered clusters or umbels. In fruit the five styles of the flower elongate conspicuously, become hairy on the inside, and at maturity dehiscent, i.e., separated into definite parts, and twisted spirally, the seeds at the lower ends of the styles becoming in the meantime sharp pointed at their bases. The plant possesses, generally, a pronounced, musky odor.

Other Species of Alfilaria.

Seven other species of *Erodium* occur in the United States, four being natives of the Mediterranean basin of the Old World and three indigenous to the Pacific coast region. Of the introduced species, musk filaree or musk clover, *Erodium moschatum*
Musk filaree is common in the Pacific coast country, from southwest Oregon to Mexico, and, as noted heretofore, in Chile. In western, middle California it is one of the commonest plants of the rich lands of valley orchards and vineyards. Professor E. W. Hilgard, Director of the California Experiment Station, says of it: "On account of its distinctly musky flavor, *E. moschatum* is eaten only in limited quantity, so that a pasture once over-run with the musky species ceases to be of much value. In heavy rich soils the valuable species, *E. cicutarium*, is often completely run out by the musky species."

Within the last month the writer has observed musk filaree growing in north Tucson, about the home of Dr. W. A. Cannon. Dr. Cannon is of the opinion that the seeds found their way here in alfalfa hay being fed by him, which was shipped in from California. While musk filaree has not been reported from other parts of Arizona as yet, it may be expected at any time in our alfilaria belt, very likely occurring in some parts now. In addition to its pronounced musky odor and more robust appearance, its sepals, leaflets and stipules are noticeably larger; also, the sepals are destitute of terminal hairs and the leaflets are less finely and deeply divided than in our common species.

*Erodium botrys* was scarcely known in California fifteen years ago. Within this period, however, it has become common in many localities from San Francisco northward, spreading with unusual rapidity over low pasture hills and gravelly plains. The following clipping, entitled "A Poor Kind of Alfilaria" is taken from a leading agricultural journal of California:

"This alfilaria may be distinguished from the two common species by the leaves, which are merely lobed, the lobes being toothed. *Erodium botrys* is a new-comer and was introduced from the Mediterranean region only a few years ago, but is rapidly spreading in some parts of California, particularly in the grazing districts of Marin and Solano counties, where it is..."
occupying the land to the exclusion of other and more important forage plants. It does not ordinarily grow in the same situations as the red-stemmed flax or the musk flax, but prefers low, rolling hills and pasture lands where it crowds out the more valuable grasses. As a forage plant its value is almost nothing. Its leaves hug the ground so closely that cattle do not get them; and the flower-stalks, although erect, are nearly destitute of foliage. Its further spread should not be encouraged, even in southern California where, on account of the long, dry summers it is likely to give the least trouble.1

Of the native species already noted, the Texan alfilaria, *Erodium texanum* Gray, is the only one occurring within our borders. It grows quite generally throughout the southern half of Arizona; never in sufficient quantity, however, to add materially to the floral covering. Its flowers and seeds are quite similar to those of the red-stemmed alfilaria, though it may be recognized easily by its fine, gray or ashy, appressed pubescence and its rather deeply lobed ovate or heart-shaped leaves. It appears most abundant over clayey, gravelly plains and foothills, but even here it is devoid of any tendency to become a controlling factor in the flora, and hence always ranks as a very secondary species.

FACTORS FAVORING THE GROWTH OF ALFILARIA.

The conditions which influence most the growth of alfilaria in Arizona, and generally in the southwest, are, (1) mild winter temperatures, (2) winter precipitation, (3) altitudes as influencing precipitation and temperature, and (4) to some extent soil conditions. The winter rains in Arizona differ from those of the summer period in that, normally, they are heavy, of considerable duration and quite general in distribution, as compared with the local, showery character of the latter. They begin as early as November, though commonly later, and continue frequently until well into April. Like the summer rains, they are, unfortunately, not to be depended upon from year to year, and hence we may pass an entire winter season without precipitation.

The amount of winter and spring rainfall necessary to produce a good growth of alfilaria ranges perhaps between five and seven inches, which is not far from our common allotment dur-
ing moderately wet seasons. Two or three inches of rain from December to February, inclusive, is sufficient to start the plants to grow, and winter them over in good condition, after which time there should be rains of a half-inch or more during March and April. Precipitation in excess of the above, especially during the spring months, makes possible a heavier growth both of alfilaria and the native species. The abnormally heavy rainfall of the winter and spring of 1905 induced one of the heaviest growths of alfilaria in Arizona, on record.

During the delightfully mild winters which are characteristic of the Southwest, the temperature ranges for the most part far above freezing though falling occasionally at night five to twenty degrees below that point. Accordingly, the seeds of alfilaria, in common with those of a number of our native species, that is, the winter annuals, are able to germinate and grow, when there is sufficient moisture in the ground, at practically any time during the winter season.

As concerns elevation, alfilaria appears to grow best between the altitudes of 1,500 and 4,500 feet. The plant is virtually excluded from those areas lying much below a thousand feet, on account of the greatly reduced rainfall; while above five thousand feet the winter temperature is usually severe enough to prevent its growth until the spring and summer months. The writer saw alfilaria on the White Mountain Indian reservation, between Fort Apache and Cooley's station, also in the vicinity of Cibicu, August, 1905, growing sparingly as a summer annual at altitudes of 5,500 to 6,500 feet. Under these conditions, however, it loses its identity among the numerous taller-growing species and ceases to be of value as a forage.

