

NATIVE AND EXOTIC PLANTS

IN REGION 8



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SOIL CONSERVATION SERVICE
Region 8
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NOTES ON NATIVE AND EXOTIC PLANTS IN REGION 8
With Special Reference To Their Value In The
Soil Conservation Program

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FOREWORD

Artificial revegetation in Region 8 has passed through varying stages of development, and has now reached the point where its significance in the soil conservation program is becoming apparent. We have all seen the results that can be accomplished by natural revegetation under management. Management alone will not suffice in all cases; we know that in those difficult situations where nature needs help, the best thought, judgment, and experience of trained men are required.

I have read the manuscript with great interest, and wish to commend it to the field men of Region 8, both as valuable technical material and as good reading. Mr. Goodding's notes should be a most valuable reference work to those who are engaged in revegetation activities. They will be useful to the layman as well as to the technician who knows botany.

Hugh G. Calkins,
Regional Conservator.



INTRODUCTION

The following notes are not compiled with any thought that they constitute the last word. No claim is laid to infallibility. Often the statements represent the opinion of the writer. The notes, it is hoped, will be thought-provoking and will help the field men to a better understanding of the plants of the region.

Common names are given where possible and these are included in the index. It was planned at first to include a botanical key but it was found that such a key of necessity would be very technical and voluminous. If the field man becomes interested in any plant or plants, he can obtain a determination by sending specimens to the Regional Nursery Section. If this cannot be determined readily at Albuquerque the plant in question will be forwarded to Washington. It is often very difficult to determine specimens from "scraps". An adequate specimen is pressed and contains stems, leaves, flowers, and if possible, fruits. The Soil Conservation Service men in Albuquerque, and even those in the National Herbarium at Washington, are not for the most part wizards, so if you wish plants determined, send in adequate material.

The notes do not constitute a manual. Perhaps the first plant you will wish to look up will be one not discussed. Your suggestions for a revised edition will be greatly appreciated.

Plants marked with an asterisk (*) are considered to have the greatest erosion control or forage value.

PTERIDOPHYTES

Equisetum spp. The Scouring Rushes are not so common in the Southwest as they are in the more humid parts of the United States. They, however, are not infrequent in swampy places along mountain streams. The root system makes of these plants an ideal soil binder but there are many other plants which are less moisture-loving which are to be preferred. These scouring rushes must be considered weeds. They are frequently reported as causing internal disturbances in stock and for this reason are listed among the poisonous plants. The scouring rush is indelibly associated with childhood. What little girl has not woven curls, bracelets and crowns of the jointed stems of the scouring rush?

Marsilea vestita, Fern Clover, is only mentioned here because of its striking appearance during certain seasons. Since it is certain to attract attention it is well to note some things about it. During the summer of 1937, following the rains which made numerous shallow lakes in certain parts of eastern New Mexico, this plant came in abundance and when the lakes dried up the entire lake beds were covered by a solid green carpet of this little fern ally. Many people without examining it carefully take it to be a clover. Others think it is an Oxalis. A slight examination, however, reveals at the base of the plants little brown nut-like structures, slightly smaller than peas. These are the fruiting bodies and contain the spores. This plant has been rather persistently reported to be poisonous to sheep. This report, however, has not been definitely verified.

TYPHACEAE

Typha latifolia, the common Cattail, has an extremely wide distribution. In our range it is found almost every place where there is adequate swampy land. As it grows only in situations where the water is still, it has little value as an erosion control plant. The fresh shoots are occasionally used for food, especially by the Indians. The tops are not browsed by stock.

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*Ephedra sinica. Among our most successful exotics is the Ephedra, which is the source of the drug Ephedrine. Under cultivation it grows rapidly and produces fruits in great abundance. Plants established at Pinal and Continental, Arizona, withstand the drought well, growing without irrigation. They have not, however, up to the present, escaped and run wild, the final test of a good exotic for desert conditions. Seedlings planted on the rifle range west of Tucson under strictly desert conditions but with the advantage of contouring, seem to be living through the very dry part of the season.

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If in the future strains of this and other Ephedras can be found or developed which contain the active principle Ephedrine in commercial quantities they can well be expected to become commercial crops in our warmer regions.

*Ephedra viridis, Mormon Tea. This is one of our best native Ephedras. It has a wide range but reaches its optimum development in the Navajo region north and west of the Carrizozo Mountains. Here it covers thousands of acres where it has taken advantage of conditions of grazing adverse to other plants. It is not hard to conceive what this country would be like without this and the prickly muhly. It would be like vast areas to the east -- merely bare rock. This plant supplies abundant forage for sheep and seems to thrive under abuse. X

Many references can be found to the uses made of this and other native Ephedras as medicine. Tests have shown that they contain no Ephedrine. Can it be that tests ended here? Plants so universally used must contain some active principle worth the effort to locate and study.

Other native Ephedras of the Southwest which seem to be inferior to E. viridis but which should be studied when a real attempt to locate the active principle of these plants is made, are E. antisiphilitica, E. nevadensis, E. trifurca and E. torreyana. These are all generally known as Mormon Tea.

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*Juniperus pachyphloea, Alligator Bark Juniper. The part the junipers should play in our erosion control program is somewhat of a riddle. The part they are playing is evident to anyone who observes as he travels. The juniper trees already occupy millions of acres which if the land were not thus occupied, would at present be barren and windswept. All attempts at exploiting our woodlands type either in the pretense of establishing farms or grass areas, should be studied with avowed prejudice in favor of the existing trees. The utilization of wood and posts is legitimate but it should guarantee a similar cover to return. The juniper forests are an enormous source of revenue; the trees protect the land against rapid erosion of water and wind and with proper grazing permit the growth of an abundant grass cover. The juniper twigs are browsed by game animals and deer, particularly, fatten on the berries when they fall. The fruits of J. pachyphloea and J. monosperma have been utilized by Indians for food. In many of our small towns juniper is the chief fuel wood on the market. A general plan of planting juniper, however, seems to be uncalled for. Properly managed, the X

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forests will take care of themselves and continue to yield their revenue to man. The use of the junipers for ornamentals and for wind breaks will probably be much greater in the future. The cutting and mutilation of large alligator bark juniper should be discouraged. The trees are used only for wood and posts and the common practice is to cut the limbs which will not leave the wood chopper too fatigued after his job is done. In the nursery the seeds of this species and of J. utahensis have proved difficult to germinate.

Any discussion of the utilization of junipers in woodlot, shelter belt, for erosion control or of the protection in the woodland forest, is not complete without reference to the very serious diseases which affect them. Several Gymnosporangia cause severe damage to small trees and distortion of large ones. All of these have other hosts than the juniper and their elimination from an existing juniper area or from a planting program which might bring them into association with junipers, will effectively control the diseases. The planting of the following in association with junipers is not a guarantee of the immediate attack by disease but their elimination does guarantee continued freedom from the disease of which they are alternate hosts:

The Service Berries (Amelanchier spp.), Haws (Crataegus spp.), Mountain Ash (Sorbus spp.), Desert Crabapple (Peraphyllum ramosissimum), Mock Orange (Philadelphus spp. or Fondlera spp.), and Vauquelinia californica. Apples and pears are likely to cause trouble with the eastern Red Juniper and one variety of pear is attacked by a Gymnosporangia which attacks the alligator bark juniper near Prescott. There may be an excuse for taking a chance on planting fruit trees but it is hardly necessary to use the above mentioned hosts in association with junipers when there are many other plants which can be substituted.

*Juniperus monosperma, One-Seeded Juniper. This juniper has been discussed somewhat in connection with J. pachyphloea and J. utahensis. In nursery work it has the advantage in that the seeds are easy to germinate. In at least one locality what we have been calling the one-seeded juniper grows to be a very handsome shapely tree with a single trunk. This is in the Sycamore Canyon region of southern Arizona. The trees in this region also produce a fruit that is very juicy and sweet, almost fit for human consumption. A fair supply of seed of this was collected in the fall of 1937 for nursery production. Another type of the one-seeded juniper grows in western Texas and southern New Mexico. It is very low, much branched and shrub-like and produces a bronze colored fruit.

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*Juniperus scopulorum, Rocky Mountain Juniper. This species closely resembles the eastern red juniper. It is a very handsome tree with straight bole and drooping twigs. It frequently forms thickets at the heads of draws where rapid erosion would be likely to occur if the trees were not present. It, however, grows only at relatively high altitudes (5,000-8,000 feet). It is more rapid growing than our other native junipers and is much more suitable for an ornamental.

*Juniperus utahensis, Utah Juniper. This is sometimes confused with the so-called one-seeded juniper, Juniperus monosperma. The former is commonly coarser, usually more tree-like and has a large fibrous one-seeded fruit. The latter is more slender, usually has abundant trunks from a single base and has small juicy one-seeded fruits. Each is to be found in pure stand covering thousands of acres. The Utah juniper is usually considered superior to the single-seeded juniper because of its more tree-like habits which yield better posts. It, however, becomes somewhat of a weed in places, encroaching rapidly on grazing land when it becomes overgrazed. This is the condition over large areas between Ashfork and Prescott for example.

Pseudotsuga taxifolia, the Douglas Fir, is too widely known to need discussion here. As is known, it is one of our best forest trees. This applies to the Southwest as well as to the Rocky Mountains and the Northwest. It, however, is not suitable for erosion control work in any of the projects now under consideration as it grows at too high an altitude.

Cupressus arizonica, the Arizona Cypress, is one of our best known and most widely appreciated trees in the Southwest. It is a grayish-green cedar-like evergreen tree native to the canyons and mountain slopes in the southwestern ranges at altitudes of 3,000 to 7,000 or 8,000 feet. Cupressus arizonica var. bonita closely resembles this species. It reaches its optimum development in the Chiricahua Mountains (Chiricahua National Monument) and in northern Mexico. In congested stands and in deep canyons it frequently reaches a height of seventy feet and a diameter of one and one-half feet or more. It reaches its greatest altitudinal range in the Chiricahua Mountains, there appearing on the crest of the main range as a low spreading tree of striking beauty. Doubtless the species and variety are used indiscriminately on the market. Balled trees can be purchased in many of the Southwest and Pacific Coast nurseries. The greatest value of this tree is for ornament and shade but its drought resistance suggests it for woodland planting and for binding rocks and soil in canyons. In the mountains above Clifton and in the Sedona section of Arizona it is severely attacked by a fungus, Gymnosporangium cupressi.

Picea spp. Two species of true Spruce extend into the Southwest. Both occur in the Rocky Mountains to the north and extend

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south into northern New Mexico and northern Arizona. They occur only at quite high altitudes and are hardly suitable for erosion control practices. They are frequently used, however, for ornamentals for street, park and cemetery plantings at altitudes of 4,000 feet or less as one goes north. The species are Picea pungens, the Colorado Blue Spruce, and P. engelmannii, the Englemann Spruce.

Abies spp. Two true Firs occur in the Southwest, -A. lasiocarpa extends from Alaska southward into the Cascades of southern Oregon and in the Rockies to the mountains of northern Arizona and northern New Mexico. In the southern portion of its range it is frequently called the Arizona Fir (A. arizonica). A. concolor, or common White Fir, occurs from northern Oregon into Lower California and from southern Colorado along the Rockies into northern Mexico. The latter is frequently a very large tree, sometimes 250 feet high and six feet in diameter. It is frequently used for ornamental plantings and may prove of value for erosion control work to a limited extent at altitudes of 5,000 feet or more. A. lasiocarpa grows only at high altitudes in our range.

*Pinus edulis. The most common of our Pinon pines is P. edulis. It extends from the Wyoming line into western Texas and northern Mexico and is scattered over most of Utah, Colorado, Arizona and New Mexico. It, with the other pinons and junipers, makes up most of the woodland type of forest in the Southwest. Too much has been written about the pinons to call for reiteration here. Perhaps few realize, however, the enormous economic importance of these trees, - from the standpoint of water and wind erosion control, fire wood, posts, and most of all, nuts. When one notes a few packets of the shelled nuts in confectionery stores or a bushel or so of the unshelled nuts in the grocery store, he commonly fails to multiply these small amounts in his mind by the thousands of stores in which they occur. Many car-loads are shipped each year to markets in the east, to say nothing of the quantities consumed by school children locally. These nuts are collected by the Indians almost solely and sold to traders at prices ranging from five to ten cents per pound. As retailed the price is much greater.

The pinon is not being grown extensively in our nurseries for the reason that where it is most needed it is usually present. It is likely, however, that very gradually superior strains will be planted either for rapid growth or for superior nuts. Of all the pinon nuts on the market it is safe to say 80% are from Pinus edulis. Other species may be better for the production of big nuts. Samples brought from southern Utah indicate that P. monophylla produces a much larger nut, at least in some localities. Empty shells found below a tree on Superstition Mountain were easily three times as large as the normal pinon nut. The Single-leaf Pinon (P. monophylla),

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however, seems to produce many empties and those sampled were not so well flavored. Reports come to us that the best pinon nut comes from southern California and northern Lower California. It is the nut from the Parry Pine (P. quadrifolia). Thus far we have failed to collect nuts of our pinon so common in the extreme southwestern ranges, i.e., P. cembroides, and at present our information on their importance is nil.

Other pines than the pinons produce edible nuts. One, P. strobiformis, the Mexican White Pine, produces nuts comparable in size to those produced by P. edulis. These are sometimes sold on the market as pinon nuts along the Mexican border or were in the past. The Torrey Pine, the Digger Pine and the Coulter Pine, all produce nuts of good size. Very extravagant statements have been made about the nuts produced by P. pinca, an exotic, and the number of people they feed. All these and the pinons are too slow growing to warrant the nurseries in producing certain selections. Such work must be left to other agencies. Our own men can render a service to future generations by reporting the exact location of trees producing nuts of superior size or quality.

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*Agropyron cristatum, Crested Wheat Grass, has been introduced long enough that it is considered naturalized in many places. Some years back it was tried out by the Forest Service at Flagstaff but the results at that time were not promising. Recently Dr. Raymond sowed it on his ranch near Flagstaff and he reports excellent results. The difference is probably due to strain or to the source of the seed used. Dr. Hardies in his experimental work is finding that seed from grasses brought from the north, for example from the Dakotas, commonly does not respond so well at Tucson as seed produced in warmer sections. Crested Wheat is being tried on the Rio Grande and the Navajo projects. Mr. Musgrave reports very excellent results with it at Mexican Springs. An interesting feature of his work and one which may prove very significant later is that Crested Wheat Grass and Western Wheat Grass planted in association, have hybridized. What part this hybrid will play of course remains to be seen. Crested Wheat is one of our most promising exotics for our dry southwestern conditions. It is not suitable for our low altitudes such as those around Tucson and on most of the Gila projects.

*Agropyron smithii, Western Wheat Grass, has such a wide distribution that this discussion will be limited to observations made in the Southwest. This species is one which in the struggle

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for existence in the Navajo region has apparently adjusted itself to the adverse conditions of drought and over grazing in the Southwest. In spite of its resistance to drought the chief limiting factor seems to be lack of moisture. It hugs the swales where there is some over-flow, creeps into the low places along the highways, and spreads with apparent reluctance to the drier sites in brushy flats and slopes. As a soil erosion control plant it is excellent because it occupies the places where the slightest runoff gives a little added moisture and the long rhizomes tend to bind the soil. Often the lower places are heavily sodded and the culms and leaves of the grass form excellent desilters. Unfortunately the grass is rather unpalatable to sheep and goats, or possibly this is fortunate. While this species is one which forms extensive upland meadows in the Dakotas and eastern Colorado, with us it is usually quite scattering except in meadow stretches such as occur at Bluewater, New Mexico, where the grass is irrigated. This species is of doubtful value at altitudes below 4,000 feet with us.

Since seed can commonly be obtained on the market, no attempt is being made to raise this species in the nursery. In fact the grass is so much more abundant in other sections that we do not attempt to collect seed. It is probable, however, that strains can be selected and propagated in the nurseries which are more drought-resistant than those normally found in the Dakotas or Colorado. The hybrids of this, with crested wheat grass, should receive special attention.

Alopecurus ventricosus. Observational work on the range may change our conception of many of our exotics. While this grass is low and not likely to produce much forage, its rhizomatous habit may make it more valuable than others. Its resistance to drought has not been ascertained.

*Andropogon glomeratus, Bushy Beard Grass, is widely distributed from New England to California by way of the southern states. In the Southwest it is a rare grass, being found only in deep canyons as the Grand Canyon, Fish Creek and Sycamore Canyons in Arizona. It can commonly be distinguished by its long spathes or bracts which extend beyond the very plumose seeds, and by its purplish color. The culms are strongly tufted from a dense, hard base which has numerous long, fibrous roots. Where it can be persuaded to grow, that is in places where there is some moisture, it is an excellent soil binder. Up to the present too little is known about its palatability and the situations in which it will grow, to make it a significant grass in our erosion control work. Since it grows well in the nursery, however, it should be tried in suitable situations in connection with our observational program.

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*Andropogon hallii, or Turkeyfoot, is widely distributed in the central states west of the Mississippi and in the Rocky Mountain regions. It also grows in Iowa. It is a tall, coarse grass with plumose seed heads which grows by choice in very sandy regions. It has large, creeping rhizomes. In eastern New Mexico and Colorado it is an excellent sand binder. A grass which is considered to be the same species but which has peculiar yellow heads, grows in the Navajo region. This is called A. chrysochomus by some authors. It is also a good sand binder.

*Andropogon furcatus, Bluejoint Turkeyfoot, is a grass quite similar to A. hallii. It has shorter rhizomes and the finger-like divisions of the seeding heads are narrower and less plumose. It grows in all the states of the Union except California, Washington, Oregon, Idaho and Nevada. In the Southwest, however, it is relatively rare. From eastern New Mexico eastward and northward it becomes of much greater importance. It is comparable to A. hallii as a sand binder.

*Andropogon scoparius, the Prairie Beardgrass, grows in all of the states of the United States except California, Nevada, Oregon and Washington. It is probably most abundant in the central western states where it is a very important range grass. It is frequently called Little Blue Stem and can be recognized by its bushy habit, purplish tinge, single spikes of flowers and flexuous beards. Within Region 8 it is commonly very scattering but nevertheless an important part of the grass cover. It is common in eastern New Mexico and the upland region east of Flagstaff. With us it is not commonly considered a highly palatable grass.

Andropogon saccharoides, Silver Beard Grass. Perhaps A. barbinodis should be considered along with A. saccharoides. The two are very similar, cannot be readily distinguished in the field and have a similar range in Region 8. Perhaps the chief point in favor of this grass is its ability to reproduce itself and "carry on" on the range. It has been tried successfully on small scale seeding operations in the past. It commonly occupies swales, strips along old roads and trails and other places where there is a little excess moisture. It is a fair soil binder and makes fair forage when young. Seed is difficult to collect except by hand as the plants are too tall for the use of power machinery. No attempt has been made to raise this species on increase plots in the nurseries.

Andropogon cirratus, Texas Beard Grass. Although this species can hardly be considered a form of A. scoparius, it is very similar to it in habit and environment. It is also comparable to it as a soil binder and probably somewhat superior as forage. This species is seldom found in pure stands and occurs in such rocky sites that

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seed cannot be collected by means of machinery. No attempt has been made up to the present to raise it in the nurseries and it has not been planted in the field.

Aristide spp. Most of the Three-Awns may well be considered weeds on the range. They are almost without exception indicators of an overgrazed condition. They are unpalatable and for the most part not exceptional as erosion control plants. One of these, exceedingly common throughout the Southwest, is an annual which is abundant along highways and in waste places. This is A. adscensionis, Six-Weeks Three Awn, an introduction from the old world. In southern Arizona, southern New Mexico and extending southward through Mexico into South America, is A. ternipes or Spider Grass, a grass two to three feet high. In Santa Cruz County in Arizona in many places it forms pure stands. The very loose panicles give rise to the name Spider Grass. Although it forms a complete ground cover in places, the stand is seldom dense. Its palatability is relatively low and its erosion control value is certainly not equal to such grasses as the Boutelouas. A somewhat similar three-awn is A. orcuttiana or Beggarstick Grass. It is less common but more widely distributed from Texas to southern California than is A. ternipes. It seldom forms pure stands and on the whole is less valuable. It may be said in passing that these two three-awns, A. ternipes and A. orcuttiana, are poorly named. They do not have three awns. Two of the awns in each case are rudimentary. For this reason they have been confused with the Stipas and the Muhlenbergias.

Aristida divaricata or Poverty Three-Awn, is widely distributed from Kansas to southern California. On hundreds of square miles of overgrazed uplands it is abundant. Perhaps it should be considered a godsend in the land that man has mutilated. As it is unpalatable and promoted by overgrazing, it has an opportunity to occupy land which would otherwise be barren.

Aristida barbata, the Navard Three-Awn, extends from western Texas to Arizona and central Mexico. It is much more common with us on the plains of northern and eastern New Mexico than elsewhere. It is a low grass with very open panicles which break off at maturity and roll about in masses before the wind. It is valueless as forage but is sufficiently abundant in places to be a fair soil binder.

Aristida fendleriana, Fandler Three-Awn, is widely distributed through the west. With us it is very common in the plains country of eastern New Mexico and northern Arizona, frequently forming almost pure stands. Like the others, however, its abundance indicates range abuse. It is perhaps one of the better Aristidas and is a fair soil binder.

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*Aristida glabrata, Smooth Three-Awn, is a dense bunch grass found in our range only in southern Arizona. It extends also into lower California. According to Professor J. J. Thornber of the University of Arizona, this is excellent forage grass. It is sufficiently abundant in some places to be considered a good soil binder.

Aristida hamulosa is a Three-Awn very closely resembling the Poverty Three-Awn and often confused with it. According to Hitchcock's Manual of Grasses it is more common in Arizona than the Poverty Three-Awn. Its range is from Texas to southern California and south to Guatemala.

Three other Aristidas which are more or less abundant in the Southwest are A. longiseta, Red Three-Awn; A. purpurascens, Arrow-feather; and A. pansa, Beaten Three-Awn. Each one of these is abundant in places but none are outstanding for forage or as soil binders.

Aristida pinnata, Pinnate Three-Awn. Enlow reports this grass to be remarkable as a sand binder in Asia Minor. There it grows large and forms spreading clumps which are effective soil binders in sand dunes. In the nursery at Tucson this and a couple of varieties are rather indifferent and thus far do not come up to expectations. Until they have been tried extensively, however, they will not be given up. In the mesquite sand dune regions of Texas and New Mexico, in the drifting sands along the Rio Grande and in the Shinneries of eastern New Mexico, this species or its varieties may find a worthwhile place. Unfortunately we are not in a position at present to establish observational plots in these regions.