Little is known, as yet, concerning the various soils in which alfilaria will grow; practically, it seems to thrive in any soil that is not manifestly alkaline. In common with other species of Erodium it has a tendency to spread over gravelly, clayey slopes, —a condition easily met with in many parts of Arizona. The writer has noted its successful growth in calcareous soils, in sandy mesa soils, in alluvial clays of valleys and washes, in mechanically decomposed granite soils (arkose soils) and gravelly, iron-stained clays, the two latter common about Oracle.
It also occurs in mesa clay, an interesting modification occurring in swales and other depressions. In the vicinity of Oracle, in the spring of 1905, among shrubs, over rat and gopher mounds and other small areas where the soil had been loosened also in canyons, valleys, and broad swale-like depressions, it frequently attained a height of eighteen inches, forming such a heavy, matted growth as to break down under its own weight. In the same region, on red, clay-like, gravelly hills and in-

![Figure 2: Aftilaria growing among shrubs in gravelly, iron-stained clay soil. The situation is most unfavorable.](image)

clines, its growth, though quite continuous, was only about one-third to one-half as heavy.

**CHARACTERS OF THE PLANT ADAPTING IT TO THE SOUTHWEST.**

The ease and rapidity with which aftilaria has been able to get possession of large areas in Arizona and other portions of the Southwest, to the practical exclusion of the native annual species growing under the same conditions, indicates that it is admirably

*Name suggested by Prof. C. E. Tolman, Geologist, University of Arizona.*
adapted to our peculiar environment. From numerous accounts it is at this time more abundant, more generally distributed, and apparently more at home over large portions of the West and Southwest than any other introduced species.† In those parts of Arizona where it has become established it is by far the most predominant annual plant during its period of growth.

As already stated, alfilaria begins to grow in the late fall or winter months, which is a season when moisture conditions are

Fig. 3. Nearly continuous growth of alfilaria over gravelly, rolling mesas at 4000 feet altitude. The soil is mechanically decomposed granite.

most nearly uniform, owing to the greatly reduced surface evaporation. During this rather favorable period the small plants pass quickly through the critical seedling stage, developing immediately into compact, many-leaved rosettes, which lie flat upon the ground, thus securing for themselves a maximum exposure to heat and light, in addition to very desirable protection from animals. The rosettes continue to grow slowly during colder

winter weather by increase of leaf surface and development of a rather deep, thick taproot, numerous flower-buds forming, in the meantime, at their centers. The flowers begin to appear with the first warm days of late winter; they are soon followed by several vigorous ascending stems from each plant, which growth continues until April or May. Plants growing on the University grounds, and favored with a southern exposure, produced the earliest flowers this year on the 19th day of January, and matured seeds six weeks later. Obviously, alfilaria plants have a decided advantage over others that begin growth later, in that they have well developed root and leaf systems in the early spring to begin with, thus enabling them to get a much earlier start and mature seeds before a possible drought may set in. Also in virtue of its deep taproot, the plant can withstand, longer than most of the native annuals, the unfavorable effects of a dry period. Annual plants, commencing growth in the fall or winter, are called winter annuals, of which there are numerous examples in the southwestern flora, as, the mustards, borages, evening primroses, plantains or Indian wheat, and many Composites.

**Qualities of the Seeds.**

The splendid adaptation of alfilaria seeds has undoubtedly contributed much to the success of the plant. They mature during the spring months and pass the hot, and for the most part, dry summer in an apparently unchanged condition, even with the presence of any considerable amount of moisture. All attempts to germinate them, together with the seeds of a number of our commoner winter annuals, during the summer months, failed.

The seeds taper from above, to a slightly curved and sharpened base, and are clothed with an abundance of brown hairs which are longer below and so disposed as to aid them to stick to and penetrate the furry coats of animals, thereby insuring for the plant a very general distribution. The awns, which are one inch or more in length and spirally twisted below, are hygroscopic, rolling and unrolling with the changes of moisture in the atmosphere from day to day. In virtue of this adaptation a good percentage of the seeds literally plant themselves, the stems.
composing the plant covering, acting as fulcrums against which the coiling and uncoiling awns brace themselves, which action forces the seed into the ground. Thus the seeds escape the fate common to those of many of the native species, namely, of being blown away by the winds or washed away by the torrential summer showers.

This planting is more readily accomplished in the deeper and richer soils of valleys and swales, where the floral covering is heavier and more continuous. Nevertheless, the writer observed the beds of numerous arroyos and abandoned roads in the vicinity of Oracle, into which depressions the seeds had collected in tangled masses or windrows, planted so thickly in spots as to present a brown, furred appearance from the presence of the innumerable awns, which alone remained exposed, and as yet, had not separated from the buried seeds. This interesting observation explains fully the rather striking and unexpected occurrence of occasional matted patches of alfilaria in stony, abandoned road beds, arroyos and other similar situations least calculated for the growth of an annual species. These small, rank-growing patches contrasted so sharply with their immediate surroundings in the landscape as to be subject to comment from the resident and the occasional passer-by, divers speculations being offered as to their origin.

In order to study with more than usual care the ecological features attending them, the writer camped for several nights in their immediate vicinity. At the close of a dry, hot day the seeds were seen to have their awns coiled tightly in the characteristically spiral manner, thus giving a nominal coherence to the seed masses. The next morning at four o'clock, the formation of dew having been quite abundant during the rather cool night, the awns were observed everywhere to be uncoiled, straight and pliable from the large amount of moisture taken up, so that the heretofore tangled seed-mass could be separated readily now and appeared as so much finely chopped, discolored hay. With the first increase of the day's heat, the excess of moisture being gradually taken up again by the atmosphere, the characteristic, hygroscopic movements of the awns became apparent, at first slow, but later very active, thus giving to the seeds
composing the mass curious twisting or writhing movements. Toward noon, the moisture being dissipated again, the movements came gradually to a close, leaving the bunches of seeds in apparently the same condition in which they were found on the previous afternoon. Thus the process continued from day to day, with the result that the planting of the seeds under the mats was quite complete. Occasionally, also, the work is finished by passing showers, whose flood-waters, collecting in these depressions, cover from view both seeds and awns with rich sediments. Further observation demonstrated that as a result of the intermittent hygroscopic movements, the seeds, if spread out over the ground in a uniform layer, tended to be pulled together into heaps, unless prevented by a more or less continuous covering of vegetation, which, taken in connection with the wind's action, explains their grouping together and occurring commonly in depressions. The above observations have been verified, as far as possible, by a series of laboratory experiments under essentially like conditions.
Wherever alfilaria has become abundant in a vicinity it has doubled the spring forage supply, without interfering in any way with the later growth of summer species, chief of which are the grasses. Once established in a region, it requires no special effort on the part of the rancher to insure its growth from year to year, provided it is not grazed to the extent of seriously interfering with its seed production, which is not likely in a country with an unlimited grazing area and with a necessarily limited number of range stock.

Stockmen everywhere speak in the highest terms of it as a forage plant. All kinds of range stock eat it from the time its succulent and nutritious rosettes attain any considerable size, in February, until late in June, when usually the last remnants of the dried, broken and discolored stems, and the occasional matted bunches of awned seeds, are eaten from among the rocks and shrubs. While relished by all kinds of stock, it is for obvious reasons the forage plant par excellence for sheep. With a seasonable rainfall, and the occasional browse at hand, it supplies them with a nearly continuous feed from February until June, after which time the summer species appear. In virtue of their capacity for close grazing, sheep are able to nibble its flattened leaf-tufts, or rosettes, some little time before the other range animals. During the lambing season, especially, alfilaria furnishes for ewes and lambs an unexcelled supply of nutritious and succulent forage. Dr. L. Trabut, government botanist of Algiers, in which country the plant is indigenous, writes as follows concerning sheep grazing it: "Erodium cicutarium is quite widespread in our region, where it presents a great number of varieties. It forms rosettes which lie close to the ground, and is much eaten by sheep."

The fact must not be lost sight of, however, that sheep grazed over an alfilaria country are certain to get a large amount of the seeds in their wool, thereby reducing its value one to one and a half cents a pound. So far as the southwestern sheepman is concerned, he has ordinarily to choose between an ample supply of alfilaria feed and the sparse and less certain native forages.
Mr. C. H. Bayless, who owns a large sheep ranch in the vicinity of Oracle, and who is a stockman of wide experience, says that this loss in value of wool is reduced to a minimum by shearing twice annually, that is, in March and September, in which case the second clip will contain practically all the seeds.

**ALFILARIA AS A HAY PLANT.**

Alfilaria is used to a limited extent for hay, though for this purpose it is employed only as a temporary makeshift, and, of course, is not depended upon from year to year. As early as 1890 alfilaria hay was put up in the Dripping Springs valley and also in other parts of the Territory. Mr. Bachtiger of Wickenburg, writes that he has fed it from time to time for fifteen years, and that last year (1905) he put up fourteen tons, cutting it when in blossom and otherwise treating it as he would alfalfa hay. Mr. Bachtiger is of the opinion that, when properly cured, it is equal to alfalfa hay for milch cows. As a hay crop the growth of alfilaria is limited to the richer soils of valleys, swales, and similar.
favorable areas, where, as already stated, it produces a heavy, continuous growth twelve to eighteen inches in height. In such situations, in 1905, between Oracle and the Tortillita mountains, it produced at the rate of one and a half to two tons to the acre. It must be noted, however, that these heavy yields obtain only in the more favorable situations, and that they are not to be expected over any considerable area. Under ordinary conditions, perhaps a ton and a half of hay to the acre would constitute a fair yield.

The ordinary method of harvesting alfilaria hay, if such it may be called, is indeed primitive, and will undoubtedly be improved as its use comes to be more general. The crop is allowed to remain on the ground during the late spring months until thoroughly dried, when the broken, fragile and discolored stems, which are destitute of leaves and seeds, are gathered into shocks and stacked, or rather, piled up. It goes without saying that such hay has lost, to a very great extent, its value as a feed. It must be apparent to all that if the crop were cut in full blossom and properly cured, both the quality and the quantity would be raised by the addition of the nutritious leaves, young stems and seeds, at the same time avoiding the detrimental effects incidental to long weathering. With a good horserake and a crib hayrack two persons would be able to put up several tons a day, provided the hauling distance is not great; while with the ordinary crude appliances that are made use of, perhaps a thousand to twelve hundred pounds represents a day's work for one man. It is interesting to notice to what extent all kinds of stock relish alfilaria hay, even when more or less broken up, discolored and otherwise uninviting. The University horse, which has the reputation of being a well-fed animal, ate more readily of it than of his daily allowance of alfalfa hay, which may have been due, in part however, to a change of feed.