*Astrebula lappacea. What is its common name? Many of our exotics have not yet acquired common names with us. This grass might be designated as Rat Tail from its very long slender curved spikes of seeds. While the culms are two feet or more in length, the bunches do not stand nearly so high as both culms and leaves curve, the spikes often touching the ground. The culms and seed spikes of this species are coarse. While this appears to be a grass well adapted to our warmer sites, its use may be limited by the difficulty in collecting the seed, the grass being very hard to mow because of the recurved habit of stems and leaves.

*Astrebula elyroides. This might be called the slender rat-tail as the seed spikes are much more slender than the last named species. It is very similar in habit and probably the two could be used indiscriminately.

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*Bouteloua curtipendula, Side Oats Grama, is one of our most widely distributed grama grasses but it seldom forms pure stands of large extent, being usually mixed with other grasses such as the Blue, Rothrock or Spruce gramas. It is excellent forage and withstands grazing fairly well. It is one of our best from the standpoint of seed germination and ease of production in the nursery. In order to avoid the necessity of travel and the expense of hand-stripping we have planted seventy-five acres in the nurseries. Since this lends itself so well to cultivation we should look forward to having farmers and ranchers produce our seed.

*Bouteloua eriopoda, Black Grama, is more restricted in its distribution than Blue Grama. It, however, forms pure stands over wide areas almost throughout our range. In 1936 seed was collected east of Belen, New Mexico on the Jornada Lange in southern New Mexico and northeast of Flagstaff, Arizona. In 1937 seed collecting was confined to the Flagstaff region. It has been stated that it requires a lime soil but this is not always evident from casual observations. For example, a luxurious stand was located in the foothills of the Baboquivari Mountains, a region largely composed of igneous rocks.

While this grass is highly stoloniferous it does not withstand grazing as well as Blue Grama. The sites, however, indicate that it is more drought-resistant.

The Forest Service has had considerable success in transplanting this species from one site to another. The system they use is called the Paper Bag method. By it a small clump or plant is lifted on a shovel and placed at once in a No. 8 or No. 10 Kraft paper bag, top up, and the bag closed and placed in the bed of a truck. After a load of these bags has been obtained it is taken to the planting ground and planted at once. In planting, a shovel is pushed into the ground and forced to one side to open up a hole. Into this the entire paper bag is pushed and the soil packed against it. As it is left in the field the top of the bag is open and protrudes slightly above-ground. This seems to protect the young plant from the drying wind and from rodents and insects.

Commonly it is much more difficult to obtain good seed of Black Grama than of Blue, and the grain in the former not infrequently fails to form. It is hoped that we may get satisfactory results on our increase plots at Albuquerque and Pima, -five acres at the former and ten acres at the latter place. We should be able to ascertain whether it is feasible to propagate it for seed production.

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*Bouteloua gracilis, Blue Grama, is probably suited to a wider range of conditions in the Southwest than any other grass. It is a grass, however, that has suffered severely from overgrazing and from ill-advised attempts at dry land farming. Our conditions in these respects are no different from those in eastern Colorado, Kansas and Nebraska. There are wide stretches of country in eastern New Mexico, formerly in Blue Grama, which have been plowed and later abandoned, the land coming up to annual weeds such as Russian Thistle. On the overgrazed areas the common weed coming in the wake of the grass is one of several species of Turpentine Weed (*Gutierrezia*). These are variously reported as being acceptable browse to being seriously poisonous. It is certain that in some sections stock poisoning occurs when there is practically nothing on the range but the turpentine bush. Available moisture seems to play a very important part in the behavior of the turpentine bush and the Blue Grama. In 1934 the drought was so severe in southern New Mexico that the turpentine bush came on by the thousands. It seems likely that the grass on a properly managed range would take advantage of a situation like this as the small seedlings can but poorly compete with the grass. One thing is certain, the grass is better equipped to withstand drought than most of the accompanying vegetation.

Dr. E. W. Hardies, Assistant Agronomist at our nursery at Pima, Arizona, is growing Blue Grama from several localities. There is a great variation in the species and doubtless some forms withstand extreme abuse better than others. For example, we have one strain from the west slope of the Huachucas which withstood the trampling of stock, turkeys and chickens in a barnyard. Mr. E. A. Telford, Manager of the Soil Conservation Service Nursery at Colorado Springs, Colorado, has a clump in his nursery that is strongly rhizomatous.

While this species is sufficiently abundant on the range that it should not be necessary to grow it on the nursery for seed production, it seems likely that choice ranges receiving some overflow should be selected and cared for to assure the production each year of a high grade of seed. In the not distant future, also, definite strains doubtless should be grown to suit certain conditions. To ascertain the feasibility of growing this species for seed production a five-acre plot has been planted at Shiprock, New Mexico. Blue Grama is not uncommon in southern New Mexico and in southern Arizona. Under the more severe drought conditions there, however, it does not survive overgrazing as well as it does further north.



BLUE GRAMA (*Bouteloua gracilis*)

The most abundant grass in the Southwest

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*Bouteloua chondrosioides, Spruce-Top Grama. This is a grama which is confined to a relatively small range in our region. It occurs, however, in extreme western Texas and in northern Mexico. It is a firm rooted bunch grass of excellent erosion control and forage value. Because of the scattering nature of this species and the rough country in which it grows, an attempt will be made to raise it for seed in the nurseries at Tucson and Pima.

Bouteloua eludens, Santa Cruz Grama. This very promising grass is confined in our range to extreme southern Arizona. It seldom grows in pure stands and has not been located in sufficient quantity any place to warrant its collection by machinery. As this has excellent erosion control value and is a good forage plant, we hope to be able to raise it in increase plots in the nurseries at Tucson and Pima. It is a dense bunch grass with numerous short spikes to each culm and abundant basal leaves. Professor Thornber says that this grass was named B. eludens by Dr. Griffiths of the United States Department of Agriculture, because in spite of the extensive collections and careful study of grasses in southern Arizona by Professor Thornber, this particular species had eluded him as well as other plant collectors in the region prior to Dr. Griffiths' trip to the region.

*Bouteloua breviseta, Alkali Grama. This is one of our rare grasses, being confined to western Texas and southern New Mexico in our range. It, however, extends into Old Mexico. Its range is limited possibly by its soil requirements. It grows by choice in gypsum sands or in rocky calcareous soils. On the borders of the White Sands of New Mexico it is one of the chief grasses but at that it is quite scattering. On the ridges above the Bottomless Lakes it is abundant and constitutes the chief grass. A strain of this species forms pure stands on the rocky slopes of hills north of Van Horn, Texas. In general appearance it resembles Blue Grama but is much more wiry and has a rather open woody base. Contrary to what might be expected this grass grows beautifully in the nursery and produces much leafage. While it does not have a rhizomatous base it stools freely in sandy soil and forms a very effective erosion control agent. As very little seed of this grass has been collected we are gradually getting an increase block through seed collected from the initial trial planting. It is well worthy of trial in very dry sites, especially in calcareous or gypsum soils.

*Bouteloua hirsuta, Hairy Grama, closely resembles Blue Grama. It does not, however, produce so dense a sod and does not commonly form pure stands. It is very difficult to find on any range where anything but hand strippers can be used in seed collection. Plants

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from different localities show great variation, for example, those from west Texas generally have very short spikes and the plants are low, while plants of the same species from Turkey Creek in the White Mountains of Arizona are tall and have long hairy spikes. The species is widely distributed in the central and southwestern states. Because of the difficulty experienced in collecting pure seed we have planted ten acres on the nurseries for increase.

*Bouteloua rothrockii. The Rothrock Grama closely resembles Blue Grama grass but has several more spikes to the culms and does not form so dense a sod. By stockmen it is usually considered to be little better than the annual Boutelouas and it is a question whether it should be planted except in mixture with more valuable gramas such as Side Oats and Hairy Grama. Seed germination tests have on the whole been very disappointing but field tests on the range in the San Simon Valley have shown promising results. Outside of Mexico this species is confined to extreme southwestern New Mexico and extreme southern Arizona.

Bouteloua barbata, Six Weeks Grama, is a grama closely resembling B. rothrockii. It is probably the best of our six-weeks grasses, coming on rapidly after the summer rains begin. It is a good nurse crop and makes fair forage. B. aristidoides is our other six-weeks grama. It is more abundant than B. barbata, probably because it is much less palatable. Seed can be collected of both of these on limited areas by Peppard strippers.

Bouteloua uniflora, Slender Side Oats Grama. This is a grama closely resembling side oats but more slender and usually not so tall. It is much more limited in its distribution, being confined, according to Hitchcock, to western Texas in our range. It is rather common in the San Antonio Mountains but nowhere abundant. It is possible that it is inferior to side oats. Sufficient seed has been collected to plant a small row for observational purposes.

Buchloe dactyloides, Buffalo Grass, comes into Region 8 only in eastern New Mexico. It does not hold the significant place here that it does east of us but what little work has been done with it indicates that it can be induced to occupy sites much further west. At present it is growing in lawns at the State University and at the Soil Conservation Service Nursery at Tucson. In these places it receives some irrigation. The plant, however, is able to withstand extreme drought once it becomes established. In the Clovis region in New Mexico the combination of heavy grazing and drought killed much of the vegetation in 1934. The ground looked perfectly bare, scarcely a bare grass caudex showing, -a veritable land of

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desolation. As soon as rains came the Buffalo grass made a remarkable recovery.

Buffalo grass does not occur in our territory in sufficient abundance to warrant seed collection. As a result we must rely on a supply of seed from elsewhere. We plan, however, to collect enough pistillate plants to establish a small area on the Albuquerque Nursery with just enough pistillate plants to insure fertilization.

Bromus anomalus, Hodding Brome. This species is very widely distributed throughout our range, occurring at moderate altitudes with a fair rainfall. It is perhaps our most drought-resistant perennial brome. It is only fair as a soil erosion control plant but makes good forage. This species is nowhere sufficiently abundant to be collected by machinery in our region and up to the present nothing more than samples of seed have been collected and no nursery increase planting has been made.

Bromus carinatus, California Brome. In 1935 we obtained several thousand pounds of what we called B. polyanthus, at Flagstaff, Arizona. B. polyanthus, according to Hitchcock, is merely a form of B. carinatus. This species (B. carinatus), is very widely distributed throughout our range and far to the north and east. It is perhaps our best perennial brome for moderate to high altitudes. The comparatively low altitude of our projects has precluded the extensive use of this species outside of the state of Utah. This season we have contracted for several thousand pounds, all of which will be used on Utah projects.

This species is handled much as wheat or oats, being either mowed or harvested with a binder and threshed. It is a crop that can be grown readily by ranchmen. It is probably best to plant seed in the fall at about ten to twelve pounds per acre.

Bromus tectorum, Downy Chess, is a short-lived annual brome grass introduced in the United States some years ago. It has spread like wildfire in the warmer sections of the south and southwest. Owing to the fact that it is so short-lived and that it dries up so completely, this is all but useless. In fact it is generally considered a nuisance or a weed. It can usually be recognized by its slender habit and its purplish tinge.

*Calamagrostis pseudophragmites, Fake Cane Grass. This exotic has all the earmarks of a grass which may be difficult to control if planted in cultivated fields. It is a rather coarse grass with long rhizomes which sprout freely. While it has some of the characteristics of Johnson grass it is not poisonous to stock under any condition or at any season. The growth is not so luxuriant as that of

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Johnson grass. This is an ideal grass for swales where floods give a little extra water. It seems to be one that may be expected to escape and to carry on for itself once it is established in favorable sites.

*Calamovilfa gigantea, Giant Sand Grass. There are several grasses which may prove very valuable in our erosion control work which must be classed as special use plants. This is true of our giant Calamovilfa. It cannot be recommended as a forage plant or even for general erosion control purposes but it is par excellence as a sand binder, particularly along dry desert washes such as are to be found in the Petrified Forest of Arizona. Its natural distribution is North Dakota to Texas and west to Arizona. Not only does it have rhizomes which quite effectually bind the sand but it is of sufficient size (1-2 meters high), to check the winds. Up to 1938 we had been able to obtain only a handful of seed. This will be used in the nursery where the plant can be kept under observation and possibly a small amount of seed produced.

*Chloris berroi, Finger Grass. Some of the Chlorises are annual weeds of rather low palatability. This is an exotic perennial which forms dense stands and seeds itself vigorously at Tucson. Up to the present we have not tried any experiment to determine its palatability except that we know it is sufficiently tasty to please jack rabbits. It thrives with little irrigation but has not been tried on the range. At Shiprock it freezes out in winter but may be used as an annual in our colder regions.

Chloris cucullata, Texas Finger Grass. In Western Texas this Chloris appears more like an indifferent weed found occasionally along bottom lands in the foothills, but plants in the nursery are perhaps two feet tall and form excellent large, leafy clumps. It is a drought resistant grass which responds nicely to a little care and water.

Dactylis glomerata, Orchard Grass, has been so widely distributed that we no longer think of it as an exotic. Seed can be obtained from seed houses. It is an excellent meadow and pasture grass and escapes rapidly. It is not well adapted to our desert types but grows well in moist sites at practically all altitudes.

Digitaria orientha var. stolonifera. This exotic is related to the common crab grass found in lawns and orchards. It is coarser and a more vigorous grower with long stolons. It has not been tried on the range but indications are that where there is a little extra moisture it will be an excellent soil binder and furnish good forage. It seems hardy at Tucson.

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Elymus gigantea. Under nursery conditions this grows very much like cat-tails in swamps, having heavy culms and coarse leaves. Its forage value is probably low but its heavy rhizomatous roots suggest it as a good erosion control plant. It is a native of Siberia and has been grown in this country as an ornamental only.

*Elymus sabulosus. One of the most vigorous and tenacious soil binders we have under cultivation is this exotic rye grass. The roots spread rapidly and sprout abundantly. The blades are light green, coarse and harsh, and the stems are stout. The grass requires very little irrigation and where sand piles among the culms the growth becomes more vigorous. This has not yet been tried on the range and no feeding experiments have been conducted.

Elyonurus barbiculmis. In the extreme southwest are to be found some grasses which have their maximum development in Mexico and which are little known to the usual agrostologist in the southwest. One of these is Elyonurus barbiculmis. It is a rather coarse grass $1\frac{1}{2}$ to $2\frac{1}{2}$ feet high with a dense mass of perennial roots. Along the Mexican line from the south end of the Huachuca Mountains to the region south of Ruby, Arizona, this is in places an important part of the grass cover and of the available forage. It occurs also in southwestern Texas. Up to the present we have not tried this in the nurseries. Indications in the field are that it should be hardy far north of its present range. This is assumed from the fact that it grows at altitudes which are cold in winter.

*Distichlis stricta, Desert Salt Grass, also often called Alkali grass, is extremely widely distributed throughout the west and Mexico. It is a moisture and alkali lover, being confined to moist alkali meadows. It is a short grass with very sharp leaves and short spikes. It has large, often very long rhizomes. For this reason it constitutes an excellent soil binder. Wherever the water table is lowered, however, the grass soon disappears because of water shortage. It is probably of much greater value for forage than is generally thought. Cattle and horses at certain seasons of the year are seen feeding on it in great numbers. Its palatability, however, is usually considered low.

Echinochloa colonum, Jungle Rice. Throughout the south this grass grows as a weed on waste land and in gardens and cultivated land. It is very common in the nursery at Tucson. In habit it is almost prostrate, and can readily be recognized by the rather broad leaves which are crosslined with purple. It is an annual, and may have some value for erosion control as a ground cover on wasteland where there is some overflow. It is not sufficiently abundant to

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be considered of value for forage.

*Eragrostis curvula, Giant Love Grass. In 1934 the nursery at Tucson received a small packet of seed of Eragrostis curvula, a perennial grass from South Africa. In 1937 the first seed crop increase from the original packet was more than two tons of cleaned seed. A second crop was harvested later. It yielded slightly less. This grass is an exotic and was grown under irrigation. It remains green practically the entire year and produces a heavy hay and seed crop early. A seed crop was harvested at Tucson by June 15 in 1937. Experiments on the range indicate that the grass is very drought resistant and able to reseed itself at least to some extent. To be sure no such results on yield can be anticipated from open range grass but if it can withstand our dry seasons and provide a grass cover as well as desirable forage, it should prove to be a worthwhile contribution.

Since this grass provides forage of fair value and can be readily cut for hay, there may be those who will desire to raise the grass either as hay or as a seed crop. At present there is no call for the seed owing to the fact that ranchers and farmers do not know anything about the grass. When it is learned, however, that about three tons of hay can be produced per acre per year and that this has none of the objectionable features of Johnson grass or that approximately 1,000 pounds of seed can be harvested per acre per year, many ranchers may desire to grow a small acreage of it.

This grass was tried in 1937 in several localities to determine its ability to survive and to reproduce itself on the range. Observations on these plantings will largely determine future policy in growing this grass for seed on the nurseries. It has been suggested since this is likely to freeze out in our colder regions, that it be tried as an annual. With this in mind seed will be planted in other regions than the Gila. Seed planted in 1936 on the Albuquerque Nursery produced a good stand. While this stand was quite severely injured during the winter of 1936-37, there was still a marked survival.

*Eragrostis lehmanniana, Genuiculate Love Grass. Seed of this exotic from South Africa was sent to the nursery at Tucson labeled E. parosa. At the beginning of the second season it was discovered to be a well rooted perennial and as E. parosa is an annual the name was revised. This is not as heavy a hay yielder as E. curvula nor does it produce so much seed. In the spring when E. curvula is a rank luscious growth of green, this grass is merely beginning to show a little new growth. While all of this may seem to recommend

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E. curvula it does not prove its superiority on the range. The excellent root system and the tendency of E. lehmanniana to remain dormant during the very dry spring months, may make it more sturdy and drought resistant in our dry climate. It grows rapidly in the summer and produces a seed crop early enough to assure a second crop after the first is cut and harvested. This grass is being tried on the range on sites similar to those used for E. curvula.

*Eragrostis chloromelas. Seed of a third exotic perennial Eragrostis from South Africa was received at the same time the seed of E. lehmanniana was received. In growth habit it is between the two just discussed. It is a handsome grass which can be depended upon to produce two crops of seed a season. It is being tried along with the others on the open range and further reports on it can be expected. The above determination may be revised later.

Eragrostis brizantha. This exotic from South Africa is coarse and spreading but it not stoloniferous. It is probably much inferior to E. lehmanniana for our purposes.

Eragrostis obtusiflora, Stoloniferous Love Grass. In our region this is a relatively rare grass. At any rate it is but slightly known to our personnel. Where it grows near Willcox, Arizona, however, it is abundant and forms pure stands. It is reported from southwestern New Mexico also. It is harsh to the touch, has very stiff, sharp-pointed leaves, and forms long rhizomes and stolons. The flats on which it grows are strongly alkaline and very wet for short seasons but the ground soon becomes dry and very hard and baked. For sites of this kind this grass is probably superior to Distichlis. In spite of its harshness this grass is quite heavily grazed at times according to reports.

We have only a small experimental plot of this at present and no seed has been collected. Its characteristics are so outstanding, however, that it seemed well to discuss it briefly.

*Pestuca arizonica, Arizona Fescue. At present our program of erosion control takes us into higher altitudes very little, first, because the erosion problem there is not usually so acute and second, because this work is usually within the boundaries of the National forests and they assume the duties of soil conservation there. Perhaps, however, a few of the grasses which are noteworthy erosion control agents at higher altitudes should be mentioned. One of the most important of these in the pine timber and in the upland parts, is the Arizona Fescue. It is a grass which

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has long narrow leaves and forms dense clumps anchored to the ground by a mass of fibrous roots. Two other grasses of similar habit but not at all related are Elepharoneuron tricholepis and Muhlenbergia montana. These three often form the greater part of the upland meadows and small parks in the pine timber. In places north of the Grand Canyon Festuca idahoensis replaces F. arizonica. It is very similar and the two are hard to distinguish.

Festuca elatior, Meadow Fescue. Seed of this can be obtained on the market. It is a common meadow grass suitable for more moist sites at practically all altitudes. It is not extremely drought resistant. It was introduced many years ago from Eurasia and has escaped in many quarters about the country. It is worthy of careful observational work in the field.

Festuca arundinacea. This Fescue is very similar to F. elatior and is probably no better or worse for erosion control work. It does well under irrigation at Tucson.

*Hilaria belangeri. This is quite commonly called Curly Mesquite. It ranges through western Texas, southern New Mexico, southern Arizona and northern Mexico, where it often covers extensive areas in pure stands. It is very aggressive, withstanding drought and quite severe grazing. It seems to be spreading into new territory. The sites on which it seems to thrive best are rocky slopes and mesas where the soil is heavy. The culms are short but rather long stolons are produced which root at the nodes and produce new bunches of grass. While the sites on which it grows are not those which are usually subject to severe erosion, the roots and stolons act as excellent soil binders. It is highly palatable especially to cattle and horses.

Our use of this valuable grass will be very limited unless we are able to produce seed in the nurseries. In its native haunts it fruits very sparsely and the ground is commonly so rocky that seed cannot be collected with power or horse-drawn strippers. Sixteen pounds of cleaned seed was collected in 1936 and this was used in the nursery in increase plots, two acres being planted at Pima.

*Hilaria jamesii, Galleta Grass. Grasses which can be expected to stage a come-back after severe overgrazing are few. Among these few Galleta is outstanding. On stretches of land in southern Utah, northern Arizona and northern New Mexico where sheep and cattle have been run during extremely dry years and where the grass cover has all but disappeared, this grass recovers rapidly where it is given the slightest chance. When you add to this its high palatability and its excellent erosion control value due to

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its strong rhizomatous character, you have a well nigh perfect grass for sites on which it will grow. On the Navajo Reservation east of the Chuska Mountains this is probably the dominant grass and one that is coming in abundantly on the fenced areas along the highway between Gallup and Shiprock, New Mexico. Mexican Springs reports it to be much more palatable for sheep and goats than Agropyron smithii, another very important grass in this region. In the Milford region of southern Utah on areas heavily overgrazed by sheep, this grass shows a more rapid recovery than probably any other of that region. If given a chance it could be expected to relieve the severe erosion during flood time in southern Utah. It should be remarked, also, that this grass is to be found in a very wide range of conditions and soil types. It thrives best on rather heavy soil that gets some overflow.

Collecting seed of this species offers a problem. Often beautifully headed grass is very short in caryopses, the grass is commonly sparse on the ground, and the stands are scattering. The growth of this species adjacent to irrigation ditches at Shiprock suggests the desirability of planting and irrigating it for seed production. Five acres have been planted at Shiprock for seed production.

*Hilari nutica, Tobosa. In the southern part of our range tobosa occupies sites comparable to those occupied by H. jamesii in northern New Mexico and Arizona. It is somewhat more confined, however, to the heavy soils along swales which receive overflow during the rainy season. It is poorly appreciated by stockmen and perhaps by Soil Conservation Service men because of its extreme abundance and its habit of forming masses of old dry leaves and dense clumps which make the ground rough. A careful study in the management of ranges on which it occurs might greatly increase the appreciation of this species. Its erosion control value cannot be questioned but it is highly probable that proper grazing and treatment of these lands would increase both the erosion control value and forage value. Mr. Riggs, proprietor of the Riggs Ranch out of Willcox, Arizona, reports this species to be one of the most valuable on his range. It seems likely that systematic discing of the land would prevent the formation of dense clumps and help the grass to spread to the low places caused by stock paths and water courses.

This grass has short rhizomes but does not spread as widely by them as does H. jamesii. The collection of seed is not difficult in fields that are smooth enough to permit the use of power or horse-drawn strippers. While the growing of this species in the nursery is hardly desirable, it seems likely that much greater amounts of seed and seed of a much higher grade could be obtained

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from fields properly levelled by discing and systematically flooded during the rainy season. Sometimes entire fields of this species are badly infested with ergot and these must be carefully avoided.

*Hilaria rigida, Big Galleta. We do not commonly expect to find grasses in this country which can be classed as bushes. Big Galleta, however, has woody perennial stems and branches at the base much like many of our shrubs. It is very common and in many places abundant in our warmest regions of the southwest where the rainfall frequently falls below three inches per annum. In many places it grows flowers and fruits almost continuously throughout the year, its periods of activity depending on the rainfall rather than on the season. Almost pure stands of it occur in the Kingman, Arizona region, on the plains east of Yuma, and on many of the lowlands in the extreme southwestern part of Arizona. It seems to have little choice in soil requirements, growing equally well in regions of drifting sand and rather heavy adobe soil. It is not uncommon well up in the mountains on very rocky slopes.

Owing to the very bunchy nature of this grass it can hardly be classed as an excellent erosion control agent. Its wide distribution, however, permits the wider distribution of stock, thus preventing heavy trampling in localized areas.

While the palatability of this species is low when the entire plant is considered, it produces a relatively large amount of palatable leaves which form a large part of the forage in certain regions.

Several attempts have been made to transplant the heavy rhizomes of this plant in the nursery without success, and young seedlings seem to have a low tolerance for alkali. The use of this very valuable species will depend almost entirely on the development of nursery or seed collecting technique. The plant must be induced by some system of cutting back or harvesting to produce seed at definite intervals. This may be accomplished in the field or with cultivated plants in the nursery.

Hyparrhenia hirta. This exotic is a bunch grass which forms dense clumps about four feet or more high. It seems well suited for a low windbreak and as a sand binder, though it is not creeping or rhizomatous. It is not hardy in the cooler parts of our region. Hitchcock reports it as probably having little forage value.

Koeleria cristata, June Grass. This is widely distributed in the west and southwest. While it does not commonly or possibly ever, form pure stands, it still constitutes an appreciable part

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of the grass over large areas. This species is so extremely variable as to be frequently unrecognized. It may be that the species will eventually be divided into two or more distinct species or at any rate, varieties. There seems to be considerable variation in the moisture conditions of the different forms of the June Grass. Its natural home seems to be the open meadows, plateaus and plains in and adjoining the Rocky Mountains. Recently a form was found quite abundant on the hills between Safford and Clifton. The site seems much drier than that normal to this grass and it may prove to be a strain better adapted to our arid conditions.

Lycurus phleoides, Texas Timothy. This seldom grows in pure stands in our range. It, however, is rather abundant in eastern New Mexico and in limited areas in southern Arizona. While it is not one of our outstanding grasses, its rather high palatability and fair root system, combined with good seed production, commend it. We have planted an acre of it at Albuquerque and if seed can be produced in this way the lowered cost of harvesting may warrant its more extensive use.

Muhlenbergia. The genus Muhlenbergia (or the Muhlys), constitutes an enormous group of grasses in the southwest. They are so numerous that they will only be discussed very briefly here:

Muhlenbergia asperifolia, Scratch Grass. In the nursery at Tucson this shows some of the characteristics so desirable in an erosion control grass. It has abundant rhizomes and forms a rather dense sod. It grows in quite dense alkali. Its usefulness is limited by its moisture requirements, as it grows only in moist or wet soil. It has a wide natural distribution occurring throughout the west.

Muhlenbergia dumosa, Cane Muhly. This is one of the grass curiosities of the southwest. The slender canes are perennial and branch quite freely. They are leafy from bottom to top with slender soft leaves which give the entire plant a plumose appearance. This grass is a handsome ornamental and it is sometimes used as such by those who are acquainted with it. The places in which it grows are nearly as unusual as the grass itself. This must be so for the grass is so little known. In places in the Baboquivari Mountains of Arizona, however, it forms pure stands in secluded spots where there is little or no grazing. It is to be found also in the Santa Rita and Santa Catalina Mountains and along Sycamore Canyon in Santa Cruz County, Arizona. Its distribution is probably much wider even in Arizona. Where it grows in pure stands the stout rhizomes almost completely fill the top soil and the

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bunches of grass cling tenaciously to the ground. What appears to be a wonder grass seems to have some limiting factors,- it does not seem to be able to withstand grazing; the hard solid perennial stems and the tender leaves all seem to go; the grass does not seem to produce a good crop of seed often; and finally, it is confined to relatively warm sites. Observations in the field and in the nursery may enable us to use it to a limited extent.

Muhlenbergia emersleyi, Bull Grass, is very common in the mountains of southern Arizona, southern New Mexico and western Texas. It is a large coarse bunch-grass, often three or four feet high with a plumose head of flowers. It is quite palatable, especially for horses. It has a dense mass of roots and serves as a fair erosion control grass. It grows well in the nursery but seems to produce no viable seed or practically none. This grass is not likely to gain any general use in our program because of its low seed productivity in the nursery. It can be recommended for ornamental purposes.

*Muhlenbergia porteri. This grass played an important part in the early history of the southwest. While its range is probably as great as it ever was, its abundance has decreased under heavy grazing until in many places it has all but disappeared where it was formerly the chief forage. From its habit of occupying clumps of brush, mesquite and catclaws, it is often called Mesquite Grass. Formerly, however, it was called Hoe Grass from the fact that those gathering it hoed it out of the bushes. In fact this was the only way it was collected, hundreds of tons being gathered each year and sold at the forts in early days for horse feed.

This grass has very long culms, often four or five feet in length on ungrazed plants but the culms which are slender and wiry recurve, fall to the ground and root at the nodes. Thus a single plant often produces a round-topped clump several feet across and three or more feet high. Unlike most of our native grasses, the culms are perennial and large clumps are often the accumulated growth of several years. In spite of the hard, wiry nature of the old culms stock, if given a chance, eat the plants down to the ground. It becomes evident that this species can be grown only where grazing is rigidly controlled.

It has been found that the seed of this grass germinates readily and the young plants thrive on open ground where no protection from brush is available. A small wisp of hay or brush, however, will often protect the small plant and enable it to become established. Mr. Collins, Assistant Agronomist on the Gila Project, reports that their best results in seeding denuded areas to grass have been obtained with this species. He also reports that it has



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not been necessary to apply a hay mulch to obtain these results. Mr. Hamilton, Regional Agronomist, suggests an experiment in seeding range land with the grass by permitting the seeds which are very light, to be blown about during a heavy wind storm. He believes the seed will lodge at the base of bushes and germinate there. If such a method proves feasible and sufficient seed can be produced, there may be a chance to rejuvenate some of our old Hoe Grass ranges.

As it is much easier to obtain seed from nursery grown plants than from those growing in brush or on the range, a patch of about two acres has been established on the nursery at Tucson and three acres at the Safford Nursery. While many of the plants are small it seems evident that we shall soon have excellent stands and we shall be able to obtain seed from them. As the plant seeds for several months, the ripening is similarly drawn out, making the collection of seed slow and difficult. The seed, too, are so small that threshing is all but impossible. These difficulties have led to the practice of raking out the tops with the contained inflorescences and running them through a rubbing machine which breaks up the heads and tops. Instead of attempting to get the pure caryopses the entire mass of macerated material is used in seeding. The fine broken up hay is spread out on the areas where seeding is desired, the hay forming a protective mulch. Promising results have been obtained in this way.

Special emphasis should be placed on the erosion control value of this grass. A. J. Bayer in writing about the erosion problem in the Thornveld in South Africa, emphasizes the apparent fact that trees in arid regions often promote, instead of retard, erosion. This seems to be the case in some sections of the southwest where mesquite growth has become so abundant that grasses are precluded. While doubtless it will be difficult to establish this grass in dense stands of mesquite, it seems to have distinct ability to grow in these bushes where the stands are not too dense and, according to observation of ranchmen and others, frequently to cause their death. The erosion control value of the grass is doubtless greater than that of the tree or shrub.

It should be mentioned that a part of the difficulty experienced in raising this grass comes from the persistent habit of jack rabbits in eating up the plants before they become established. Thus far we have resorted to poisoning rather than enclosing the areas in rabbit-proof fence.

*Huhlenbergia pungens, Blowout Muhly. It is probable that much of the Navajo Indian Reservation now covered more or less

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completely by Ephedra viridis and Muhlenbergia pungens, was once covered by other plants. At present, however, much of the wind-blown sandy area is so completely taken by these two species that a definite statement regarding the original vegetation seems conjectural. This species likes the drifting sands where the movement is not too severe and since it forms dense clumps, spreads by creeping rhizomes and is quite unpalatable even to sheep and goats. It is an ideal sand binder. Our knowledge of its propagation is nil at present and reports must await the results of observational planting which the Nursery Section or the Navajo agronomists can make in the future. While it seeds abundantly, the only way seed can be conveniently collected is with hand strippers because of the extreme roughness of sites on which it grows. Incidentally, it should be mentioned that this is one of our most handsome grasses well worthy of trial as an ornamental. This species reaches its maximum development in northern Arizona and northern New Mexico but extends as far north as Wyoming and South Dakota in the Rocky Mountains.

*Muhlenbergia repens, Creeping Luhly. Among the plants which have taken advantage of the severe overgrazing of the range in some of the southwestern mountains, is M. repens. It is very low in palatability and as it spreads rapidly by creeping rhizomes and forms dense carpets, it is an ideal erosion control plant. Like all other plants, it is limited in its usefulness by the site requirements. It, however, covers hundreds of acres of the gentle slopes in such mountains as the Capitans of New Mexico and the Dos Cabezos of Arizona. It has a persistent habit of closing in on small water courses started by cow trails and old wagon or auto ruts. On gentle slopes and in the bottoms of swales it is an almost perfect desilter. A little of it planted on the nursery at Tucson has grown vigorously and spread rapidly by rhizomes but not by seed. On the range it is not easy to locate good seed. A good collection, however, was made in 1937. Since it is very low it is best collected by means of lawn mowers with the usual hopper attachment. Its natural distribution is western Texas, New Mexico and Arizona. It doubtless is widespread in northern Chihuahua also but thus far it has been reported from but one locality.

*Muhlenbergia rigens. Deer Grass, as this one is often called, is confined to rather moist places usually in the beds of rocky washes and to steep usually north-facing slopes in the extreme southwest. It has rather coarse, stiffly erect stems from a tough hard rhizomatous base which is calculated to hold its ground even in severe floods. In fact the clumps anchor themselves so tightly to the rocks that water merely bends the culms downstream after

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which they promptly become erect or send up new culms. In spite of the coarseness of the stems stock eat the grass down very close but the hard knotty base soon sends up new culms. In fact this is a grass that is very hard to defeat in its proper site. Its chief limitation is that it requires considerable moisture. In the nursery it produces at least two excellent crops of hay and seed.

*Muhlenbergia longiligula, Slender Bull Grass, is a tall bunch grass closely resembling M. emersleyi. It does not have awns on the spikelets and the lower sheaths are not compressed-keeled. This is a good forage grass from western Texas to southern Arizona and Mexico.

Muhlenbergia subpatens, Beardless Bull Grass. Hitchcock's Manual makes this species a synonym of M. emersleyi. Field observations, however, indicate that it a well defined species which frequently hybridizes with M. emersleyi. A form in the Dos Cabezas Mountains of southern Arizona is less than two feet high and may prove to be distinct even from M. subpatens. This has long, hard scaly rhizomes and almost spicate panicles. Judging from the way it is browsed it is a highly palatable grass.

*Muhlenbergia glauca, Glaucus Muhly, occurs in the mountains in the southern part of Region Eight and in Old Mexico. It is confined to quite steep, rather dry, loose rocky slopes. It is a very leafy, rather loosely bunched grass with numerous rhizomes and looks like a very promising grass for propagation and erosion control work.

*Muhlenbergia polycaulis ranges from western Texas to southern Arizona and central Mexico. It is a perennial from a rather loose crown. The culms are numerous and leafy. The entire grass is usually not more than a foot and a half high. This grass has probably been driven back into the fastnesses of the steep rocky hills because of its high palatability.

*Muhlenbergia monticola, Mesa Muhly, is a perennial from a rather loosely tufted base, the culms being numerous and quite leafy. The panicles resemble those of M. polycaulis. It ranges from western Texas to Arizona and central Mexico and is quite similar in the sites in which it grows to that species, being confined by stern necessity, hiding itself away in rough, rocky places where stock cannot reach it.

*Muhlenbergia montana, Mountain Muhly. In the southern part of Arizona and New Mexico this species is scarce, if not rare. In the Flagstaff section, however, and along the Mogollon mesa it is

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one of the dominant grasses. It is almost constantly and abundantly associated with *Festuca arizonica* and *Blepharoneuron tricholepis*. It is a bunch grass with hard base and abundant roots. The leaves are mostly basal. To obtain pure seed hand strippers must be used but power machinery may be used to obtain mixtures of the above-mentioned species. It is probably better to plant seed in the fall, broadcasting perhaps five or six pounds to the acre. For our use the value of this species is negligible as it grows at altitudes at which we do not have projects. This year, however, we will have some seed collected and expect to give it a trial at Albuquerque and Shiprock next season.

**Muhlenbergia virescens*, Screwleaf Muhly, closely resembles *M. montana* and may be considered its southern counterpart. It is confined to the higher mountains of central and southern New Mexico and Arizona to central Mexico. This is a very important grass on the higher slopes of the Huachucas.

Muhlenbergia racemosa, the Marsh Muhly, may be considered a truly eastern grass. It extends from Newfoundland to British Columbia and south to Arizona. In fact it grows in practically all states of the Union except those of the true south and California. It is a rather loosely tufted grass with numerous broad leaves and slender culms, a mass of rhizomatous roots, and contrary to the common name, grows in many places that are not swampy such as sandy bottoms of canyons. It is, however, not very drought resistant.

**Muhlenbergia rigida*, the Purple Muhly, is confined to rocky, gravelly foothills and mountain slopes from Texas to Arizona and northern Mexico. It is a beautiful bunch grass, $1\frac{1}{2}$ to 2 feet tall with dark purple, widely spreading panicles. Very little is known regarding its palatability. What has been termed *M. rigida* grows in pure stands in the San Rafael valley in southern Arizona where it constitutes practically a pure stand and is an excellent erosion control grass.

Muhlenbergia torreyi and *M. arenicola* are called Ring grasses. *M. torreyi* is commonly much shorter, - 4 to 8 inches tall, - while *M. arenicola* occasionally reaches a height of $1\frac{1}{2}$ feet. Both are exceedingly common in the plains and mesas of western Texas, New Mexico and Arizona. The dense bunches of purple panicles make these grasses very showy. An abundance of these grasses is a definite indication of an overgrazed condition on the range. They are unpalatable but fairly good erosion control plants.

Muhlenbergia arizonica, the Arizona Muhly, is relatively

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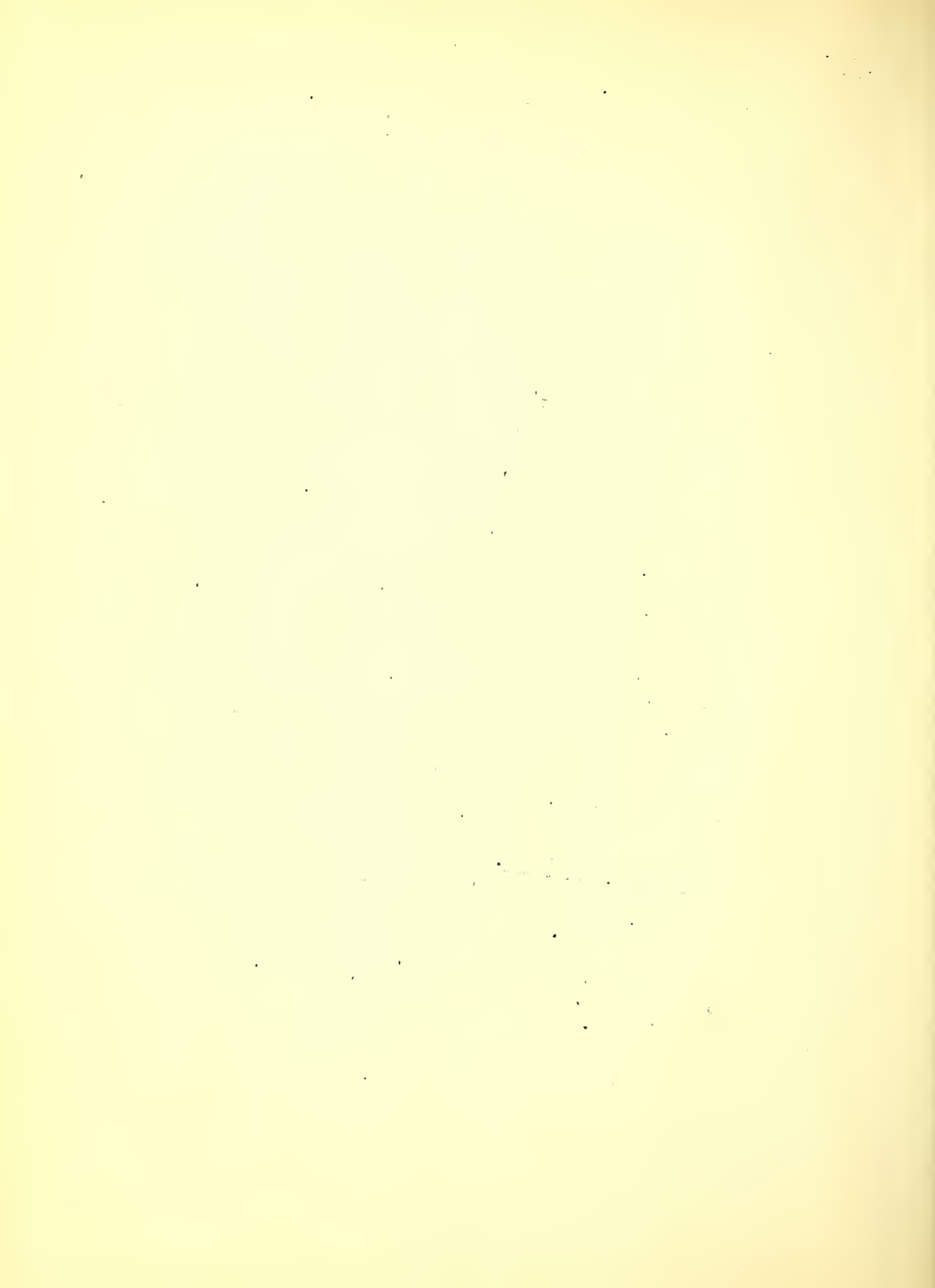
rare, being confined in our range to southern Arizona and northern Mexico. It is a very loosely rooted perennial grass found on dry mesas and bottom lands in shallow, poor soil. The grass has a loose appearance on the ground. The panicles are widespreading and the culms quite short. It is relatively poor forage and owing to the loose root system, a comparatively poor soil binder. Further study of this species may lead to a higher appraisal of its value for erosion control.

Muhlenbergia arenacea in superficial appearance, is something like M. arizonica. It, however, has a loose stoloniferous rhizomatous habit, the rhizomes being very close to the surface of the ground. In many places it forms pure stands over small areas along swales in the lower mesas of western Texas to Arizona and Sonora. It is not very palatable but owing to its rhizomatous character, is worth attention as an erosion control plant.

*Oryzopsis hymenoides, Indian Rice Grass, can hardly be classed with grasses of high erosion control value. The dense bunches are always too much separated and scattering to do more than check the flow of water slightly or retard the wind and sand. Its chief value is for forage. Formerly it was much more abundant than at present and covered thousands of sections from Idaho and Montana through the Rocky Mountains into Mexico. In fact Hitchcock's distribution map indicates that it occurs in all the western states except Oklahoma. It is found on almost all types of dry mesa soils from quite heavy to very sandy. It is a familiar sight along road grades where grazing has not been heavy. We have experienced considerable difficulty in getting a reasonable germination. Cutting tests indicate that a high per cent of seed collected has not filled out and germination tests at Tucson seem to show that seed must be dormant for a season. At Shiprock, however, no difficulty was experienced, the seed germinating as readily as most grass seeds.

As this grass is usually so scattering that it is expensive to collect and as it is one for which we have a large demand, we have established a 10-acre plot at Albuquerque and a similar one at Shiprock for seed increase.

*Oryzopsis miliacea. Under irrigation at Tucson this exotic Rice Grass is very vigorous, forming large dense clumps two feet high or more. Under cultivation it will produce two crops of hay or seed in a season. Though it has not yet been tried on the range it is probably not very drought resistant and since it will not withstand the winters at Shiprock, its range of usefulness is probably limited. It should be tried, however, as an annual in cooler climates.



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Oryzopsis coerulescens is another exotic Rice Grass which is less promising than O. miliacea. Until careful observational work in the field has been carried on, however, their relative merits cannot be determined.