CHEMICAL ANALYSES OF ALFILARIA HAY, WITH DISCUSSION.*

The following analyses of alfilaria were designed to study the relative composition of this plant in both the green condition and as hay. The sample of Arizona grown alfalfa represents the

* By A. E. Vinson, Associate Chemist, Arizona Experiment Station.
average of two analyses made at this Station, and is given here as representative of our best native hay. The protein in this alfalfa is slightly lower than the average for other parts of the country, which is 14.3 per cent for twenty-one samples. To facilitate comparisons, all the analyses have been reduced to a dry basis; although a succulence in a feed has an undeniable value, especially under our conditions.

In Original Samples.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture</th>
<th>Ash</th>
<th>Protein N x 6.25</th>
<th>Crude fiber</th>
<th>Nitrogen-free extract</th>
<th>Ether extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1. Alfalfa in seed</td>
<td>81.55</td>
<td>3.52</td>
<td>2.96</td>
<td>4.46</td>
<td>7.82</td>
<td>0.39</td>
</tr>
<tr>
<td>No. 2. Good hay from Wickenburg</td>
<td>8.88</td>
<td>13.30</td>
<td>13.40</td>
<td>20.56</td>
<td>41.58</td>
<td>2.20</td>
</tr>
<tr>
<td>No. 3. Alfalfa in rosette stage</td>
<td>85.84</td>
<td>2.48</td>
<td>3.99</td>
<td>1.89</td>
<td>5.98</td>
<td>0.42</td>
</tr>
<tr>
<td>No. 4. Damaged hay from Oracle</td>
<td>11.60</td>
<td>11.26</td>
<td>7.78</td>
<td>27.97</td>
<td>38.56</td>
<td>2.16</td>
</tr>
<tr>
<td>Alfalfa hay, Experiment Station farm</td>
<td>6.60</td>
<td>6.34</td>
<td>11.61</td>
<td>34.73</td>
<td>38.95</td>
<td>1.71</td>
</tr>
</tbody>
</table>

In Water-Free Material.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Ash</th>
<th>Protein N x 6.25</th>
<th>Crude fiber</th>
<th>Nitrogen-free extract</th>
<th>Ether extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1. Alfalfa in seed</td>
<td>per ct.</td>
<td>per ct.</td>
<td>per ct.</td>
<td>per ct.</td>
<td>per ct.</td>
</tr>
<tr>
<td>No. 2. Good hay from Wickenburg</td>
<td>19.04</td>
<td>12.37</td>
<td>24.18</td>
<td>43.85</td>
<td>2.11</td>
</tr>
<tr>
<td>No. 3. Alfalfa in rosette stage</td>
<td>14.50</td>
<td>22.56</td>
<td>45.62</td>
<td>242</td>
<td></td>
</tr>
<tr>
<td>No. 4. Damaged hay from Oracle</td>
<td>17.55</td>
<td>28.16</td>
<td>9.85</td>
<td>41.50</td>
<td>2.94</td>
</tr>
<tr>
<td>Alfalfa hay, Experiment Station farm</td>
<td>13.50</td>
<td>31.64</td>
<td>43.61</td>
<td>2.45</td>
<td></td>
</tr>
</tbody>
</table>

No. 1. Pulled by the roots April 29, 1905; mostly in seed but still flowering.

No. 2. Taken from haystack at Wickenburg as it came. Cut slightly past maximum flower; dried, raked and stacked; not rained on or otherwise damaged; delivered in canvas bag to prevent loss of leaves. Hay of best quality.

No. 3. Rosettes just previous to blossoming, four to eight inches in diameter, cut from the root at crown.

No. 4. Dried, exposed and damaged hay, composed almost exclusively of stems, from Bayless' sheep ranch.
Considering the analyses as a whole, we are at once impressed by the high percentages of ash in all samples of alfilaria. This is, however, nothing unusual for uncultivated plants of the arid regions. The great amount of transpiration carried on by them causes an accumulation of salts in the stalks and leaves, which is further increased by the fine sand blown by the winds into the flower heads and other parts, where it remains until eaten by stock. From the standpoint of animal nutrition, this indigestible extraneous matter must be regarded as a component part of the feed; therefore, no determinations of pure ash were made. Considerable quantities of such sand could be recognized by testing the ash between the teeth, and has, of course, the effect of lowering the percentages of the other constituents. Alfilaria is, however, per se, a plant rich in mineral matter, and should tend to produce strong, healthy bone in growing animals.

The ether extract, commonly known as fat, is fairly uniform in the dry matter of all the samples, and is in all cases higher than in alfalfa. It appears to be slightly less than that of most varieties of hay. All animals require some fat in their daily rations, but the ether extract of fodders in general, containing large amounts of coloring matter and resinous substances has not the same value as that found in grain and the concentrates, which is more nearly pure fat.