Piptochaetium fimbriatum, the Pinon Rice Grass, is a remarkable grass, closely resembling the common rice grass, Oryzopsis hymenoides, but it has a very dense mass of slender, basal leaves. It has the peculiar habit of seeking extremely dry, sandy sites at the base of cliffs and in canyons. Occasionally, however, it forms almost pure stands under pinons and junipers. It ranges from Colorado to western Texas, Arizona and Mexico, is a fine forage grass and fairly good soil erosion control grass but is extremely difficult to handle in the nursery.

*Panicum antidotale, Giant Panic. Judging from observations on the nursery at Tucson, this is one of our most valuable grass introductions for warmer regions. Under irrigation it is very vigorous, forming heavy rhizomatous roots and tops five to six feet high. It is ideal as a low windbreak and as a sand binder. In winter the culms die but remain standing, thus continuing to offer protection against the wind. On the nursery it requires very little irrigation. While it freezes at Shiprock, its very vigorous first year's growth suggests its desirability as an annual. It is reported to be fair forage. We have not verified this at Tucson. At Mandan, North Dakota, this grass grows vigorously and seeds the first year, convincing proof that it can be used as an annual in cooler climates.

Panicum bulbosum, Bulb Panic. We find very little mention of this species among our Soil Conservation groups. It is, however, widely distributed in the southwest but with us is confined to canyons and valleys in the mountains where the grazing is not too severe. It is found also in Texas, Oklahoma and Mexico. The culms are often three feet or more tall and small areas are often completely covered by it. The roots are gnarled and the bases of the culms are bulbous. There are at least two distinct strains in our collections from Arizona. Both make luxuriant growth in the nursery but one is considerably larger than the other. When irrigated the bulbs all but disappear and up to the present seed production has been very disappointing. Since this is a good forage grass and a fair soil binder, further observational work on it is warranted.

Panicum hallii, Hall's Panic. The features of this little grass which recommend it are that it grows in very dry sites and

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withstands rather heavy grazing. It is not rhizomatous and it does not grow in pure stands, so its effect on holding the soil is not very great. It may have a place in grass mixtures for revegetation purposes. Its range is Texas, New Mexico, Arizona and Mexico.

Panicum obtusum, Vine Mesquite. The Forest Service has conducted some experiments and made some observations in the field on this species. Reference is made to their Leaflet No. 114. This grass can be used through a wide range both of conditions and altitudes. It is best adapted to swales and gullies in rather heavy soil where erosion is likely to be heavy when a grass cover is not present. Its long stolons spread rapidly and form a good protective cover. While this is rated as low in palatability, the upright culms with the fruiting heads are quite greedily eaten and the hay is highly prized in certain localities as feed for dairy cows. It is highly probable that we will be able to obtain seed of this in the near future as a crop raised by the farmers. The grass can be cut at seed ripening time, threshed and the straw either stacked or baled for stock food. The natural range of this panic is Arizona, Mexico and eastward to Texas and Iowa.

Panicum texanum, Texas Millet. Seed was received from Texas of this promising panic. The clumps we have at Tucson do not seem to root at the decumbent nodes, a characteristic of some strains of this grass. While it is fond of damp ground it withstands some drought. It often becomes a weed in waste fields. While this grass has been reported in our range it is rare in the extreme southwest. It extends eastward through the southern states to South Carolina and Georgia.

Panicum reverchoni, Reverchon Panic. This is another Texas grass. While it does not make the growth of P. texanum, it is much more drought resistant, growing on dry rocky and sandy land. It forms dense clumps from rhizomatous bases and should prove to be a good erosion control plant. Plants at Tucson are growing nicely though a poor stand was obtained from seed planted. It is confined in natural distribution to dry rocky, sandy hills of Texas.

Panicum virgatum, Switch Grass. In many places in the East this is doubtless a more important grass than in Region 8. With us it is found occasionally. It is often in small clumps but sometimes is found in almost pure stands of an acre or so. In all cases its extensive rhizomatous root system suggests its possibilities as an erosion control plant. While it prefers meadow lands and even wet ground, it is frequently found on dry sandy slopes.

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We have planted six acres in the nursery at Albuquerque for seed increase.

It is probably a strain of this which we obtained near White City, New Mexico, which is very promising in the nursery.

Pappophorum wrightii, Spike Pappus. This is a rather unusual grass in our region and is hardly significant for erosion control or for forage. Its natural range is Texas, New Mexico, Arizona and south of Bolivia in South America. We are trying it in the nursery, however, as its growth habit, slightly decumbent culms and perennial root system recommend it. We obtained seed from Texas of P. bicolor, a grass confined to the southwest and Mexico, and have a planting in the nursery at Tucson. Plants are two feet high, very leafy and promising as forage plants.

Paspalum dilatatum, Dallis Grass. This is a native grass of South America but has been extensively introduced into southern United States. It accommodates itself to quite dry bottom lands as well as to marshy, brackish places. Its use with us is certain to be very limited.

Paspalum distichum, Knot-grass, is only suitable for low moist places or ground under irrigation, and for this reason its use must be very limited in the southwest. It often forms low clumps with numerous stolons. At the nursery at Tucson it looks promising and for any situations where water is rather abundant it may prove to be a valuable soil binder. It is excellent forage. It is widely distributed through the east, south and west.

Pennisetum chilensis. This exotic grass does not resemble Elephant Grass mentioned later, being very much smaller and more slender. It is seldom over two feet high. Its response in the nursery is good but it has not been tried in the field. We obtained a good seed increase in 1937.

Pennisetum orientalis. This exotic Pennisetum is similar to P. chilensis. It is a rather slender grass without rhizomes. Further observations in the nursery are necessary on this as well as P. chilensis before they can be tried in the field.

Pennisetum purpureum, Elephant Grass, is even coarser than corn but is a perennial with a heavy root system. With us it is probably no more than an interesting exotic. It is not suitable for dry sites or cold climates. It is, however, grown for forage in Florida and should be tried in wet sites in our southwestern ranges.

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Phalaris tuberosa, Canary Grass. This is very vigorous in the Salt River Valley and at Tucson. It is a tall coarse exotic grass with a loose rhizomatous base and is suitable for hay and pasture. It is not drought resistant but is a wonderful soil binder in moist situations. It is not hardy at Shiprock and owing to the rhizomatous character of the roots which require a couple of seasons to become established, cannot be used as an annual.

Phragmites communis. The Mexicans call this Carrizo or Cane Grass. It grows commonly in damp places,- in fact it is a quite definite indicator of underground moisture. Occasionally it is found in stretches of desert along arroyos as in places in the Petrified Forest or even along ridges as in the Navajo country south of Shiprock, but even in such localities there is always a slight seepage. As a soil binder this grass is par excellent, its usefulness being limited only by available moisture. It is not commonly thought of as a forage plant but indications in the Navajo country are that it is quite highly palatable for sheep. The culms are variously used by Mexicans and Indians as material for lattice work in adobe huts, in mats, screens, thatching, cordage, etc. The culms are reported to contain some sugar.

While this plant produces large clusters of flowering heads, it produces very little seed in our region. For this reason its propagation must be by roots. It has not been grown in the nursery for distribution up to the present.

What appears to be a strain of this plant grows along Fish Creek above the Apache Trail Highway in Arizona. Here it has not produced flowers or seeds since it was first observed by the Soil Conservation Service personnel, nor has it produced them in cultivation in the nursery. This strain produces abundant large rhizomes and the culms root readily at the nodes where the tops happen to fall to the ground. It seems to be well adapted to moist stretches along draws or streams where erosion is likely otherwise to be heavy. This is being planted experimentally along ditch banks on the nursery at Tucson. Plants closely resembling this strain were collected near Hatch, New Mexico, and planted in the bottoms along the Gila. These are very promising as soil binders.

Phragmites communis is a grass of world-wide distribution.

Poa pratensis, Kentucky Blue Grass, has assumed a position in our erosion control program which would have been considered

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preposterous at the beginning of our work. It may be stated at the outset that it is doubted by many that our Rocky Mountain strain of Poa pratensis is the true Kentucky Blue Grass. Be that as it may, what we are calling by this name is spreading very rapidly even under heavy grazing in our comparatively high altitudes of southern Colorado and northern New Mexico. The true Kentucky Blue Grass is an introduction from Europe. Its long rhizomes and numerous fibrous roots make it an excellent soil binder, - in fact one of the best. It is highly probable next season's program will call for the collection of a quantity of seed of our southwestern grass to be grown for comparison with grass grown from commercial seed.

Another Poa worthy of mention is the Canada Blue Grass, Poa compressa, also an introduction from Europe. While it is inferior to the Kentucky Blue as a grass, it grows in sites where the latter will not grow, in very poor and even alkaline soil. It is of similar habit to the Kentucky Blue.

A Poa found on the north slopes of the Superstition Mountains, probably P. fendleriana, has rhizomes similar to the Kentucky Blue though somewhat shorter. It forms very large, dense clumps with much leafage. It is very drought resistant and may prove worthwhile at some of our lower altitudes where Kentucky Blue will not grow. We have very little seed with which to start our observational work.

Redfieldia flexuosa, Blow-out grass, as this is called, is comparable to the giant Calamovilfa. It is much smaller but has very extensive rhizomes and is a good sand binder. It is a much smaller grass and from this standpoint is not so effective an agent in retarding the wind. It has about the same distribution, not extending quite so far north. Our seed increase plot of two acres is being established at Albuquerque.

Schismus barbatus. We find very little mention of this grass in grass literature of this country. It was introduced from the old world where it is widely distributed from southern Europe through India and South Africa. In the United States it is reported only from southern Arizona. From Tucson to Phoenix it is very abundant in many places following mostly the draws in the driest portions of the desert. It is seldom more than eight inches tall. In Paradise Valley north of Phoenix it forms dense pure stands covering large areas in the more or less sandy creosote land. Where there are any winter rains this grass forms a good ground cover and acceptable forage. By June it has commonly seeded and

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dried, in which condition it is unpalatable. Compared with our Six-Weeks grass this is superior both as forage and as a ground cover. It remains green much longer but furnishes forage in the winter instead of late summer.

Mr. Gambee of Phoenix, Arizona has devised a small machine which he pushes by hand like a lawn mower on which he has mounted a small gasoline engine to run the stripping device. He has used this machine quite successfully in collecting *Schismus* seed.

Scleropogon brevifolius, Burro Grass, is relished by animals other than burros. It is one of the things that is so very common that it is poorly appreciated. It occupies large areas often of very dry flat land but not infrequently it extends up the more gentle slopes. It's a heavenly gift to fools who insist on grazing the last spear of grass from the range. While it is flowering and fruiting the long awns are forbidding to stock but after the seed are mature and fall the grass forms a good winter pasturage and the long rhizomes are very effective in binding the soil. Its normal range is western Texas, southern New Mexico, southern Arizona and Mexico. It occurs also in Argentine, South America.

Setaria macrostachya. The Bristle grasses are among our most drought resistant grasses in the extreme southwest, growing in many places where the rainfall is less than five inches. They are also among our keenest disappointments. The seed is very poor, most of it empty. While the germination is fair the transplanting which is very necessary is all but impossible. We may be able eventually to sow the seed directly in the field which may give us desired results. The heavy roots with numerous rootlets suggest that plants could be transferred from the field to the nursery and thus valuable strains secured. Almost invariably such transplanting results in killing the plants.

South of Carlsbad we secured a strain of this which has large rhizomes. In case our transplants all prove failures we may succeed in getting seed later in the season. When we learn how to handle these plants we will add a very desirable grass to our revegetation program.

The *Setarias* grown from seed at Tucson in 1937 gave remarkable results. What we have called *S. macrostachya* from different localities proves to be practically as many well defined strains as we have localities represented. We may have more than one species. *S. macrostachya*, for example, from the Baboquivari Mountains is two feet or more tall and has coarse stalks and wide leaves,

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while the same species from the Kofa Mountains is much smaller in every way but is still a vigorous bunch grass. A second species from the Baboquivari Mountains which is possibly only an annual, is very promising under cultivation.

The above discussion must reveal the fact that our *Setarias* are badly in need of careful taxonomic work.

Sporobolus airoides. This is variously called Alkali Grass and Alkali Sacaton. It is much more resistant to alkali than any of the other *Sporoboli* and occupies hundreds of acres of low bottom lands which receive overflow during flood time but which often become very dry during a portion of the year. Commonly, however, the material lowering of the water table as occurs from severe erosion where deep channels are cut through the meadows, is sufficient to completely kill the sacaton. For this reason large areas formerly occupied by this grass have become denuded or have come up to mesquite.

The palatability of alkali sacaton is rather low but it frequently constitutes a large part of the available grass during dry years and it is frequently mowed for hay.

The collection of seed is usually a problem because of the roughness of the land, the grass forming large bunches which in turn collect debris. If the ground could be given a little preliminary attention, the hummocks disked or dragged down and a little irrigation applied, the grass could be harvested with mower or binder and afterward threshed. With this in mind we have planted eighteen acres at Albuquerque. The threshing of all the *Sporoboli* is easy in any thresher with the proper screens. In 1936 some of the seed was collected with power strippers but much had to be gathered by means of hand strippers. The crop in the summer of 1937 was exceptional and was collected by mowers, rakes and power strippers.

Alkali Sacaton is widely distributed throughout the west.

Sporobolus contractus, Spike Dropseed, is easily confused with two other species. Often the spikes are long and narrow and are mostly enclosed in the sheaths. In this case it can be mistaken for *S. cryptandrus*. If the culms are stout and the spikes thick, it can be confused with *S. giganteus*. It is very similar to *S. cryptandrus* in site and soil requirements and can be planted in practically any place where the latter will grow. Further work is necessary before it can be definitely determined which is the

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better, S. contractus or S. cryptandrus. It often forms pure stands in small areas and produces an abundance of seed. Since it is desirable, however, to harvest it by machinery, we are planting six acres for increase.

The range of S. contractus is Colorado to western Texas, southern California and Mexico.

*Sporobolus cryptandrus, Sand Dropsseed, occupies wide areas across the continent which are not outstandingly sandy. In fact its value lies in part in its adaptability to a wide range of soil conditions. It is much more drought resistant than either the alkali sacaton or the giant sacaton and is frequently found on wide, dry open flats. The grass is usually quite scattering. For this reason it commonly is inferior as an erosion control agent to either the giant sacaton or the alkali sacaton where these will grow. Though commonly it comes in as a result of overgrazing it is an exceedingly valuable grass because of its ability to withstand heavy grazing and because of its relatively high palatability. It not infrequently produces two crops of seed a season and often the character of the inflorescence of the second crop is so different from the first as to confuse one as to the identity of the grass. Not infrequently the inflorescence of the first crop is very long and narrow and practically or completely enclosed in a sheath while the inflorescences produced later in the season are more or less exposed and open.

Considerable quantities of seed were collected in 1936 in southern Utah on the Milford Experimental Range.

This is probably the easiest of all our native grasses to produce in the nursery and as it can be grown in much denser stands than are found normally on the range, we are growing twenty-five acres in increase blocks. It should be remarked that in the nursery this is inclined to become a weed because of its habit of readily seeding itself.

*Sporobolus flexuosus. This is called the Mesa Dropsseed though it is hardly more entitled to this name than S. cryptandrus. It not frequently grows in drifting sand in such places as the Shinneries of New Mexico or the plains country east of El Paso. It will, however, grow in flats where there is considerable alkali. It is thus seen that it is adaptable to a wide range of conditions. It is much more drought resistant than S. airoides or S. wrightii, even more than S. cryptandrus. It is not infrequent in the low bushes in the extremely arid situation along Vermillion Cliffs, Arizona, and the desert around Toquerville, Utah. It is widespread in the southwest.

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This grass is nearly as easily produced in the nursery as S. cryptandrus. The ease with which it can be handled, together with its other qualities, recommend it. We have eleven acres for increase. We have experienced difficulty in germinating seed, it being in this respect similar to S. giganteus. Mr. Downs of the Albuquerque Nursery has been successful in germinating the latter by treating it with hot water (about 150 degrees Fahrenheit for ten minutes). Seeds of S. flexuosus will be subjected to this treatment for trial.

*Sporobolus giganteus, the Giant Dropseed, is a close relative of the Spike Dropseed (S. contractus) but is much more robust, having thick stems and wide leaves. This does not form dense clumps. It is at home in deep drifting sand and for this reason is well adapted for use as a sand binder. It produces very long, dense spikes and a heavy crop of seed. This and closely related dropseeds have been used extensively in the past by the Indians and Mexicans for food. The seed habits of this species seem to make it more suitable for this purpose than other species. In the pioneer days in New Mexico and Arizona the dropseeds were mixed with sugar, commonly the unrefined pinoche, and carried in a pouch or sack and used as a concentrated food. This was called "pinole", the term applied to any mixture of grain and sugar.

S. giganteus ranges from Texas to Arizona.

Since there are no extensive stands of this valuable grass we are planting twenty-five acres for increase. (See note on S. flexuosus seed germination).

Sporobolus wrightii, Giant Sacaton, is another large, coarse dropseed. In contrast to the giant dropseed it forms very large, dense clumps. The stems are not as coarse and the long seed tops are open. The seeds of this species were probably more generally used for human food than the seeds of other species because of the abundance of the grass. The large dense clumps occupy rather narrow draws and flats, areas which receive overflow and which are not too alkaline. The clumps not only prevent erosion but act as desilters of flood waters.

Occasionally this grass is cut for hay but the extreme roughness of the land after the large clumps form discourages land owners from mowing the grass. Also, it is much less palatable than many others even when young. It is possible that discing the land every two or three years and using the hay for ensilage might make this grass a profitable crop.

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The range of the Giant Sacaton is western Texas to southern California and Mexico.

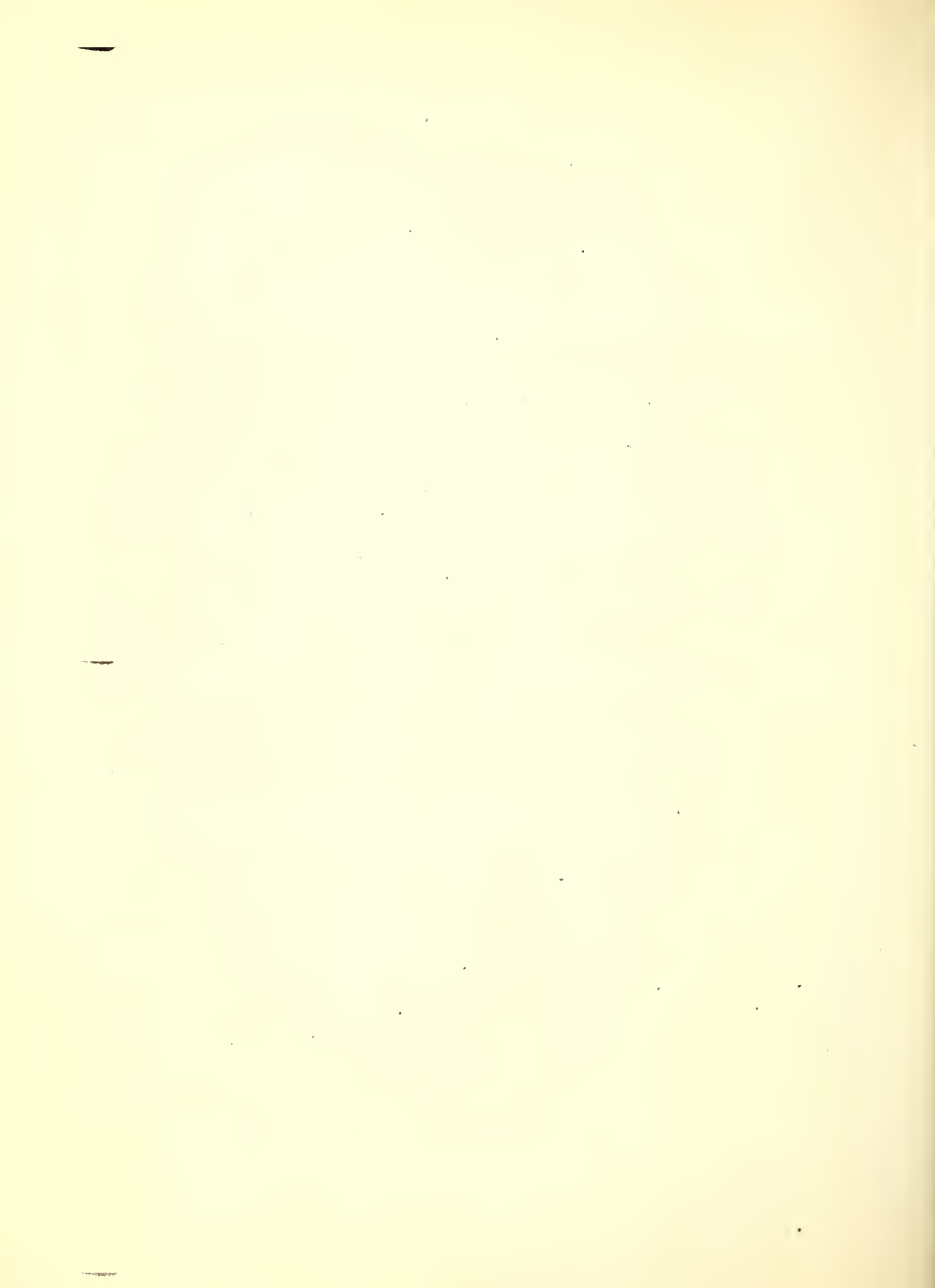
In the nursery the Giant Sacaton is easily propagated. Its seed production, however, is erratic. Twenty-three acres are being planted for increase. This experiment will be conducted not only on harvesting but also on methods of preventing the grass from forming the very large clumps.

Sporobolus fimbriatus. Packets of seed of two species of dropseed were received from South Africa labeled Eragrostis. The error is not surprising as the two bear a striking resemblance to Eragrostis spp. mentioned above. These have responded beautifully in the nursery but experiments with them have been limited to nursery performance. Further experimental work is called for before definite results can be reported. The two collections have been determined by Mrs. Agnes Chase, (Sr. Agrostologist in the United States Department of Agriculture), as S. fimbriatus.

Trachypogon montufari, Crinkle-Awn. This is a grass similar in habit to Elyonurus barbiculmis. With us it is confined to southwestern Texas and extreme southern Arizona. It, however, extends through Mexico and south to Argentina. It is frequently found with Elyonurus barbiculmis and is doubtless similarly hardy. Because of the awns it is probably inferior to E. barbiculmis for forage.