The protein content of alfilaria is very high and compares favorably with hay from the legumes. The Wickenburg sample shows about the same amount of protein as red clover hay of the North. In the rosette stage we find an unusually high per cent of protein, but, as is the case with all young, rapidly growing plants, this protein is partly represented by amide compounds, which give an apparently high result, but do not have the nutritive value of true protein. Their effect, however, is often believed to be very favorable on milk production, as is experienced when feeding "June grass" and malt sprouts, both of which are rich in amide compounds. Furthermore, the protein of young plants is much more digestible than that of old ones, in which it exists to a large extent as indigestible nuclein. Likewise a hay that is well cared for, as the Wickenburg sample, contains more nutrients and is more digestible than one that has
been rained on or has lost its leaves, seeds and more tender parts, as is the case with No. 4. Experiments have been carried out with alfalfa, which show that the actual crop of hay was reduced from 100 per cent to 86.7 per cent, and the protein in this hay from 8.3 per cent to 7.9 per cent by a moderate rain. The fibre increased from 24.8 per cent to 28.6 per cent. In another case 67 per cent of the protein of an alfalfa hay was digested by stock when the hay was well cured, but the protein of the same hay, after exposure to a moderate rain, was only 58.2 per cent digestible. Thus hay exposed to the weather, as is the case with No. 4, suffers three losses: the yield per acre is lessened, the composition of the hay is unfavorably affected, and less of the nutrients which remain are assimilated by the animal; therefore such hay is less valuable.

The crude fibre in all samples is very moderate, even that from the dried, weathered stems of No. 4 is not higher than in good timothy hay, and is considerably less than our average for alfalfa. We always desire to have the fibre as low as possible, for while it ranges from 20 to 100 per cent digestible, it has been shown by actual experiment that the energy which the animal derives from it is not greater than that required for its mastication and digestion, which is really only a fermentation carried on by bacteria. In general, the older the plant the more fibre and the lower its digestibility. The small amount of fibre in the young rosette stage, No. 3, we should expect to compare favorably in digestibility with that of the root crops, namely, upwards of 90 per cent. In judging a feed, however, we must not forget that each particular class of animals requires a certain amount of indigestible matter, known as ballast, within which range we must stay for the best results. If the maximum is passed, as would be the case in feeding straw alone, the animal can no longer handle sufficient to supply its daily needs; while, if the minimum is not given, as would be the case in feeding concentrates alone to ruminants, digestive disturbances would set in.

The nitrogen-free extract, also known as carbohydrates, is, per excellence, the energy and fat producer. In this respect al-

1 Maerker, Futtervergleiche, 8. Fol.
filaria shows about the same per cent in the dry matter throughout the various stages; but, as with the protein and fibre, its coefficient of digestibility would undoubtedly show wide variations,—more digestible in the young and tender, less so in the old and woody material. Considered as they stand, we should expect alfilaria of good quality to equal hay of similar quality from any other source in fat producing effects.

In summing up the samples we notice at once that Nos. 1 and 2 are approximately the same material in the green condition and as first-class hay. They show no noteworthy variations, although grown on rather widely separated areas. The material represented by No. 3, the rosette stage, is reputed by ranchers as being an excellent growing feed, but does not put on flesh like Nos. 1 and 2. Without a more detailed study we should not like to venture an opinion as to the reason, unless it be that the more scanty growth of the rosette, together with its higher percentage of water, requires more hustling to obtain the necessary feed. Activity is always opposed to laying on flesh, while rest is highly favorable. The similarity in composition of young alfilaria to rape suggests that it should prove as valuable as the latter plant in the northern States for "flushing" ewes after the lambing season is over. The results for No. 4 show that this is not a desirable method of preparing alfilaria hay, but the material is apparently well worth raking together and feeding if needed. If our suppositions as to the digestibility of alfilaria are correct, it should take a place among our best hay producing plants, especially as the other very important feature, the way in which stock take to it, has been favorably answered in practice.

**Circular Letter and List of Questions.**

In order to secure as nearly as possible an impartial and accurate expression from the standpoint of the rancher, with reference to alfilaria as a forage plant, the writer mailed a circular letter containing a list of questions to a number of stockmen and others interested in ranges, living in different parts of the Territory. In addition to having witnessed its introduction and spread over considerable portions of Arizona, many of these stockmen have had twenty to thirty years of practical experience with it on
the ranges; accordingly, their testimony is entitled to most care-
ful consideration, and is, in a way, to be regarded as final. The
above mentioned letter and list of questions need no explanation
in their reproduction below.

TUCSON, ARIZONA, October 13, 1905.

Dear Sir:

Enclosed please find a list of questions relating to alfilaria. The Ar-
izona Experiment Station desires to obtain further information from the
experience and standpoint of the rancher, concerning this promising forage
plant in Arizona, and will be pleased to have you answer as many of
these questions as you can at your earliest possible convenience. Any
other information that you can send relating to alfilaria will also be wel-
come. Enclosed find stamped, addressed envelope with which to send
answers. Shall be pleased to hear from you soon.

Very truly yours,
(Signed) J. J. THORNBER,
Botanist, Ex. Station.