Trichachne californica. This is our common Cottontop Grass, frequent and sometimes abundant from western Texas to southern California. Usually it is too scattering to be significant as a soil erosion control agent but its swollen knotty base with tenacious roots suggests its use for this purpose as well as for its forage value.

There seems to be much confusion with us on the identity of some of our Trichachnes. Under T. californica we have several forms, all promising. We also have what we have called T. insularis from the Baboquivari Mountains and from western Texas which are by no means exactly alike. Then we have picked up others which up to now we have called Trichachne sp., but have since been determined T. californica. All are promising in nursery production. The seeds for T. patens were received from Texas. This is perhaps the most promising with the possible exception of the T. insularis from the Baboquivari Mountains. Our nursery work on these must eventually be followed by feeding experiments to determine palatability. In some localities all of these are classed as undesirable weeds.



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Triodia pulchella, Fluff Grass, is very common on depleted ranges in the southwest where the soil is dry and rocky. It is commonly associated with Creosote Bush. The low tufts are rather shallow rooted. Short stolons root freely and frequently the plants make an appreciable ground cover. The plants, however, are never grown closely enough together to constitute a dense stand or to form a good binder. Stock do not eat an appreciable amount of this grass. It is possible that its value as an erosion control agent has been underestimated and that it can be used satisfactorily as a preliminary ground cover and be gradually replaced by better species. No work has been done with this species in the nursery.

Triodia nutica. The Slim Triodia is more widely distributed in the Southwest than Fluff Grass. It has a good root system but not stolons or rhizomes. It is not usually sufficiently abundant to be a real factor as a forage plant. The clumps are rather small and the panicles narrow. There are several other Triodias in the southwest. All are interesting handsome grasses but they are not abundant enough to be of much value for forage or for erosion control. The more important ones are T. pilosa, T. albescens and T. elongata. All are bunch grasses which grow in very dry, rocky sites.

Tripsacum lanceolatum, Mexican Gamma-Grass, is a very rare grass in the United States. Three localities have come to our attention,- one in the Huachuca Mountains, one in Sycamore Canyon and one near the Mexican border south of Ruby, all in extreme southern Arizona. We, however, have it growing in some profusion on the nursery at Tucson. Up to the present we have not gotten fertile seeds in quantity. Because of its rank growth it seems possible that this might be made a commercial forage crop under irrigation. It is a perennial with large rhizomatous roots and tops resembling small corn plants. In erosion control it is suitable only to moist places along streams. A large collection of roots of this species was sent to Washington with which to experiment in hybridization with corn.

CYPERACEAE

The Sedges are too numerous and of too little significance at present to warrant more than a passing word. Carex spp., are most important. Most of them are soil binders of first quality and some are fair forage. Those, however, which are the best soil binders are suited only to stream banks,- thus their use is limited. They are grass-like plants with triangular stems and usually saw-like coarse leaves. Cyperus is best known by the common name, Nut Grass.

CYPERACEAE

It has a very wide range, almost throughout the world. Unlike many of the sodges it is reasonably drought resistant and is an undoubted soil binder. Don't plant it in your garden, however. Cladium jamaicensis is quite rare in our region though common in swamps in the east and south. It is one of the interesting plants around the edges of several of the Bottomless Lakes in New Mexico, where it forms dense stands of the tall stems which droop over the edge of the water. The seeds are abundant and doubtless supply much food for water fowl. Scirpus occidentalis is our common bulrush found in the edges of lakes and ponds. It has round, thick pithy stems which are leafless. It is worthless for forage and as it grows only in still water, has no soil-binding value. It is a godsend to the duck hunter, especially the one who can't hit them on the wing.

PALMACEAE

*Washingtonia filifera. This beautiful palia has been called Washingtonia arizonica, Arizona Palm, since some think that it is distinct from the true Washingtonia filifera which grows at Palm Springs, California. Be that as it may, the palia we have reference to here is found only in the Kofa Mountains northeast of Yuma. These mountains are exceedingly dry, the rainfall being not more than three or four inches per annum. They are very jagged and cut by deep, narrow canyons. There is no running water to be found in the mountains. The palms are found only in the very steep cuts opening into the larger canyons. Frequently these palms are thirty feet high or more and constitute a sight worth going many miles to see. The range in which they are located is about ten miles off the highway between Yuma and Quartzite, Arizona. This ten miles is extremely rocky and the road is hard to negotiate. When you visit the palms, plan to spend at least one hour to travel this last ten miles. Many naturalists and wildlife enthusiasts feel that the Kofa Mountains should be set aside as a National monument, first, to preserve the palms; and second, as a refuge for mountain sheep. In contrast to many of the southwestern ranges in which mountain sheep live, these mountains seem to be a permanent refuge. In most other ranges the sheep are there today and perhaps fifty miles away in a very short time. But even in the Kofa Mountains occasionally the water supply is very short. This should be corrected and artificial water holes for the summer rains provided. Referring once more to the palms, it is strange that anyone should care to destroy something as beautiful and unusual as these palms, yet you will find that many of the trunks are bare of the old leaf sheaths because fire bugs have set fire to them to enjoy seeing them burn. If the mountains were set aside as a National monument and a minimum amount of policing done, the future of the palms and the mountain sheep could be assured. These palms are easily propagated in the nurseries and

PALMACEAE

should be planted along our southwestern highways where the mean annual temperature is high. Groves of the trees have a marked erosion control value and the trees are possibly suitable for use in other southwestern canyons.

JUNCACEAE

The Rushes resemble the Sedges but are not closely related to them. The stems are commonly round or flat. Some are good erosion control plants but hardly drought resistant. The most common one in the west is the wire grass, Juncus balticus, so common in meadows. It has a long thick rhizomatous base and is an excellent soil binder. The stems are tough chowing for the cow but they have played a real part in the fairyland of childhood in the weaving of crowns, rings and garlands.

LILIACEAE

Asparagus officinalis, Asparagus, is not a native of North America, but its use has become almost universal and in many places it has escaped from cultivation. Where it will grow it is to be recommended as both a forage plant and as an erosion control plant. It requires too much water to be of much value except as a cultivated crop or in sandy bottoms where there is considerable moisture.

Dasylerion wheeleri, Sotol, is abundant on dry, rocky slopes from western Texas to southern Arizona and adjacent Mexico. It has long, narrow, drooping leaves on a thick crown or short trunk. The leaves have curved spines along the margins. These turn towards the free end of the leaves. In some localities the plant is abundant enough to have a noted effect as a soil binder. Since the plants are very slow-growing and are valueless, or nearly so, as forage, we are not using them in our program. The plants, however, have been of economic importance in the past. The butts have been used much as the butts of the Agave for food after being roasted in pits in the ground. A very potent distilled drink was formerly, and doubtless still is, made from the sugary juice of these butts. The plant makes an interesting ornamental.

Dasylerion leiophyllum, also called Sotol, is very similar to D. wheeleri. It is the most aggravating plant in the state of Texas. The recurved spines on the leaves curve toward the butts of the leaves and thus catch hold of the passer-by. The plants thus become very hard on pants and likewise on a man's religion.

LILIACEAE

The distribution is limited to western Texas, adjacent New Mexico and Mexico. It has doubtless been used the same as D. leiophyllum.

*Yucca elata is the common Yucca of the southern portion of our range. The trunks often grow to be ten feet high or more. Under cultivation 20-foot trunks are not uncommon. It is probable that this plant has not been properly appreciated as an erosion control plant. It has a tenacious fibrous root system and in many valleys is sufficiently abundant to constitute a real factor in erosion control. In times of severe drought stock eat the leaves to considerable extent and at times the entire plants have been ground and fed to stock, thus enabling cattlemen to tide over disastrous times. The flowers are greedily eaten by all kinds of livestock. Fortunately for the Yuccas the flowering stalks are usually out of reach. The flowers are also eaten by several tribes of Indians. If it were not for the finicky notion of the whites against eating a few insects along with their food they too would doubtless appreciate a salad made of these large succulent flowers. The roots of this plant constitute one of the amoles so commonly used for soap by the Mexicans. A bed of this plant has been grown at Tucson and so dense has it become in the bed that it suggests itself for use in plugging gullies or for forming living desilting structures and spreaders above eroding gullies.

*Yucca glauca is the common Yucca of northeastern New Mexico and the foothills of eastern Colorado. It is low, having little if any stalk, and very narrow, glaucous leaves. In places plants are very abundant. The fruits and flowers are used for food by the Indians, the leaves are sometimes used for making stable brooms, and the roots are used for soap. It seems likely that this plant could be grown for desilting and spreading structures as suggested in the discussion of Yucca elata.

*Yucca baccata, Baccate Yucca, is a low yucca with stiff, rather broad leaves. It is common in northern New Mexico and southern Colorado and extends westward to Nevada. It probably has little erosion control value but might be used by spreading structures. The fruits are used by the Indians for food both fresh and dried.

*Yucca macrocarpa, Big-fruited Yucca, is the common Spanish Bayonet in western Texas and southern Arizona. It is the ~~one~~ commonly used for ornamental planting along highways east of El Paso, Texas. The trunks become large and often 15 feet or more tall, especially under cultivation. Mooton & Standley report that the

LILIACEAE

fiber of the leaves of this plant is used extensively for basketry. Since this is more rapid growing and more easily transplanted than some of the *Yuccas* it might be well to try it for erosion control plantings.

**Yucca harrimaniae*, Harriman Yucca, is a low acaulescent form found naturally in southern Utah and southern Colorado. It forms dense colonies and may be suited for erosion control work. It grows in the heavy slippery soils with considerable alkali as well as in more rocky sites. It is extremely drought resistant and may be found suitable for erosion control work in certain sites.

**Yucca mohavensis*, Mohave Yucca, is confined to the extreme desert in northwestern Arizona and adjacent Nevada and California. It extends southward into the desert of Lower California. Trunks are three to fifteen feet high and grow either singly or in small clumps. It is doubtful if this plant has any place in our erosion control program. Seedlings in the nursery at Tucson while apparently healthy, are extremely slow growing. The one feature about this plant is that the fruits when ripe are very juicy and have a fine flavor. If it were not for the work of the pronuba moth the fruits might readily become a table delicacy.

**Yucca schottii*, Schott's Yucca, is confined in our territory to extreme southwestern New Mexico and southern Arizona. In Santa Cruz County its apparent optimum range, it grows to be ten feet high or more and frequently forms caespitose clumps a rod or so square. It has enormous clusters of large flowers which are greedily eaten by stock when they can reach them. The fruits are large and both fruits and flowers are doubtless used for food by the Indians. The flowers should be tried as salad by more adventurous wives of Soil Conservation Service.

Veratrum speciosum, False Hellebore, is widely known in the Rocky Mountains as Skunk Cabbage. This, however, is more properly applied to a very different plant of the northern and northwestern swamps, *Lysichiton kantschatense*. The *Veratrum* grows at high altitudes in wet places, forming dense stands. The plants bear large, dark green leaves which at times are greedily eaten by sheep, frequently with serious results as the plant is one of the definitely poisonous herbs. Needless to say, this plant is not recommended for erosion control work.

Molina bigelovii. This grows in the southwest in the extremely hot arid territory in Mohave and Yuma counties of Arizona and

LILIACEAE

adjacent southern California. It resembles a Yucca instead of a Bear grass and aside from its possible use as an ornamental, is probably valueless. During blooming and seed time it is one of the most handsome plants on the desert. The clusters are several feet long and two to three feet wide, and are pearly white with a tinge of green.

*Nolina microcarpa. There are two species of Bear Grass in the southwest. They are so similar in character and habit that what applies to one applies equally well to the other. Nolina microcarpa ranges westward in our territory, being common in the mountains about Tucson and northward. It reaches its maximum development in the mountains north of Globe, Arizona. Nolina greenii, or what we have been calling by this name, is abundant through Dragoon Pass in Arizona, covering several sections there. It has very short flowering stalks and differs slightly from the typical N. greenii which is common on the lower slopes of the Sacramento Mountains and the Guadalupe Mountains in New Mexico. The western type, N. microcarpa, has tall flowering stalks which stand several feet above the tops of the bunches of leaves. In regions where either species is abundant the plants are effective in holding the soil, especially around and below the clumps. The leaves are eaten by stock during storms and excessive drought. It is reported that stockmen at times use the butts and roots for stock food after grinding them up. The tall Yucca, Yucca elata, is used in the same way. According to Dr. Castetter of the University of New Mexico, the seeds of N. microcarpa have been used for food by the Indians and doubtless those of N. greenii have been similarly used. These two species can be grown from seed in the nursery very satisfactorily. Up to the present no use has been made of them in the field. Recent observation here revealed that N. greenii along the Hondo Valley in New Mexico is heavily browsed by cattle even when other vegetation is abundant.

AMARYLLIDACEAE

*Agave lecheguilla, known locally as Lecheguilla, is more limited in its distribution with us than A. schottii, being confined to western Texas and southern New Mexico. It is said to be abundant in northern Mexico. A very similar plant, possibly identical, occurs in extreme western Arizona. Lecheguilla is a commercial plant in Mexico, the leaves being used extensively for the fiber used in cordage. The caudices constitute one of the articles of market. The Lecheguilla is similar in habit to A. Schottii but the leaves are longer and are armed with hooked spines on the edges in contrast to the spineless leaves of the latter.

AMARYLLIDACEAE

The flowering stalks of the lecheguilla are also much heavier and taller than those of A. schottii. The Agaves have a marked erosion control value but whether they can be used successfully in a revegetation program is doubtful because of their extremely slow growth.

Agave huachucensis, Huachuca Century Plant, is one of the century plants which is abundant in the Huachuca Mountains of southern Arizona and some of the nearby low ranges. Plants closely resemble the common century plant but the leaves are much shorter and proportionately wider. It often forms pure stands covering small areas on rocky slopes and ridges. Comparatively recently a permit was issued to a liquor firm to harvest the caudices of this plant in the Huachuca Mountains for the manufacture of mescal, a potent alcoholic beverage possibly no worse than "that good old whiskey" which goes down smoothly and makes its victims see red. Since this Agave is slow growing it is not likely that it will be raised commercially in competition with the common century plant which is the source in Mexico of sisal fiber, of pulque, Mexico's national drink comparable to United States beer, and of the potent drink, mescal. In recent years a syrup of the agave plant has been marketed in the United States as a palliative or cure for high blood pressure, - even the drink mescal has for many years been reported as a remedy for arterio sclerosis.

There are several other Agaves in the southwest, none of which are of importance probably, except as ornamentals. One of the most promising from this point of view is Agave palmieri which has rather narrow long, very thick leaves which are dark green in color.

Agave schottii, sometimes called Anole, is so abundant in the mountains of the southwest that it is often considered a nuisance. The short stiff leaves often form a continuous carpet on dry rocky slopes. There is considerable evidence that the butts of the plants and the leaves are eaten by rodents, peccaries and probably deer. This seems to occur only in places where water is not available. It seems not unlikely that this plant may sometimes be commercialized to the extent that the caudices and root crowns will be harvested in the field since it is high in saponin or a similar substance. The plant has been used probably for centuries by the Indians and later by the Mexicans as a source of lather for washing, the hair particularly. The saponin content is similar to that of the closely related plant, Agave lecheguilla, and to several of the Yuccas.

SALICACEAE

Populus acuminata, Lanceleaf Cottonwood. This poplar is less common in cultivation than many others. Mooton & Standley in their "Flora of New Mexico" recommend it for ornamental and street planting.

Populus MacDougalii, the MacDougal Poplar, and Populus wislizenii, the Wislizen Poplar, are used in the southern part of our range for ornamental and shade trees.

Populus alba, the Silver-leafed Poplar, is far from popular in many places. It will grow almost any place where even a little moisture is assured and proceeds to make thickets in lawns and meadows and becomes very difficult to eradicate. The beauty of the tree and its value as an erosion control agent cannot be questioned. It should not, however, be planted without due thought of the consequences. It is not indigenous to the southwest but has been planted in many places and has escaped.

Populus angustifolia, the Marrow-leafed Cottonwood, is probably more suitable for planting along streams than any of our other cottonwoods. It is abundant along mountain streams from Central Arizona and New Mexico to the far north. It grows readily from cuttings and while small, furnishes much browse for cows and horses.

Populus sargentii, Cottonwood. The use of the broad-leafed poplar in our erosion control program should always be limited to sites where there is no reason to conserve moisture and to places where a quick shade is especially desirable. A bottom filled with cottonwoods is likely to be streamless, for the moisture required to supply a large cottonwood will water a much larger area of grass and quench the thirst of a few cows also. Cottonwoods are not very good erosion control plants for they wash out too easily and tend to divert water courses to new channels. Willows, especially small ones, form much greater masses of roots and bend downstream at flood times instead of being uprooted.

The Sargent Cottonwood, common to southern Colorado and northern New Mexico, grows readily from cuttings and is a fast growing tree suitable for planting about dwellings.

Salix nigra, or the common Black Willow, is probably our most effective tree as a soil binder along streams. It forms small roots in such abundance that erosion is largely or completely stopped. This can hardly be spoken of as an overlooked plant as it has probably been used more than any other tree in this region. The disadvantage of this tree is that it is practically worthless for other purposes; when it grows to any size the forage value is gone; and the wood is not suitable for posts or even firewood.

SALICACEAE

*Salix exigua, the Basket Willow, is ideal for erosion control along bottoms where there is some moisture and where erosion is likely to become extreme without a protective plant cover. This willow is low and becomes very dense on the ground. At flood time it bends downstream, allowing rubbish and water to pass easily over while the roots hold the soil. This is the willow which is so abundant along the Rio Grande bottom. It is to be found along many washes where there is water only at flood time. It grows readily from root or stem cuttings. This is the willow used by Indians in basketry, much more extensively in the past than now.

*Salix gooddingii. What is variously called Dudley Willow, Goodding Willow, or locally, Black Willow, is abundant along the Lower Colorado and the Gila rivers. It grows to be a large willow second only to the Toumey Willow in our region. This is reported to be the one being so successfully used along bottoms on the Gila Project.

*Salix exigua var. This willow, found in the canyons in the Baboquivari Mountains, is growing well in the nursery at Tucson. Cuttings grow vigorously, making great masses of rather small stems and branches and the roots become very abundant, seeming ideal for erosion control. It is so tenacious that it is difficult to dig up, sprouting from very small roots left in the soil. It seems to be more drought resistant than many.

*Salix taxifolia, Yowlaf Willow. Our attempts at growing this in the nursery have not been satisfactory. It is one of our most handsome and unusual willows. It has small silvery leaves and old trees have broad canopy tops. The tree never grows tall but does form an erect single trunk. The limbs are always pruned just as high as a cow can reach as the leaves and small twigs are excellent browse. As this tree is quite drought resistant and has a tenacious root system, it is worthy of further attempts to grow it. Apparently the only difficulty in raising cuttings is in obtaining young wood of sufficient size, the entire tops of the trees being masses of very slender branches. As this tree is confined to the extreme southern part of Arizona at altitudes of 3,000 to 4,000 feet, it may not be suitable to our more northern and higher sites.

*Salix bonplandiana var. toumeyii. The Toumey Willow is the most common large willow in Southern Arizona and Northern Mexico. It often grows to be a tree one to three feet in diameter and sometimes fifty feet high, in habit strongly resembling a cottonwood. It has a very tenacious root system. This should prove to be less satisfactory than smaller willows for erosion control.

We have other willows in the southwest but the above mentioned group seems to be most outstanding. The willows offer a very

SALICACEAE

difficult group to name. They hybridize freely and in the future outstanding willows for certain purposes may be developed.

BETULACEAE

*Alnus tenuifolia, Mountain Alder, is the shrub alder along streams throughout the Rocky Mountains to northern Arizona and New Mexico. It also occurs in the Cascades of Washington and Oregon and the Sierra Nevadas of California. Since it requires wet situations in the mountains its use for erosion control is limited though it is an excellent soil binder along mountain streams. This shrub or small tree is one of the potent reasons for the loss of religion on the part of western fishermen.

*Alnus oblongifolia, Mexican Alder, replaces the A. tenuifolia in southern New Mexico and southern Arizona. This species makes a real tree in spite of the statement regarding it in Sargent's Manual of the Trees of North America. It is not infrequently fifty feet high or more and sometimes one and one-half feet in diameter. Trees of this size are to be found by the highway from Globe to Young, Arizona; in canyons in the Gallino Mountains along Oak Creek south of Flagstaff; and canyons in the south slopes of the Santa Catalina Mountains. Large trees doubtless occur in other places as well. This tree is an excellent soil binder along mountain streams and the size of the tall straight trees suggests the use of the wood for furniture.

Betula fontinalis or Mountain Birch, extends from northern New Mexico and Arizona northward into Canada. In habit it is similar to the small alder. It is an excellent stream bank binder but can only be used at relatively high altitudes along fresh water streams. It is extremely hard on the fisherman's religion.

Betula glandulifera is a low erect slender-stemmed birch with small leaves, found only in swamps at high altitudes from Colorado northward. It is a good soil binder but its water and altitude requirements preclude its use as an erosion control agent at present in man-devised plans.

Ostrya knowltoni, the Hop Hornbeam, is a small tree and a very rare one, confined to the Grand Canyon and Oak Creek Canyon in Arizona, and to the Grand River in Utah as far as records establish its distribution. The leaves resemble those of a birch but the fruit resembles that of a hop. This tree should make an interesting novelty in arboreta, otherwise it is probably valueless. Ostrya baileyi, Bailey's Hop Hornbeam, is a quite similar tree, confined to the canyons of the Guadalupe Mountains in southern

BETULACEAE

New Mexico and adjacent Texas. It grows to be a much larger tree, frequently forty feet high and eight inches to a foot in diameter. This, like the previous species, should be grown in arboreta as a novelty.

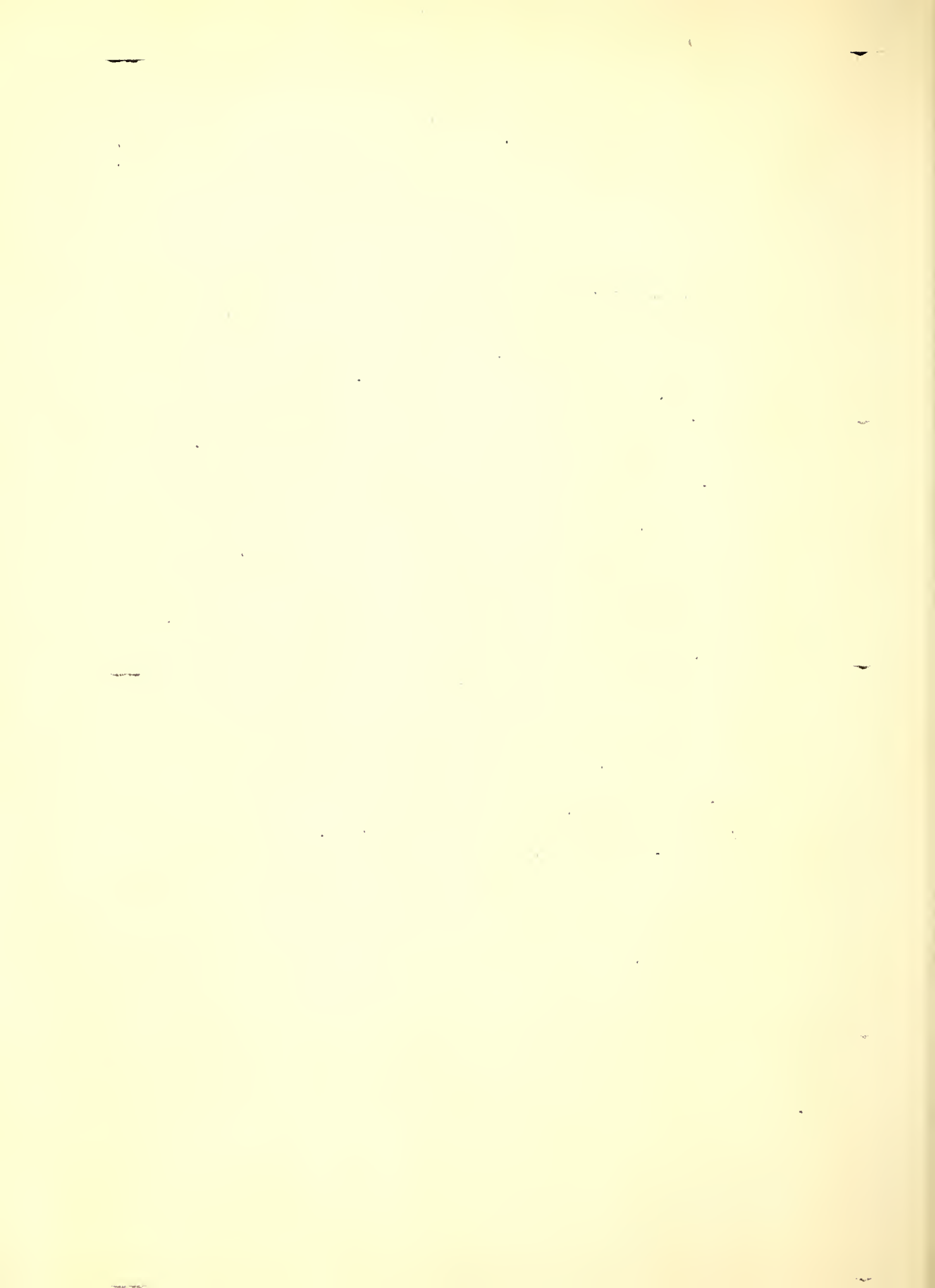
FAGACEAE

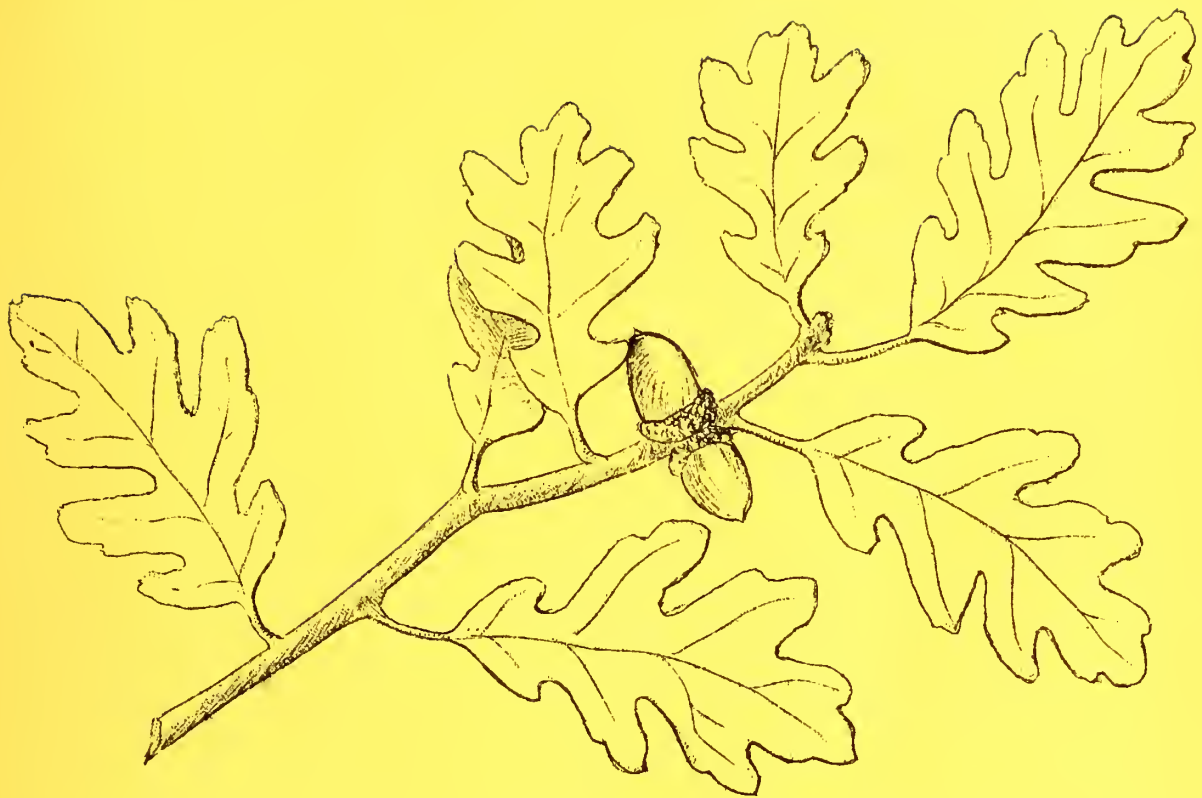
*Quercus emoryi, the Emory Oak, may well be considered a forest tree although it is found commonly in our foothills. The further they extend into the open at the base of the mountains the more widely spaced they become. Viewed from high points they lend to the landscape the appearance of orchards. Large trees are commonly hollow. The wood is very hard and heavy and excellent for firewood. The camper and hiker in the Southwest is remiss who has not broiled beefsteaks over the coals of the Emory Oak. The acorns of this tree are an important article of diet among Mexicans and Indians. In the Pine and Payson region of Arizona Indians go for a couple of weeks or more on camping trips at acorn time to pick these acorns. Most of them contain worms and if sacked and stored immediately after picking are soon a total loss. The Indians spread the newly picked acorns out in the sun and as soon as the shells begin to get hot the larvae emerge. If the acorns are planted immediately they germinate in spite of the larvae. Because of rodents it is probably not feasible to sow the acorns in the field. They should be planted in the nursery and the young seedlings transferred to the field.

While the Emory Oak is probably the most outstanding oak in the southwest, it is in no way comparable to some others as an erosion control plant.

*Quercus gambellii, the Gambell Oak, and its near relatives such as Q. neo-mexicana, the New Mexico Oak; Q. gunnisonii, the Gunnison Oak; Q. utahensis, the Utah Oak; and possibly others, all here classed as Gambell Oaks, are far superior as soil binders. In fact a little study of the Gambell Oaks about Prescott, Arizona in the White Mountains, and in the Durango region of southern Colorado, must convince anyone of their merit in holding the soil on steep hillsides.

Quercus undulata, Rocky Mountain Shin Oak, has followed ancient fires in the mountains south of Las Vegas, New Mexico, along the lower slopes around Cimarron, and in the Sacramento Mountains, carpeting and holding thousands of sections of land that would otherwise be washed into the ocean or at least part way.





Gamble oak (*Quercus gambelii*)

An excellent soil binder. The acorns supply abundant food for wild pigeons, turkeys, pigs and live stock.

FAGACEAE

*Quercus havardi, Havard's Oak, steps into the sand dune regions in the Shinneries of eastern New Mexico. What this region would be without the oak is hard to conjecture. The bushes are seldom more than two feet high but the whole country is completely covered and the sand stays put.

*Quercus turbinella, Scrub Oak. The Turbinate Oak forms pure stands covering section after section about Prescott, Arizona, and the hills north of Toquerville, Utah, as examples. These oaks are not very inspiring as trees but the hills are staying where they belong because of them. The acorns of these are collected by the Indians in southern Utah for food. While they contain more tannin than the Emory acorns, they still sustain the inner man.

Our work has been confined almost exclusively to the Emory Oak.

ULMACEAE

*Ulmus pumila, Chinese Elm, is an exotic as the name indicates. It is one of the favorite trees for street planting over wide areas at low and medium altitudes. Its drought resistance is marked though it makes very slow growth when not irrigated or planted where there is a high water table. It succumbs quickly to Texas cotton root rot and for that reason is not desirable in many parts of the southwest.

*Celtis pallida, Hackberry. An ever recurring topic when erosion control is being considered is that of wildlife and any program of conservation is hardly complete without some treatment of plants suitable for game food and game refuge. In the extreme desert probably no plant is more important than the desert hackberry. It forms dense thorny thickets and bears a very delectable fruit considered from the standpoint of the taste of birds and foxes. It has not been tried as an erosion control plant in any planting program but in its natural sites in draws and along washes, it is an excellent soil binder. It is readily propagated by seed and root sprouts.

*Celtis reticulata, Palo Blanco or White Bark Hackberry. Shade for stock is an item frequently not considered in our conservation programs. Stock often gather along bottoms where shade is abundant and trample as well as eat all available material. The western hackberry furnishes shade along many of the dry washes and even up on the dry slopes where otherwise shade would be unavailable. It forms a small symmetrical tree and furnishes an abundance of fruits relished by birds and foxes. It is easily propagated by seeds and the very long roots are excellent soil binders along washes and draws.

MORACEAE

*Morus microphylla, Native Mulberry. Few of our indigenous trees have a wider distribution than our small and exceedingly variable native mulberry. It is common throughout the southwest at altitudes from 2,000 to 6,000 feet. Frequently it grows singly but more often in dense clumps. In many places near the road from Tucson to Oracle, Arizona, it forms clumps along the bottoms of swales and along rocky washes in open dry sites. More frequently it occurs along very rocky washes and in canyons in the mountains. It is particularly fond of rocky north-facing slopes below cliffs or high bluffs. The fruits are commonly very small and are not produced in too great abundance. They are, however, more tart and of better flavor than the usual cultivated mulberry. The fruits are difficult to collect because they are scattering on the trees and mostly because the birds get to them first. The trees are excellent soil binders where they occur along washes, the long horizontal roots often effectively holding arroyo banks. It seems likely that strains can be found which will produce fruit of a size better suited to collection or which will produce trees of larger size and better growth habit. For example, a tree was found on the American Ranch out of Prescott, Arizona which bore fruit fully twice the usual size and of excellent flavor. Trees much taller than the usual run and much more shapely, were found in the Mofa Mountains of western Arizona. Since mulberries can be persuaded to grow from cuttings, these offer possibilities. The Russian and white mulberry trees also offer possibilities. They form good trees and produce abundant fruit for birds. They are not so drought resistant as the Osage Orange. The nurseries grow many thousand of these each season.

Maclura pomifera (Toxylon pomiferum), Osage Orange, is very drought resistant where it once becomes established. It forms an extensive and intricate root system when grown in hedges and makes excellent windbreaks and thickets. The wood is durable and is much used for fence posts. About 100,000 plants are ready for distribution from the nurseries to the projects. Direct seeding on the range is hardly feasible.

Humulus lupulus var. neo-mexicana. The Wild Hop has been suggested for erosion control. In certain sites where there is adequate moisture it should do admirable work. Below Nutrioso, Arizona along a valley which had become badly gulched, hops are growing over the banks and doing a remarkable work in soil binding. The hop, however, is limited to sites with considerable moisture. By preference it grows in willow and brush thickets along streams. The hop has been widely distributed throughout the world as a result of its use for the manufacture of yeast and beer. Our hop is very closely related to the hop of commerce. In fact the native hops were formerly gathered in quantity for the local markets. In 1937 our Service sent fresh plants to Cornell University for experimental

KORACEAE

work in the production of hop mildew-resistant strains. Some plants, also, were set out on the Albuquerque Nursery for trial. In this location where the ground contains considerable alkali the hop does not seem happy.

JUGLANDACEAE

Juglans major. Our native black walnut or Nogal, is worthy to be classed with our forest trees although it is frequently to be found along canyons and washes below the general forest boundary. The trees are frequently large, with spreading tops. The roots are very effective in binding boulders and dirt in washes where floods are severe. The wood is of superior quality, the stumps especially, being sold on the markets at fancy prices. The trees are, however, very slow growing and the nuts though of excellent flavor, have a shell so hard and thick that they are all but valueless. They are, however, frequently gathered and used by Mexicans and Indians. Extensive experiments have been conducted in grafting other species onto this tree. In the Huachuca Mountains, Mr. Dioderman, since deceased, grafted forty or more different species and varieties onto his native trees. Some of these grafts were very promising.

*Juglans rupestris, Little Walnut. In our range this species is confined to western Texas and southern New Mexico. It can hardly be classed as a tree. It forms much denser stands than J. major. The bottoms of many of the rocky washes leading out of the Sacramento Mountains to the east and the Guadalupe to the south, are effectively held by thickets of these large shrubs. The nuts are very small but are produced in abundance.

LORANTHACEAE

Phoradendron spp. The Mistletoes are economic plants because of their extreme destructiveness. It takes more than Christmas sentiment in the tree lover to work up an appreciation for these pests. The cottonwoods in the Rio Grande Valley are in places solid masses of mistletoe. Nor is this the only tree attacked. Walnuts, Ashes, Soapberry trees, Mesquites, Catalaws, Junipers and Cypress are attacked and a very close relative, the Arcuthobium, attacks pines. The Mexican white pine (P. strobiformis), would be an important tree in the southwestern ranges if it were not for this pest.

SAURURACEAE

Anomopsis californica, called Yerba Mansa by the Mexicans, is a low broad-leafed herb which is very abundant in wet alkali bottoms in New Mexico, Arizona, southern Utah, southern Nevada

SAURURACEAE

and southern California. It has handsome white flowers resembling anemones. The leaves and stems have a strong medicinal odor and the plant is evidently used medicinally by the Mexicans. While the plant has a good root system and forms pure stands, it is hardly suitable for erosion control as it does not thrive on even wet soil that is well drained.

POLYGONACEAE

*Eriogonum wrightii is perhaps the most common Buckwheat in the mountains of the southwest. It ranges from southeastern Texas to southern California and southward into Mexico. In many places in the foothills and even up to altitudes of 6,000 or 7,000 feet, it forms a considerable part of the ground cover and constitutes one of the most valuable of the browse shrubs. In regions where there has been no grazing this plant frequently reaches a height of three feet and forms a compact mass of slender twigs with narrow, grayish leaves. The white to pink flowers are in dense racemes. We have handsome beds of this growing in the nursery at Tucson and in the Safford Nursery. The bushes can be cut close to the ground after the seed matures without injury to the plants. This Buckwheat is worthy of extensive observational work, - in fact its value through observations on the range can be considered well established.

*Eriogonum leptophyllum is abundant in parts of the Navajo Indian Reservation, particularly in the vicinity of Mexican Springs. It is a rather slender, erect shrub which is heavily browsed, according to Mr. Musgrave, Erosion Control Practices, formerly of the Research Division, Soil Conservation Service. This Buckwheat doubtless does not have the wide range of adaptability of E. wrightii but it is sufficiently important that it should be given trial in sections similar to those about Mexican Springs.

Eriogonum polifolium, Bush Buckwheat, is a divaricately, much-branched, rigid shrub two to three feet high with congested umbels of pinkish flowers. This shrub covers thousands of acres of extremely dry foothills country and plains at altitudes of three to five thousand feet in western Arizona and eastward to the mountains about Globe. It is the shrub which is so abundant for miles along the Apache Trail in Arizona. It is sufficiently abundant to be a good soil binder but its palatability is very low. In the extreme western and southwestern part of the state of Arizona this species shades into E. fasciculatum, which is common in southern California. In the Kofa Mountains north of Yuma, Arizona, E. fasciculatum seems to be a much better browse shrub. It, however, is not sufficiently abundant to be of much value for erosion control. E. jamesii and E. bakeri are Duckweats which are very similar in

POLYGONACEAE

growth habit. Both are low shrubs clinging tight to the ground but which have flowering stalks six inches or so in height. E. jamesii has umbels of white to pinkish flowers, whereas E. bakeri has umbels of bright yellow flowers. These species are scattered sparingly through the mountains of the southwest but are more abundant farther north. As they form dense carpets on gravelly or rocky soil, they constitute excellent soil binders. They are browsed to some extent by sheep and goats and very little by cattle and horses.

In many parts of the southwest we have annual Buckwheats which come on in abundance in early spring and others which follow the summer rains. These commonly are upright, very slender plants with a single taproot. They are worthless as forage and have very little effect on checking erosion. They may be good nurse crops for more permanent vegetation in places. It would be interesting to try planting grass seed in the great flats of E. cernuum west of Kingman, Arizona. Such experiments do not seem to have been tried.

*Rumex hymenosepalus, the Canaigre, is the most common dock in the southwest. It has large, green leaves and fascicles of tuberous roots. It is confined generally to quite sandy, rather dry bottom lands, particularly in the Mesquite belt. The roots contain a high percent of tannin and have been used extensively in the past for tanning,- in fact large quantities of it were formerly dug in the Mesilla Valley region and shipped east. Very indifferent attempts have been made to grow the plant commercially but as the roots are rather slow-growing and as the initiation of the program was left to farmers who were rather indifferent, these attempts have been failures. At present the United States Department of Agriculture is doing considerable work with the plant in attempts to obtain strains which are rapid-growing or which have more desirable features than the common run of the plant. Two or three acres were planted in 1937 near Las Cruces, New Mexico. A plant carrying as much tannin as this one is worthy of careful experiments over a number of years. Outside of possible commercial use the Canaigre is valueless. There are other docks in the southwest but these are of no significance for erosion control or other purposes.

CHENOPODIACEAE

*Atriplex canescens is called Chamiza. It has a very wide range in the west, extending from South Dakota to western Texas and Westward to California. Discussions of it common in literature describe it as the plant direct from heaven. It is drought resistant, produces an abundance of palatable food for all sort of livestock the year round, and produces seed in abundance. From the erosion control standpoint Chamiza is not an ideal plant. The root system

CHEMOPODIACEAE

is deep, supplying very few surface roots to prevent erosion. The bushes which are often four feet or more high are erect, not forming a good ground cover, and other vegetation such as grass, does not grow close to the bushes. Its extensive use is not to be recommended but as a browse plant scattered through grass land it is excellent. It is admirably suited to rather heavy bottom land which is not too alkaline.

*Atriplex linearis is often confused with the ordinary Chamiza. In fact some taxonomists make it a variety of that species. It is, however, quite distinct, the bushes are much smaller, two to three feet tall, and the leaves are smaller and more slender. The seeds are not so widely winged. The range of this salt bush is much narrower than that of A. canescens, being confined to southern California and southern Arizona in rather heavy adobe soil which is not very alkaline. As forage it is probably superior to A. canescens and since the bushes are smaller it constitutes a better erosion control plant. It is probable, however, that it will not withstand the more vigorous winters beyond its normal range.

*Atriplex semibaccata or Australian Salt Bush, is hardly a bush as it is woody only at the base. It is, however, perennial but it is not hardy as such in the North. Of all our salt bushes this is the best as an erosion control agent since it is low and spreading and makes a complete ground cover. It is similarly excellent for forage. At Colorado Springs seed planted in the spring produced good plants which seeded profusely the same season. This indicates that it may be possible to raise this salt bush in cold climates as an annual.

*Atriplex sabulosus is a low erect salt bush, woody only at the base and confined to heavy quite alkaline soils. It forms almost pure stands of small extent in such regions as the Little Colorado River bottoms and ranges from southern Colorado to southern Arizona and central New Mexico. This plant is one of the striking features of the alkali flats east of Winslow where the numerous erect stems of each bush are a marked contrast to other vegetation in the region. It is particularly good sheep browse and is probably worthy of wide use in the revegetation of alkaline flats.

*Atriplex cuneata is very similar to A. sabulosus and doubtless can be used in similar sites. Its natural range is southwestern Colorado and adjacent New Mexico, Utah and Arizona.

*Atriplex nuttallii, Nuttall's Salt Bush, is one of the common low spreading salt bushes of the western central plains region.

CHEENOPODIACEAE

It occurs also in southern Idaho, Utah and Nevada but does not occur in Arizona or New Mexico. The low spreading habit of this bush makes it a very good erosion control plant though it must be remembered that none of the salt bushes with the possible exception of A. semibaccata, are comparable to grasses as erosion control agents. The chief reason is that they never form continuous stands. This plant is fair sheep browse.

*Atriplex corrugata is closely related to A. nuttallii. Its range is much more limited than the latter, being confined to southern Colorado and adjacent Utah, Arizona and New Mexico. The plants are very low, woody at the base and spreading. As an erosion control plant it is superior to A. nuttallii but does not supply as much forage. Like A. nuttallii, it occupies rather heavy adobe soils.

*Atriplex garrettii, Garrett's Salt Bush, is reported to have been brought to Lee's Ferry, Arizona by a Mormon missionary. This has never been substantiated scientifically and probably is an error as it has been found also in several widely separated localities of southern Utah. At Lee's Ferry where it grows in profusion it is herbaceous or very slightly woody at the base and is low and spreading. It is excellent stock food and worthy of very careful experimental and observational work.

*Atriplex polycarpa, Desert Salt Bush, is extremely abundant in the lower valleys of Arizona and adjacent California, Nevada, Utah and Mexico. It is perhaps our most drought resistant salt bush, and from the standpoint of forage, our most worthless one. Its use in any revegetation program can hardly be justified.