1. When did alfilaria first appear in your country?
2. Has it been spreading since that time?
3. Is it becoming more abundant from year to year?
4. So far as you know, how was it introduced into your country?
5. At what elevations does it grow best? In what kinds of soil?
6. To what extent does it occupy the land to the exclusion of most
native annual species?
7. From observation do you know of the presence of alfilaria in con-
siderable quantity in other parts of the Territory?
8. How much rain is necessary, and when should it come in order t<
produce a fair crop of alfilaria?
9. How do you regard it in the green state as a sheep, horse and cat-
tle feed? How do stock relish it? Do stock eat the seed?
10. What is your opinion of alfilaria hay as a feed? Do stock eat it
after it has lain on the ground for several months?
11. How much alfilaria hay would you consider a good yield from an
acre?
12. What experience have you had with putting up this hay?
13. Have you observed any means that encourage the spread of the
plant over the country?
14. Have you tried to introduce it in your country by sowing seed?
With what success did you meet?

The answers to the above questions, with occasional ex-
ceptions, are remarkably uniform throughout. Of the rather
large number of letters received, only two have been selected for
publication, since these are quite complete in themselves and
represent the consensus of opinion regarding alfilaria in widely separated parts of Arizona. The reproduction of others would be, in large measure, a repetition of what has already been said, thanks to their similarity. Valuable information concerning various phases of the alfilaria question has been obtained through interview or correspondence with the following persons residing in Arizona: J. H. Durham, Redrock; H. S. Gray, Mammoth; William M. Griffith, Tucson; William F. Grounds, Sr., Hackberry; C. E. Howard, Ash Fork; S. A. Haught, Rye; Col. H. C. Hooker, Willcox; J. D. Marlar, Phoenix; D. J. Peter, Phoenix; W. M. Marteny, Arivaca; M. G. Samaniego, Tucson; J. V. Vickers, Tombstone; George Pusch, Tucson; Hugh Anderson, Flagstaff; John I. Bachtiger, Wickenburg; C. H. Bayless, Tucson; Herbert Brown, Yuma; William C. Blakeley, Kingman.

The following letter was written by Mr. William M. Griffith, formerly of the Dripping Springs valley, which is about twenty miles from Globe:

TUCSON, ARIZONA, October 18, 1905.

J. J. Thornber, A. M.,
Tucson, Arizona.

Dear Sir:

In response to your letter of inquiry of the 14th instant, I am enclosing herewith answers to the questions submitted to me in your said communication, and trust that the same may be of some benefit in the matter referred to.

(1) Alfilaria made its first appearance in the section of country to which these answers are confined, viz: the Dripping Springs section, in about the years 1876 to 1878.

(2) It has been spreading quite rapidly since that time.

(3) It is becoming more abundant from year to year.

(4) From my best knowledge it was introduced into the country by several bands of sheep which were brought there from California.

(5) It grows best at an elevation of from 2000 to 3500 feet. The soil to which it is best adapted is a disintegrated granite mixed with sand.

(6) Where it has attained a fair start it excludes almost every other of the native annual species. It grows most abundantly in the lower altitudes upon the mesas and higher foothills, and in the higher altitudes in the valleys and lower foothills.

(7) No.

(8) About four inches of rain insures an abundant crop, and should come in fall rains—that is in September and October.
(9) In its green state it is a most excellent feed for horses, cattle and
sheep, and is greatly relished by all of them. They eat the seed as well as
the plant.

(10) I consider alfilaria hay as one of the very best of stock feeds. It
is better after it has cured on the ground, and is eaten with great relish by
stock in the dry as well as the green state.

(11) About two tons would be a good yield per acre of hay, under ordi-
narily favorable conditions.

(12) My experience in putting up the hay is such as I obtained dur-
ing the time I was engaged in the cattle business in Dripping Springs val-
ley.

(13) The spread of alfilaria, according to my observation, has been
by the grazing of stock over the different ranges.

(14) I have never attempted to introduce the plant.

The above questions are based upon my personal experience in the
Dripping Springs valley, and outside of that I am not able to answer.

Very respectfully yours,

(Signed) WM. M. Grinnell.

The statements submitted by Mr. J. I. Bachtiger, of Wicken-
burg, are taken from two letters received from him, the matter
being, with his knowledge, rearranged in part. The following is
Mr. Bachtiger's letter:

(1) Alfilaria, or as we call it, filaree, was introduced into this section
during the years 1870-1872. It was first noticed at Date Creek, Yavapai
County. Through this section (Wickenburg) it was noticed in 1872.

(2) It has been spreading ever since; in wet years it spreads more and
more in extent. In almost no time it spread over the country as far north
as Kirkland, and Peoples Valley, and over all the desert down to Phoenix.

(3) Yes, it is becoming more abundant from year to year.

(4) It was introduced by bringing droves of sheep from California in
1870 and 1872, to Date Creek, Yavapai County, Arizona.

(5) Filaree grows best in our sandy, clayey soils in flats, where most
of the moisture of the rains is retained; in wet years it grows on the
gravelly mesas almost as good as on the low lands, but it is always sure on
the low lands. I have seen filaree grow luxuriantly on any kind of soil,
even where other plants don't grow. I have also seen it do well on alkali
ground.

(6) It likes to grow best by itself where its growth is not interrupted
by other plants or grasses.