*Atriplex confertifolia, properly called Shad Bush, is a very low spiny bush with oval shiny silvery leaves. It forms dense clumps but owing to the scattered nature of the stands does not constitute a good erosion control plant. It constitutes a considerable proportion of the browse for sheep and goats in the Navajo region but is far inferior to A. canescens as a forage plant. It has about the same range as that species but is much more tolerant of alkali.

*Atriplex lentiformis, Giant Salt Bush, is our largest and most striking salt bush. It is often ten feet high or more with a main stem four or five inches in diameter at the base and a spread of ten or fifteen feet. It frequently forms dense thickets along washes and irrigation ditches in our warmer regions. Its natural distribution is southwestern and western Arizona, extreme southern Utah, southern Nevada, southern California and Mexico. It constitutes fair forage and makes a handsome ornamental as certain

CHENOPODIACEAE

bushes turn red or purple in the fall. From its habit of forming dense thickets it should prove to be of value in erosion control but its use is decidedly limited by its climatic range.

*Atriplex acanthocarpa, Texas Salt Bush, is abundant in western Texas and occurs in extreme southern New Mexico in low dry alkaline bottoms. It is a spreading shrub $1\frac{1}{2}$ to 2 feet high with scurfy leaves and bur-like fruits. It grows in almost pure stands and has some erosion control and forage value. It should find a place in our observational work.

*Salsola kali, the Russian Thistle, which is everywhere in our range, has the warmest friends and the bitterest enemies of any of our plants. In an overgrazed, exploited and all but abandoned range it is a godsend as it furnishes an enormous amount of forage while it is young. Often it has been gathered and stacked for stock food during the winter months. Its presence is always the sign, unmistakably, of abuse and exploitation, laziness and mismanagement of the land. Formerly nesters settled on quarter sections, plowed the land, tried to raise wheat or corn and eventually starved out, leaving the land to grow to seeds, usually Russian Thistle. Where this weed grows it is not usually difficult to establish Blue Grama or Western Wheatgrass. This seems to be indicated by work on the Navajo District where adequate protection against stock has been given and by contour work done in eastern Colorado and New Mexico.

*Kochia americana, Green Molly, is common in the Great Basin and extends into southern Nevada and southern California in heavy alkaline soils. It is a low shrub with a good root system but is commonly found in sites where there is little trouble from erosion. The forage value of green molly is rather low. It is, however, browsed some by sheep and goats particularly. This plant may be worthy of use in programs of revegetation since it is more resistant to alkali than the salt bushes and is superior as forage to *Sarcobatus*, *Dondia* and *Allenrolfia*.

*Eurotia lanata, Winter Fat, seems to be a bone of contention between eu-ecologists and quasi-ecologists. But which is Eu- and which is Quasi- remains for the Clements and the Weavers. Some say it represents a climax type and others that it is a certain sign of a depleted and overgrazed range. Whatever it is, sheep and cattle like it and whenever it is ruthlessly overgrazed it disappears from the range. Along with sagebrush, it cannot be classed as a first-class erosion control plant. A Mr. Thorley in southern Utah who has an extensive winter-fat range, maintains that winter fat should be heavily grazed during the winter and the bushes

CHENOPODIACEAE

never allowed to grow more than a foot high but that there should be no grazing during the summer while the shrubs are setting seed. In this way the plants always supply tender forage and reproduction is assured. His range seemed to bear out quite well his assertion. It was noticed, however, that he preached better than he practiced.

Seed collecting on stands that are kept grazed short can be done with power strippers. Where the bushes grow to be two or three feet high, seed collecting becomes a matter of hand stripping.

Dondia spp. - Seepweed. We have two or three very closely related species of this shrub in the west and southwest. They are among the very characteristic shrubs of the heavy alkali flats and as they grow on practically level ground, have little value as soil binders and they are valueless as forage. The plants frequently grow on alkali where no other plants can survive. Even these often grow to a foot or more in height and turn seared and black. The plants can usually be recognized by their dark green or purplish color and the narrow thick leaves.

Sarcobatus vermiculatus is the true Greasewood of the west. It frequently forms dense stands of bushes five to eight feet tall, on low, heavy alkali flats. These plants constitute considerable forage for sheep at times although it can never be spoken of as first-class pasturage. In regions that have been severely overgrazed the bushes often accumulate the sand and dirt from the surrounding land and form tall hummocks. These divert the wind into channels and leave the bottoms in a severe type of devastation. Greasewood can be readily recognized by the slender, round, succulent leaves which, as the specific name indicates, resemble worms.

AMARANTHACEAE

Amaranthus spp. The Fig Weeds and Cock's Combs are about as good and about as bad in some localities as the Russian Thistle. Some of us can remember cutting them for the pigs in the dim and distant past, in the good old days of the swill-barrel. Occasionally these weeds were used as greens. They are quick growing annuals which are pretty good forage but decided pests in cultivated fields. If annuals are needed as nurse crops and for ground cover these may serve the purpose. They are, however, water hogs and can be expected to deprive other plants of their needed moisture unless they are mowed early.

NYCTAGINACEAE

Abronia spp. The Sand Verbenas are conspicuous plants in sandy regions throughout the southwest and many other parts of North

NYCTAGINACEAE

America. Some are annuals and others perennials. No thought seems to have been given them from the standpoint of sand binder though they certainly play an important part in that work. They are low spreading scurfy plants often with showy flowers and large colored showy winged seeds. They seem never to be browsed. A close relative of the *Abronias*, a *Nyctaginia*, comes into the eastern part of our range, in the Shinneries of New Mexico. It is a wide spreading scurfy plant with very showy, dark red flowers. This plant should be worthy of cultivation.

Quamoclidion multiflorum is the most handsome Four-o'clock we have in the southwest. It is confined to the Juniper and Pinon belt from western Texas to southern Arizona. It frequently forms bushy plants two or three feet across and two or more feet high and when in blossom is a mass of crimson. The plant has no significance as an erosion control or forage plant but should be interesting as an ornamental.

PORTULACACEAE

Portulaca oleracea, the common Purslane, is good for a ground cover and for a nurse crop. It is good forage and is used for greens by both Indians and whites. After all is said, it is a poor substitute for grasses which will grow on the same soil.

CRUCIFERAE

The Mustards are very abundant throughout the southwest. When in flower they are easily distinguished from any other plants as they have four petals and six stamens, four long and two short. Rarely, extremely rarely, the flower has two or four stamens but why bring that up! Other signs failing, chew a leaf and if it tastes something like cabbage it is a mustard. The Mustards are too numerous to treat separately. Practically all are wayside weeds, many of them annuals. Practically all are important bird food plants and many are eaten by stock. Very few form any significant ground cover. Among the better bird food plants are the *Lepidium* or pepper grasses; *Thelypodium*; *Streptanthus*; *Thlaspi* or Penny Cress; *Bursa* or Shepherd's Purse; *Sophia* or Tansy Mustard; *Sisymbrium* and *Cheiranthus*, or Wallflower. There probably is no better quail food than the Tansy Mustards, which are abundant annual weeds throughout our range. The mustards are especially valuable in chicken yards as the leaves as well as the seeds are eaten. At least one species, the Black Mustard, *Brassica nigra*, causes green streaks to occur in the yolks of eggs. In some quarters this renders them unsalable. The suggestion has been made that eggs of this type may be exceptionally rich in vitamin. Up to the present no high-powered advertising

CRUCIFERAE

agency has promoted the sale of these streaked-yolked eggs. At least one of our wild mustards is used for salads. This, the Water Cress (Roripa Nasturtium-aquaticum), is abundant in cool, fresh-running water and in springs. One uncommon mustard (Lyrocarpa coulteri), is a weak shrub in very dry, hot sections of the extreme southwest. It is almost prostrate, thus forming a fair soil binder and it is closely browsed by stock and game. Stanleya albescens is a tall perennial with grayish, thick leaves and pale yellow flowers. It is frequently heavily browsed by stock but since it is reported to be a plant with a very perverse appetite for selenium, its use in any region should be questioned until plants from that region have been analyzed. In the nursery at Tucson this plant grows luxuriantly, forming large thick leaves of a very pleasant cabbage flavor.

CAPPARIDACEAE

Cleome serrulata is the common Colorado Beeplant, readily recognized by its large bunches of pink flowers. It is found in waste places throughout the west and is commonly considered a worthless weed. It is certain that it becomes abundant in places as a result of overgrazing. In many places it has apparently given way to Russian Thistle. The common name of the plant indicates that it is a choice with the bee. As it blossoms almost continuously from early summer until late fall if there are good summer rains, it must supply much honey. The plants which are often three to four feet high are sometimes mowed and placed in silos, the ensilage being reported to make passable cow feed. The seed and leaves are used in various ways by the Indians as food. C. sonorae is a similar plant to C. serrulata but has very short pods (one-half inch long) in contrast to those of C. serrulata, which are two to four inches long.

Cleome lutea is quite similar to the Colorado Beeplant but has bright yellow flowers. It is abundant in places but not so general as the Colorado Beeplant. There seem to be no reports of its use by stock or Indians though it is probable it can be similarly used.

Wislizenia refracta has a general appearance of the yellow-flowered beeplant but has a two-seeded, two-valved fruit instead of the long pod. It is a weed in western Texas and extreme southern New Mexico.

Polanisia trachysperma is called Clammy-Weed. It is a glandular sticky, foul-smelling weed resembling the Colorado Beeplant. The flowers are quite showy, entirely out of keeping with the foul smell of the plant as a whole. Though this plant is very

CAPFARIDACEAE

widely distributed in the west it is seldom very abundant. The tender shoots and the seeds are used in various ways by the Indians for food. Stock seem never to eat the plant in any stage.

RANUNCULACEAE

Clematis ligusticifolia or Virgin's-Bower, is the very common Clematis found almost throughout the west covering low shrubs, small trees and fences along draws. It has five to seven leaflets to the leaf, clusters of small white flowers and seeds with long plumose tails. As the vines layer readily and are fairly drought resistant it may have some soil-binding value. Its chief value is as an ornamental.

Clematis drummondii is another of the Virgin's Bowers. It resembles closely the last but will withstand more drought and a much warmer climate. As a soil binder it has little value but it has value as an ornamental.

BERBERIDACEAE

*Berberis fremontii is one of the common Algeritas extending through northern New Mexico, northern Arizona and adjacent Colorado and Utah. The form in southern Utah, however, is so different that it seems unreasonable to include it in this species. B. fremontii is a tall shrub which grows in very dense clumps. It has very hard, thick leaves with spiny edges. The fruits are black and quite juicy. The Utah form is similar except that the fruits are much larger and consist of nothing but a thin inflated shell which turns bright red on ripening. The black fruited form is used for making jelly. Both forms are to be recommended for erosion control, for hedges, windbreaks and as ornamentals. They are extremely drought resistant and naturally occupy very rocky sites. The species is reported as susceptible to grain rust and should not be planted in wheat sections.

Berberis haematocarpa, Red-fruited Algerita, is common almost throughout New Mexico. It occurs also in central Arizona near Prescott, not infrequently associated with B. fremontii. In size and habit it is hardly distinguishable from it. The fruits, however, are bright red and much better for jelly than those of B. fremontii. Because of its better fruits it is to be recommended over the latter. The same rules apply with reference to planting this species in wheat regions as it is susceptible to grain rust.

Berberis wilcoxii, Wilcox Algerita, is very similar to B. fremontii. Its range is southwestern New Mexico, southern Arizona

BERBERIDACEAE

and south into Mexico. It is so similar to B. fremontii that it can be used in similar sites and though its susceptibility to grain rust has not been determined, it should be tentatively classed as susceptible.

Berberis trifoliolata, Three-leaved Algerita, is the common Algerita of western Texas. In Wootton & Standley's Flora of New Mexico it is reported as occurring in western Texas, southern New Mexico and southern Arizona. The writer has never observed it in southern Arizona. Commonly this species is a lower bush than the above-mentioned Algeritas but it is quite similar otherwise. It can be readily distinguished from the others in having three leaflets to the leaf instead of five or more. It is listed among the barberries susceptible to grain rust. Its fruit is excellent for jelly.

Berberis fendleri is a Barberry which is very different in habit and general appearance to the Algeritas. It is a slender shrub seldom more than three feet high with numerous horizontal roots which sprout readily. The species is thicket-forming. The plants are thorny (not just the leaves), and the fruits are bright red. It ranges in the mountains of Colorado and northern New Mexico. As an erosion control plant it is ideal except that it requires a relatively high altitude and considerable moisture. The chief objection to it is its high susceptibility to grain rust and the fact that it cannot be expected to grow in regions where it will not be a menace to grain.

Berberis vulgaris is the common Barberry of cultivation. It is not a native of the west but has been planted extensively and more extensively eradicated to prevent the spread of grain rust. Hundreds of thousands of dollars were spent to get rid of this pest when Congress was much more Scotch with appropriation than it is today. It goes without saying that its use is not to be recommended.

Berberis thunbergii, the Japanese Barberry, closely resembles B. vulgaris. It has been quite extensively introduced throughout the United States as a substitute for B. vulgaris. It is not susceptible to grain rust but it is unsuited to the southwest as an erosion control plant as it is not drought resistant not suitable to very warm climates.

Berberis repens is often erroneously called Oregon Grape. It is a handsome, very low shrub with large pinnate spiny-edged leaves, bright yellow blossoms and clusters of black fruits which make delicious jelly. It grows throughout our range but only in

BERBERIDACEAE

cool, damp places in the mountains. It is not susceptible to grain rust but because of moisture and soil requirements, is unsuited for erosion control work except in very limited sites.

Berberis aquifolium probably does not occur in our range. One very similar to it, however, occurs in our southwestern ranges, the Huachuca, Santa Rita and Chiricahuas for example. It is a shrub frequently four or five feet high which closely resembles B. repens except in height. As it is confined to wet canyons it doubtless will never be of value as an erosion control plant.

*Berberis sp. A very handsome trifoliate Barberry occurs in the Kofa Mountains in western Arizona. For convenience we may call it the Kofa Mountain Barberry. It is a shrub three to five feet high with a marked tendency to droop to the ground and root or layer. Its susceptibility to grain rust has not been determined but because of its drought resistance, good fruiting habits and tendency to layer, it should be given careful trial in our observational work.

PAPAVERACEAE

Argemone spp. All of our white Prickly Poppies are enough alike that they may well be discussed together. All are weeds in waste places and are frequently abundant along sandy rocky bottoms which have been heavily overgrazed. Since they do not constitute weeds which are hard to exterminate and since the poppy seeds are almost the only food in certain sections for great flocks of doves for perhaps two months or more during late summer and fall, their use may be justified in wildlife programs. The plants are not good forage and their erosion control value is negligible. Since the genus contains both annuals and perennials their questionable use should recommend the annuals. Extensive analysis may show that this genus contains species high in narcotic content.

Eschscholtzia californica, the California Poppy, following winters of considerable rainfall puts a complete covering of gold over many of the foothills of southern New Mexico, southern Arizona and westward through the Mohave Desert and the deserts of southern Utah and Nevada. It is highly prized as a quick annual forage plant but owing to the fact that it dies in a short time and that the last remnants of the plants disappear, it is practically worthless for erosion control. It is raised as a garden flower practically throughout the United States.

SAXIFRAGACEAE

Philadelphus spp. There are two or three species of the

SAXIFRAGACEAE

Mock Orange scattered over a wide range in the west. They are tall, rather slender shrubs with narrow, rather thick leaves and handsome, large, fragrant flowers. They are frequently abundant in canyons and on steep slopes in the Juniper and Pinon belts and where accessible to stock they are usually quite heavily grazed. These bushes should be courted as ornamentals. Their extensive use in any revegetation program, however, is open to question because of their high susceptibility to the most serious disease attacking Junipers in the southwest, namely, Gymnosporangia speciosa.

Fendlera spp. There are three species of Fendleras in the west and southwest. They range from Colorado through New Mexico, Arizona and western Texas. What has been said of Philadelphia is true of Fendlera. The flowers are handsome and the bushes are suitable for ornamentals. They are heavily browsed and likewise subject to Gymnosporangia.

*Ribes aureum or yellow flowering currant, is extremely widely distributed throughout the west, occurring from the Mississippi to the Pacific and from southern Canada into Old Mexico. It has probably also been introduced into most parts of the world where it formerly did not grow. It is a choice ornamental and the fruits are frequently sold on the markets as black currants. This, however, is a misnomer as this species is quite different from the true black currant. In southern Arizona and southern New Mexico this shrub is rather rare but becomes abundant northward. It is confined in our range to cool, moist canyons or to cooler altitudes. Where it has been planted in gardens extensively it has escaped and now is to be found along fence rows and as thickets in chicken yards and orchards. In regions where it will grow it is an incomparable erosion control plant but has the disadvantage of being extremely susceptible to Pinon blister rust and white pine blister rust. For this reason it should never be planted in association with these trees.

Ribes cereum, Squaw Currant or Squaw Bush, is sometimes called the wild, red currant. For our consideration here we should include in this the closely related species, R. inebrians, as the two are very similar. They are drought resistant shrubs, widespread through the mountains of the west. Since they are slow growing and not particularly adapted to erosion control, as well as being subject to the blister rust and another Pinon disease, Colcosporium ribicola, they should not be considered in any revegetation program.

Ribes leptanthum is the most common wild gooseberry on dry bottoms and hillsides throughout southern Colorado and adjacent

SAXIFRAGACEAE

New Mexico. It has small black fruits and extremely thorny stems. In many places it forms thickets along dry washes and in regions where this is already common it should be seriously considered as an erosion control plant. It is highly susceptible to pinon blister rust but since it is already common in the pinon territory of southern Colorado and northern New Mexico, it can hardly add to the blister rust menace.

Ribes pinetorum is a gooseberry which is exceedingly abundant in many of the higher mountains of southern New Mexico and central and southern Arizona. It can readily be distinguished from other gooseberries of the region by its large, prickly fruits. Wherever this gooseberry is common it is quite extensively used for jellies. The bushes form thickets and are good erosion control plants but they require cool, high altitudes. This like other Ribes, is subject to the blister rusts.

Ribes mescalemium is a wild currant of the drier mountain ranges of western Texas and southern New Mexico. The fruits are black and are covered with glandular hairs. They are not usually considered palatable. This currant frequently forms very large, widespreading bushes. It is noteworthy because of its size and its abundance in certain pinon regions.

There are other currants and gooseberries in the southwest but they are all relatively rare and of no particular significance as erosion control plants. Some, like Ribes inerme, are locally considered good for their fruits.

PLATANACEAE

Platanus wrightii, our native sycamore, is one of the handsomest trees bordering our rocky streams in the foothills of the southwest. Like some others it is probably too common to be appreciated. There can be no doubt of its value in holding stream banks and the boulders in the washes. The large roots are frequently found extending entirely across the washes. While the sycamore is frequently planted as an ornamental and as a shade tree, it seems never to be planted with a view to obstructing erosion. A small grove of these trees was planted in a draw east of the Santa Rita Mountains, fifteen or twenty years ago. After the trees had grown to be five or six inches in diameter they were all cut down close to the ground. The grove was, however, not so easily discouraged. All the stumps sprouted and a very dense cover has resulted with roots so thick a rat would have difficulty in digging there. This suggests that these trees might be used to control erosion and to regulate the channel of mountain streams which frequently reach flood proportions.

CROSSOSOMATACEAE

Crossosoma bigelovii, is a low, slender, much-branched shrub with fasciated grayish leaves and white flowers with clawed petals. It is confined to the foothills and lower slopes and canyons of our extreme southwestern ranges. This shrub is showy while in flower but has little promise as an economic plant except possibly as an ornamental.

ROSACEAE

Cowania stansburiana, Cliff Rose, is comparable to Cercocarpus and Fallugia in erosion control value. It often forms almost pure stands on rocky dry slopes. This species has high forage value and grows through a wide range of altitudes. It ranges throughout the southern portion of the Rocky Mountains from central Colorado and Utah. Like Cercocarpus and Fallugia, this species can best be propagated in the nursery and plants transferred to the field. It grows well in the nursery.

*Cercocarpus montanus, the common Mountain Mahogany, is one of the most common shrubs in the mountains of our region. It extends also far north and south of our territory. Perhaps what is discussed here represents more than one species, variety or strain. For example, the form so common in the mountains between Superior and Miami, Arizona appears different superficially to that in the mountains about Prescott. The different forms, however, have much the same habit and can well be considered together. This is one of the best shrubs in our mountains for both erosion control and for forage. It usually forms almost pure stands covering large areas and its roots quite effectively check erosion. In many places grazing has been severe, resulting in misshapen twigs and bushes but these always put out masses of leaves and survive the ordeal.

The seeds of this shrub germinate readily and young plants can be easily transplanted. In 1937 in addition to our regular quota, sample lots of seed for nursery production were collected from the mountains above Miami, Arizona. The Baboquivari Mountains offer another desirable form. The plants from the latter place grow to be trees twenty feet high or more and as much as one foot in diameter at the butt.

Cercocarpus ledifolius is another Mountain Mahogany, forming a well shaped tree well worthy of trial as an ornamental. It is not uncommon in the Grand Canyon and in mountain ranges of southern Nevada and Utah. It is not comparable to C. montanus for soil conservation or for forage. The wood of this and of C. montanus is very hard and takes a beautiful shiny polish. It is well suited for use as bric-a-brac.

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Cercocarpus intricatus, Low Bush Mahogany. This is an intricately branched stiff shrub with small revolute leathery leaves. It seems to be practically valueless for either forage or for erosion control. It is browsed to some extent by sheep.

Prunus americana. This Wild Plum has a wide distribution, being found practically throughout the Rocky Mountains. It can in no sense be called drought resistant, being confined to stream banks or draws where there is considerable moisture. Its habit of forming thickets so dense that only small animals can get through them, renders it an excellent erosion control plant. In places it becomes a weed in the edges of meadows and around farm lots. The fruits are almost universally used by local inhabitants for making jams and jellies. There is no native plant which offers better opportunity for selection work than this. Individual trees have fruit far larger and superior in flavor to the general run of the fruit.

In 1936 300,000 seedlings were sent to the Navajo project from the Shiprock Nursery and a similar number was distributed in 1937. This wild plum is an ideal nursery plant. The seeds are easy to obtain, they germinate well, and no difficulty is met with in nursery production or transplanting. The only drawback is that the plant is very limited in its adaptability. The question naturally arises, also, about the desirability of distributing a tree which produces a mediocre fruit when it might be possible to obtain selections or other species which would produce a higher grade. As our program advances matters of this kind must receive greater attention.