(7) So far as I know filaree grows as far north as Kirkland and Peo-
pies Valley, also west to Cullins in Yuma County, and down as far as
Phoenix.
(8) About five inches of rain at the right time will make a good crop of hay, and for pasture alone considerably less is needed. Filaree begins to grow as early as September if the rains come, although it will grow at almost any time from fall to spring, and continues as long as we have enough moisture. If the weather turns off dry after the filaree has started to grow, the crop will be a failure for that year, but there is always enough seed matured for next year’s crop. All that it needs is rain at the right time. Late rains and cool weather are the best.

(9) For sheep it is the very best feed, being very fattening, also the same for horses and cattle; in the green state it is best when one to four inches tall; after it gets taller stock don’t eat it any more until it begins to dry up, when they eat it again with great relish until it is all gone; it is eaten by stock in preference to any kind of grass.

(10) As hay it is not surpassed by any other; it is very fattening, and none is wasted by stock in feeding, everything being eaten up clean. It grows about fourteen inches tall, and when cut in bloom makes a first-class hay for milch cows. As for my part I find alfilaria hay better than alfalfa hay.

(11) In good moist years it will average a ton of hay to the acre as it grows in the wild state. When very heavy it lays down. When cut during the latter part of April or the beginning of May, it will make another growth for pasture, about four inches tall, and re-seed the fields for the next year’s crop.

(12) Last spring I cut in my pasture fields about fourteen tons of first-class hay for my own use. Generally through this country filaree is only a failure in dry years. I think it a very valuable pasture and hay plant. Where plants like alfalfa would not grow it grows certainly with a quarter less moisture that alfalfa needs.

(13) Sheep have carried the seed in their wool, so that it grows everywhere about here now.

(14) The best time to sow alfilaria seed to my notion is from November to January, and no later. The seed should not be covered more than a quarter of an inch and well pressed with a roller and kept moist or rather wet. After it gets four inches high it needs very little wetting or rain. I think three pounds of seed would sow an acre. The seed which I get around my haystack I put on my pasture when it needs it. When I put seed on the ground I never plow. I draw a harrow over the ground so the loosened soil will cover the seed, and I have very good success in this way.

J. I. Bachtiern,
Wickenburg, Arizona.
POSSIBILITY OF THE GENERAL INTRODUCTION OF ALFILARIA

By Sheep.

The fact that alfilaria already grows successfully over a considerable portion of Arizona, under quite varied conditions with respect to soil, altitude, precipitation and temperature, and also that it continues to spread farther, leads one to believe that it will become as prevalent here in the course of a reasonable length of time as it was in California nearly or quite a century ago. The wonder is that it has not already planted itself securely in every favorable portion of our Territory. This condition, which is almost certain to come, even without efforts on the part of man, can be brought about in a remarkably short time if stockmen and others interested in the ranges will give a little attention to its systematic introduction in their respective grazing regions. This can be done either through the agency of bands of sheep, where obtainable, or by collecting and planting quantities of seeds in the more favorable situations.

Introduction can be brought about quickest and with the greatest degree of success in a new locality, if a drove of sheep that have been grazed in an alfilaria country are herded over it. Where possible, they should be allowed to graze alternately, first on the one and then on the other area. Some stockmen even maintain that it is only necessary to drive such a herd of sheep through a country once or twice in order to seed it sufficiently. The seeds that collect between their toes and that are constantly falling from their wool are not only well distributed but also planted to the right depth by the incessant tramping, with the result that the country becomes almost immediately a "filaree country," to use the rancher's expression. As ordinarily introduced by a herd of sheep, alfilaria derives an additional advantage in that the native plants are greatly reduced as a result of close grazing, which at times approaches annihilation. Thus it virtually comes into possession of the ground from the start, which accounts, in a measure, for the apparent readiness with which it supplants the native species. The natural avenue for this plant to reach new fields is through the agency of grazing animals, especially sheep, as is clearly indicated by the character of the
This is verified by the unanimous statements of experienced stockmen in various parts of the Territory, who say that its introduction and spread in their respective localities are coincident with the driving in of herds of sheep; in fact, it is difficult to see how this type of seed could enjoy a wide dispersal otherwise. When left to itself alfilaria tends to form definite patches, the borders of which are pushed out only a few feet from year to year. It is interesting to note, also, that these incipient patches occur commonly along stock paths, trails and roads, which is quite suggestive of their origin.

In addition to what has already been said concerning the dissemination of alfilaria seed by sheep, it must not be overlooked that other animals also have aided in the matter. Cattle grazing in an alfilaria country carry the seeds from place to place in their tails and, to some extent, in their droppings, though it is not known in the latter case, whether the seeds will germinate or not. The writer found twenty-eight alfilaria seeds on a young jack rabbit killed twelve miles from any considerable patch of the plants, and half that number in the bushy tail of a dead coyote. The latter observation recalls the statement of a correspondent who wrote that wherever a sheep died on the trail along which a herd was driven in the early seventies, alfilaria sprang up. Also, gophers collect alfilaria seeds, carrying them considerable distances to their mounds; and, finally, ants were observed storing the seeds twenty to forty yards from where they grew.

At first thought it would appear that a drove of sheep, however excellent an agency for alfilaria dispersal, could be employed for that purpose only in the same general region in which the plant already grows, leaving far removed communities to depend entirely upon the slower and more laborious seed-sowing methods. The writer is of the opinion, however, that it will be entirely practicable, after the shearing season is over, to apply a thin layer of seeds to the woolly coats of a herd of sheep that have not been grazing in alfilaria country, and let them take care of the distribution and planting of the seed. There is every reason to believe that the experiment would be entirely satisfactory, and that the seeds could not be handled in a more economical way. The seeds need be attached only to the lower half or two-thirds
of the body, and the coating should be quite thin, otherwise the excess might be eaten off and thus lost.

_Bulletin Seed._

Where introduction is attempted on any considerable scale by planting, the seed should be collected in quantities of several bushels and sown as soon after as convenient. Experiments made last year at the Station, although incomplete, show that where the seeds are stored in sacks in buildings during the summer months, only a small percentage germinate in the fall or winter months, even under the most favorable conditions; whereas, if they find their way into the ground in the usual manner, that is, at the time of maturation, they are exposed to the weather during the hot summer months, with the result, as yet unexplained, that growth obtains immediately with the first rains of October or November; hence the reason for sowing as soon after collecting as convenient, even though a considerable percentage is destroyed by animals or otherwise becomes dissipated before the advent of another growing season. The sowing should be done in the more favorable areas of the vicinity: namely, at elevations between 2,500 and 4,000 feet, in alluvial soils of low mountain and foothill canyons, valleys, swales and mesa depressions; also among shrubs and over gopher mounds, southern exposures being selected wherever possible. It needs hardly be said that favorable climatic periods, such as have obtained during the past eighteen months, greatly facilitate the growth and increase of the plant. The seed should be covered to the depth of a half-inch or so, which can be done in the larger plantings with a straight tooth drag, a disc harrow or other similar implement. When once started the patch will need no protection, other than to prevent its being annihilated by hungry range animals, since the more it is grazed within reasonable bounds the greater will be its opportunity to spread. From past experience, introduction by seed sowing is likely to prove a slow and tedious process. The distribution at best never can be general, and even when a patch is once well started its spread will not be rapid without the intervention of sheep or other similar grazing animals.
Alfilaria secures no small protection against animals and the extreme variations of moisture and temperature during its sowing, rosette, and flowering stages when growing among shrubs, and hence the suggestion for sowing the seeds in these situations. Under normal conditions it tends to grow first among shrubs in any locality. The presence over the mesas of the native annual growth is due in a considerable measure to the protection afforded by the shrubs; and when, for any reason, these disappear, the region becomes, indeed, bare. Under the diffused light of shrubs, temperature and moisture conditions are more nearly uniform from week to week; accordingly, seedlings appear there first and withstand longest the heat and drought of the desert. Also, about shrubs the loose soil becomes gradually heaped up by the long continued activity of the winds, which increases, in proportion, the mineral content and the water-holding capacity of the spot, to the advantage of the plant.

THE COLLECTION OF ALFILARIA SEED.

Alfilaria seed is sold on the California market at the prohibitive price of $1.00 a pound. In a good alfilaria region, like the one about Oracle, two men would be able to collect forty or fifty bushels of reasonably clean seed in four day’s time. If a team and wagon are included for a week, two days of which are allowed for driving a distance of forty miles to and from the alfilaria country, the total expense, including provisions, will still be within $40.00, or approximately eighty cents to a dollar a bushel. Since the average rancher is well supplied with both teams and help, the expense of collecting the seed will amount to practically nothing. Last year, during the latter part of May, the writer gathered from the above locality ten sacks of seed in as many hours, without even so much as a hand rake to shorten the labor. At that time, and for several weeks later, it would not have been difficult to collect two or three hundred bushels of nearly clean seed in the vicinity. As noted heretofore, it is quite characteristic of the pure seed to collect, through the agency of wind, and the hygroscopic movements of the awns, in the small angular rivulet-worn beds and arroyos in tangled
masses ranging from a quart to a half-bushel in size. An excelsior garden weeder, that is, one of the claw or finger type, which may be had from any seedsman for ten cents, would be an excellent tool to rake the tangled seed masses from among the rocks and crevices. Where the plant forms a heavy, continuous covering the dried stems may be cleared away with a hand rake, thus exposing a layer of seeds a half-inch or more in depth.

SUMMARY.

In conclusion it is to be noted that alfilaria was introduced into Arizona by herds of sheep at least thirty-five years ago, and that now it occurs over a large portion of the Territory, and is being gradually spread farther; also that ecologically it is well adapted to southwestern conditions. The chemical analyses appear to support the unanimous statements of stockmen that it is an excellent forage for all kinds of stock, especially sheep, in addition to being a valuable hay plant. Up to this time sheep have been largely instrumental in spreading it over our grazing areas and in carrying it to far removed districts, which taken in connection with the character of the seeds leads one to believe that they will continue to be the most efficient agency for its dispersal. The plant may also be introduced by sowing seeds in the more favorable situations. As heretofore described the seeds may be gathered in almost any quantity in an ordinarily good alfilaria country during the latter part of May and the first half of June, at a maximum expense of eighty cents to one dollar a bushel. Thus alfilaria combines several of the essential features which go to make up a good forage plant, viz., (1) minute adaptability to environment, so as to prove successful in competition with other plants, (2) production of a liberal amount of nutritious forage, (3) rapid spread over new country with minimum expense, and (4) maturation of viable seeds which may be collected in large quantity economically. In the light of the above the writer feels amply justified in encouraging its further introduction and spread in Arizona and other portions of the Southwest, as a valuable spring forage plant.