Prunus bosseyi, Bossey Plum. Improved strains of this low plains cherry are being grown at Shiprock and Albuquerque. Those at Shiprock produced heavily in 1937 and the seed will be used for increase and eventual distribution.

*Prunus melanocarpa. The common Choke Cherry is very abundant in our mountains at altitudes from 5,000 to 8,000 feet. It forms dense thickets on our gentle slopes leading to streams as well as growing singly in canyons and on steep banks. In such places as the valleys west of Durango, Colorado, its erosion control value is marked. In good sites it produces an abundance of fruit which is prized for jelly. Farther south this tree is replaced by P. rufula, which is much less important as an erosion control plant as it commonly grows singly. While both of these are commonly shrubs or small trees, they occasionally grow to be quite large.



Wild plum (*Prunus americana*)

Excellent fruit for man, beast & bird

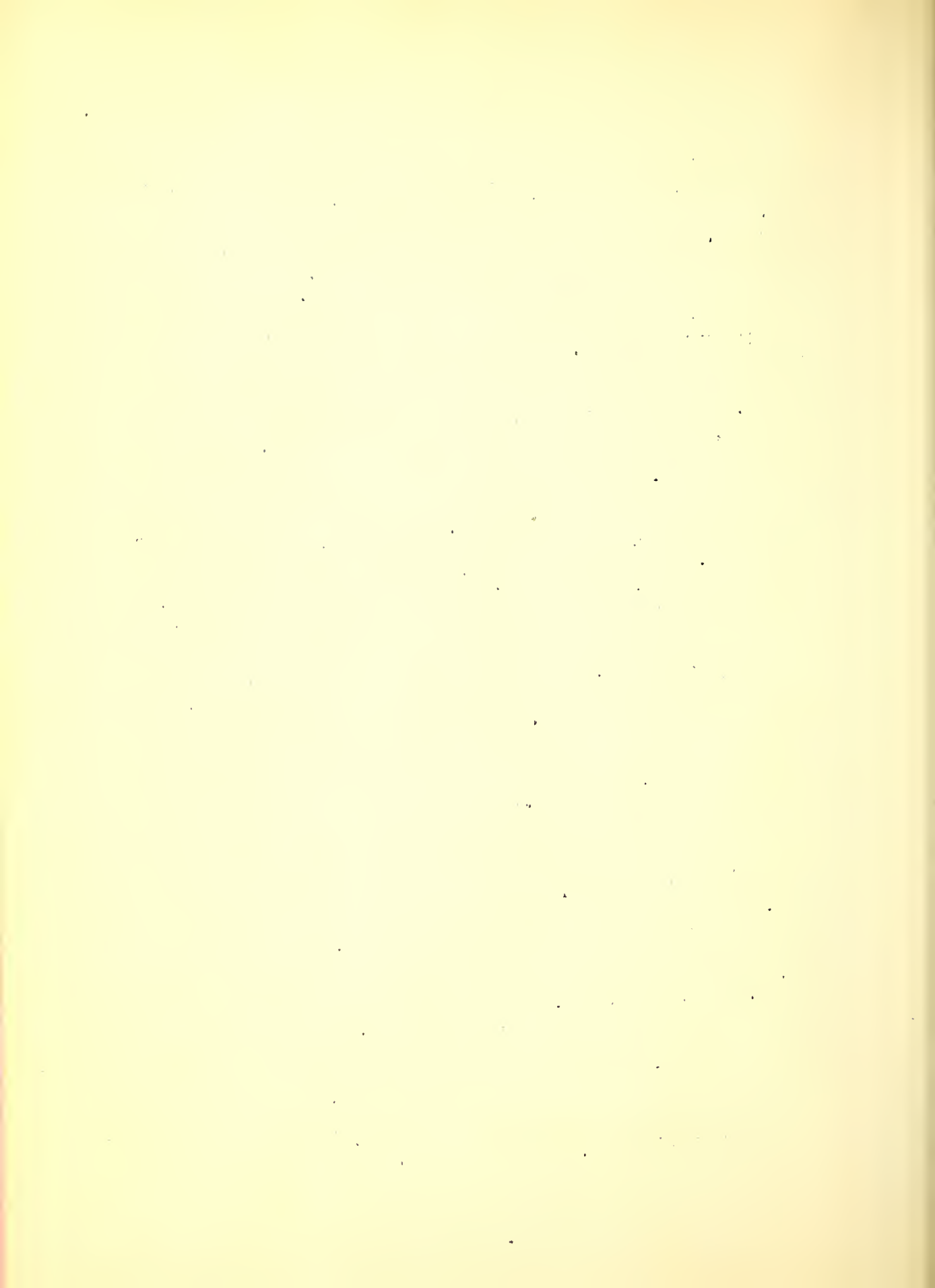
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*Prunus watsoni, Watson Sand Plum. Up to 1935 we were unable to obtain seeds of this valuable plum. It is found in the sand dune region of eastern New Mexico, western Oklahoma and Texas in very dry sites. It is an excellent sand binder and is prized locally for its fruits. It is a good sheep browse. It has long horizontal roots which sprout freely. There are several hybrids, some of which are probably offered by nurserymen under other names.

*Purshia tridentata. This shrub is known by ranchers and stockmen as Bitter Bush. The fruits when ripe are as bitter as quinine and the flavor is as lasting. Taste with cows seems a bit different from that with man for this bush is relished by all kinds of stock. Occasional plants are found in the hills about Gallup, New Mexico, and it becomes more common farther north. In southern Colorado there are almost pure stands of it on some of the steep slopes and flats. Above Bryce Canyon in Utah, flats are carpeted with it. It extends far beyond our range in the Rockies and in the Sierra Nevada and Cascade Mountains. It grows typically in association with yellow pine but extends well down in the Pinon and Juniper type. Its prostrate habit, combined with its ability to root on the layers, make it an excellent erosion control plant. It is also very drought resistant. It can be recommended for more general use in the Navajo region and in Utah.

Amelanchier spp. We have several species of Serviceberries in the southwest and doubtless they should receive a more careful treatment than is given here. In certain desert regions as in the dry rocky foothills in southern Utah and northern Arizona, serviceberry bushes are rather abundant on sites where few other shrubs or trees can exist. The ever present associate is the juniper and the combination is a bad one as one of the juniper apple diseases is almost always present and at times very damaging to both Serviceberry and Juniper. Other serviceberries are less xerophytic, that is they require more moisture and still others grow only on shaded north slopes or in canyons. Junipers in all cases are not very distant. The fruit of the serviceberry is almost as variable as the sites. Certain species produce quite pulpy, tasty fruit, (If perchance you do not enjoy it walk a few miles further without a lunch), while others produce fruit so dry and insipid as to be valueless. Frequently, too, the fruits are more masses of the fungus which causes the Juniper apple disease. From the standpoint of erosion control and as wildlife plants, the serviceberries are excellent. Their habit, however, of harboring the Juniper apple disease should greatly limit their use.

Chamaebatiaria millefolium or Fern Bush, is widely distributed throughout the west. It is, however, limited in its



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altitudinal range, commonly occurring in association with yellow pines on high plateaus as those along the Grand Canyon and on dry slopes of steep and rocky canyons. It has dense panicles of white flowers and very finely divided leaves. It has distinct erosion control value but is hardly adaptable to conditions where we have projects at present. It should be a desirable ornamental. It has no, or very low, forage value.

*Coleogyne ramosissima or Black Bush, a low, stiff, bushy shrub, covers thousands of acres in pure stand in northern Arizona and southern Utah. It is especially abundant along the Colorado River in the Vermillion Cliffs region. While this is not considered palatable, it must furnish considerable browse for sheep as flocks are ranged through it when scarcely anything else is available. It is an excellent soil binder.

Petrophyton spp. There are supposedly two species of this curious rock plant in the west. They are widely distributed at relatively high altitudes, mostly in limestone regions. They form dense solid masses of roots, caudices and leaves, usually on the face of cliffs. They are only interesting as ornamentals for rock gardens.

Holodiscus dumosus or Rock Spirea, is common at relatively high altitudes throughout the west. It has grayish hairy leaves and dense clusters of whitish flowers. It is a handsome ornamental and may have some value for erosion control.

*Dasiophora fruticosa or Shrubby Cinquefoil, sometimes called woody Potentilla, is a common, low shrub throughout the Rocky Mountains from New Mexico north. It also occurs from Labrador to Alaska and in Europe and Asia. It is a handsome low shrub with bright yellow flowers which resemble buttercups. Many mountain valleys are carpeted with this shrub and erosion stopped or retarded. It is not suitable to low altitudes, dry or alkali sites.

Throughout the Rocky Mountains at medium and high altitudes are many species of Potentilla which are closely allied to D. fruticosa but which are perennial herbs, mostly of little significance. Potentilla anserina, however, is a low creeper occupying overgrazed damp valleys in the mountains. It is a very effective soil binder but a definite indication of land abuse.

Rubus arizonica is a Trailing Blackberry not uncommon in the mountains in Santa Cruz and Pima counties in Arizona. It commonly occupies rather protected places either in canyons or on steep

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north-facing slopes, often forming dense low brush thickets. In such sites it is an excellent soil binder. The berries are so small that canaries must have trouble locating them.

There are other species of *Rubus*, all of which have some value as soil binders and as wildlife plants. All grow in sites in the mountains where erosion is not commonly active. *Rubus strigosus*, the wild Red Raspberry, however, because of its horizontal root system and sprouting habit, should be considered in certain sites in the mountains where overgrazing has started active erosion. The fruits of this plant are also delicious. *Rubus deliciosus* and its close relatives are called Thimble Berries. In places where they are abundant they are quite effective soil binders. They are much more drought resistant than the true raspberries and the blackberries. They have large leaves and large white flowers. The fruits are greedily eaten by birds.

It is not improbable that some of the cultivated raspberries and blackberries may have a place in erosion control and wildlife plans. They frequently escape from cultivation in favorable sites along canyons and draws. At times such species as the Himalaya and the Evergreen Blackberry, become real pests.

Crataegus spp. There are two, possibly four species of Haw in the southwest. *C. rivularis* has a much wider distribution than the one or more others, extending as it does from northeastern Nevada and Idaho to northern New Mexico. It is the common Black Haw of southern Colorado. It grows singly or in clumps along mountain streams and is nowhere very abundant. It is suitable for an ornamental and for bird food. As an erosion control plant it is indifferent and since it is a host for Juniper apple rusts it should be used with restraint if at all. *C. saligna* is a somewhat smaller tree or shrub confined to northern New Mexico, northern Arizona and adjacent Utah and Colorado. It is found in very rocky canyons in clumps or singly. It is readily distinguished from *C. rivularis* in the fall by its red fruits. *C. woottoniana* and *C. erythrocarpa* are reported in Wootton & Standley's Flora of New Mexico. Further studies of these two species is necessary before they can be even casually discussed.

**Fallugia paradoxa*, Apache Plume, is widely distributed in the west. With us it occupies dry, rocky washes and bottom lands from 1,000 to 7,000 feet altitude throughout our range. It is a soil conserver of the first quality, is excellent browse and survives heavy grazing. In washes the tops bend downstream during floods and often become buried, only to sprout up from the tops. Often underground stems resembling rhizomes or horizontal roots become a mass of tangled roots suggesting their use for cuttings.



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Plants of this character, however, handled with extreme care give practically no results in the nursery or the field. Seeds, however, germinate readily and one year old seedlings are not difficult to transplant. Direct planting of the Apache Plume in the field should give good results if proper methods can be developed.

Vauquelinia californica or Arizona Rosewood, is an evergreen tree with thick, grayish, linear crenate-margined leaves and large clusters of white rosaceous flowers. It is frequently a tree up to 30 feet high with a trunk 1 to 1½ feet in diameter. More often, however, it is a low, much branched shrub. The wood is very beautiful and as hard as adamant and very heavy. Apparently it has never been used for commercial purposes owing to the inaccessibility of the trees, their extreme slow growth and small size. It is confined to the southwestern ranges from southwestern New Mexico to southern California and south into Mexico. Owing to its extreme slow growth it is unsuited to erosion control work. Recently this was discovered to be the host of one of the Gymnosporangias which attacks Junipers.

Sorbus scopulina, the Mountain Ash, has a very wide range in the west but grows at relatively high altitudes. It is frequently used as a yard and street ornamental because of its beautiful pinnate foliage and large clusters of flowers and fruits. It is one of the ornamentals which is frequently sold in commercial nurseries. It has no place in a revegetation program except possibly as an ornamental along highways at high altitudes. One of the Gymnosporangia attacking Junipers lives on this as its alternate host.

Peraphyllum ramosissimum, Colorado Bitter Crab, is a tall, widely spreading shrub, very common in southern Colorado and extending into northern New Mexico. It has narrow leaves and blossoms and fruits which closely resemble those of the apple. It is an excellent soil binder on slopes just below the yellow pine region and extending into the pinons. Its use in the revegetation program cannot be recommended, however, where junipers are likely to be planted or where they are already present. It is extremely susceptible to at least two of the Gymnosporangias.

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Calliandra eriophylla, Fairy Duster, stands paramount among shrubs on our extreme southwest ranges both as an erosion control plant and as forage. It ranges throughout western Texas, southern Arizona, New Mexico and almost throughout Mexico. A good grass range well dotted with this plant can be considered the ideal stock range. This shrub can be eaten down close to the ground and thoroughly trampled and yet survive. Seed germinate readily and plants

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grow well in the nursery. Seed, however, are difficult to collect and plants with well developed root systems are hard to transplant, at least from the field.

Calliandra humilis is hardly comparable to C. eriophylla, chiefly because of its comparative scarcity. It has a wider range with us than the latter, extending farther north and reaching into higher altitudes. It is, however, confined to central and southern Arizona and outside of Mexico. It is highly palatable and a fair soil binder but does not withstand grazing well.

Calliandra reticulata is even less abundant than C. humilis. It is so small, usually not more than six inches tall, and so sparse on the ground that it is relatively unimportant either for grazing or for erosion control. Its high palatability is one reason for its relative scarcity. It has approximately the same range as C. eriophylla.

*Calliandra schottii is probably confined in our range to the Baboquivari, Santa Catalina and Chiricahua Mountains. It is a larger bush than even C. eriophylla and is more erect in habit. Clumps which have not been severely grazed are three to four feet high. Each plant is a dense clump of stems with a root system composed of numerous fibrous roots a quarter of an inch or more in diameter. This species promises to be important where it will grow within our range. Up to the present we have obtained no seed for propagation work.

Lysiloma thornberii is a very rare shrub found only in our range in the extreme southwestern mountains. It was described from material collected by Professor Thornber in the Rincon Mountains east of Tucson, Arizona. It occurs also in the Baboquivaris and doubtless others of the southwestern ranges. It quite closely resembles Acacia millifolia. In fact, the usual observer would pronounce this plant an Acacia. It is somewhat taller than A. millifolia and probably is suitable for use under similar conditions and in similar sites to that in which the last species may be used.

*Acacia greggii, Catclaw, is widely distributed throughout the desert regions of southern Arizona, southern New Mexico and Mexico. It is most abundant along draws, swales and rocky canyons from 2,000 to 6,000 feet elevation. Occasionally it makes a small tree but is more frequently a sprawling shrub. The recurved thorns make this plant unwelcome to stock and man, though it is a good soil binder and is browsed to some extent. The flowers are visited by innumerable bees and Catclaw honey is highly prized. The wood is very hard and tough and is used locally for making single-trees,

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double-trees, tool handles, wagon-body stakes and for firewood. This plant is to be recommended for use on critical areas in draws where grazing should be discouraged.

*Acacia constricta var. paucispina is occasionally a small tree but more often a tall shrub. It ranges from western Texas to southern Arizona in very dry rocky mesas and along rocky canyons and draws. The small, abundant and very fragrant balls of flowers and the straight thorns separate it readily from the Gatclaw bush. In habit this bush is much less desirable for erosion than the Gatclaw, as this has an erect habit and commonly a short single trunk from which the branches rise abruptly. The seeds of this species are easy to collect and they germinate readily. The shrubs have a low forage value.

Acacia spp. We have several Acacias in the southwest besides those already discussed (A. greggii, A. constricta var. paucispina). Some of these are thornless and more or less herbaceous but have excellent rhizomatous roots. A. lemmoni occurs in the southern part of Arizona and frequently forms a considerable part of the ground cover. The base of the plant is somewhat shrubby. The leaves are very finely divided. While this is not among the best forage plants, it is, however, browsed and its value for erosion control cannot be discounted. It occupies quite dry slopes in the lower oak belt of such ranges as the Huachuclas, Santa Rita and the Chiricahuas.

*Acacia suffrutescens is very similar to A. lemmoni. Its range, however, seems to be considerably wider, it being found in some abundance in the mountains near Globe and the plateaus near Flagstaff, as well as in the more southern ranges in Arizona. For all practical purposes it can be considered along with A. lemmoni.

*Acacia millifolia is a low to moderately tall shrub with very finely divided leaves and rather straight stems. It is found in considerable abundance on low limestone ridges in a limited range in southeastern Arizona and adjacent New Mexico. It doubtless occurs in greater abundance in Mexico. On the ridges east of Douglas, Arizona it forms considerable stands. It is heavily browsed, particularly by sheep. It is extremely drought resistant and its value as a browse shrub recommends it for revegetation programs. It is not unlikely that its range can be greatly extended. The region in which it occurs is frequently quite cold. This shrub should be tried as an ornamental.

*Mimosa biuncifera is commonly called Gatclaw although this term is possibly better applied to Acacia greggii. The entire bush, including the flowers, suggests Acacia. The leaves are finely

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divided and the stems are fortified with heavy curved thorns. The shrub is commonly low and spreading and as it occupies dry draws and canyons, is frequently a noteworthy soil binder. One reason for its excellence is the fact that stock do not normally enjoy negotiating the dense stands of the shrub. This shrub is widespread through western Texas and the southern half of New Mexico and most of Arizona. Naturally it extends into Old Mexico but it is not reported from southern California. It has very little value as forage but the extremely abundant small peas must constitute a good part of the bird food during the fall and winter. This plant is well worthy of work in selection and hybridization although it is in many places a distinct pest.

*Mimosa dysocarpa is much less abundant in our range and does not extend as far north as does M. biuncifera. It is very similar in habit but commonly does not grow as tall and consequently is a somewhat more desirable shrub. The flowers are pink and form short spikes and during the blooming time are a beautiful sight on the desert. The seed pods of this species are curious in that they fall apart in segments, each segment carrying a seed.

Mimosa lemmoni is a rare shrub in extreme southern New Mexico and southern Arizona. It does not grow as tall as the other two Mimosas mentioned. Its leaves are thorny as well as the stems and branches. Even the pods are armed with curved thorns. It is comparable in erosion control to M. dysocarpa.

Morongia occidentalis is a semi-herbaceous vine occurring in western Texas and adjoining New Mexico. It is prostrate, has finely divided leaves and is armed with numerous curved thorns. With us it is very rare but its prostrate habit and drought resistance suggest it as having possibilities for erosion control.

**Desmodium cinerascens is a tall perennial legume with somewhat woody base and erect, branching stems two or three feet in height. It has trifoliate, reticulately veined leaves and pods which form loments. The group, Desmodium, is often referred to as the Tick Trefoil because the pods have a way of breaking apart at the segments and frequently stick to a person's clothing. This plant is abundant in limited areas in the mountains of extreme southern Arizona at altitudes of 3,000 to 5,000 feet. It is not usually sufficiently abundant to be a great factor in erosion control but with some human encouragement it may prove to be worthwhile. Its palatability is probably rather low.

**This should follow Aeschynomene, p.93.

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*Desmodium bachtocaulis resembles somewhat D. cinerascens but the stems are less erect and more branches and the entire plant is more fragile in general appearance. It has rather soft, slightly hairy, trifoliate leaves which are only slightly reticulately veined. The lomenta of the pods are much smaller than those of D. cinerascens. This plant is abundant in limited areas in the mountains of extreme southwestern New Mexico and it doubtless occurs in southern Arizona as well. The root system and the semi-prostrate habit of this plant make it much more desirable for an erosion control plant than the D. cinerascens. It is also probably much better forage.

*Desmodium grahamsi is a perennial vine or semi-prostrate herb or vine with trifoliate leaves, the leaflets of which are ovate. The lomenta of the pods are quite large. The prostrate habit and divided woody root system make it an excellent erosion control plant. It is, however, relatively rare in the southwest. It occurs in the vicinity of Prescott and doubtless throughout the Mogollon region of Arizona and adjacent New Mexico. No data is available on its palatability but it is probably relatively good.

Desmodium angustifolium is a very rare and handsome tick trefoil from Santa Cruz County in Arizona. The leaves are simple and very long and narrow, the blades being often as long as five inches. The Desmodium are commonly three-foliate. The plant has an excellent root system and should make a good erosion control and forage plant. It is extremely rare, however, and has never been grown in the nurseries.

Desmodium bigelovii and D. rosei are annuals, possibly of no significance. These plants are confined to the southern part of New Mexico and adjacent Arizona. It may prove interesting and profitable to try these in observational work as annual ground cover legumes.

*Prosopis glandulosa. This Mesquite is much smaller than P. velutina, - in fact it is commonly a low shrub frequently half covered by sand. Vast areas in southern New Mexico and adjacent Texas are covered with low clumps of this mesquite and with sand dunes. The question naturally arises in one's mind what would happen if the mesquite were not there. It is certain the sand dune condition is caused primarily by overgrazing. It may be that the mesquites in the dunes aggravate the movement of the sand by diverting the wind into channels.

These sand dunes offer an excellent opportunity for a study of grasses suitable to these sites. Setaria macrostachya, Stipa cernuosa and exotics such as Elymus sabulosus and Aristida pinnata

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should help to fix the small dunes. Prosopis glandulosa offers the same opportunity to make selections for fruits as P. velutina.

*Prosopis velutina. There can be very little excuse for planting this mesquite for erosion control. Along river bottoms it has become sufficiently dense to crowd out all grass and most other vegetation. During heavy rains it is probable the top soil is more readily carried off than it would be if the ground were covered with grass or even weeds, such as Russian Thistle. Mesquites have steadily spread on grazing land until they occupy even much land on the slopes of hills. Mesquite trees are browsed but many a cow has starved to death in a mesquite thicket. The chief value in the mesquite is the fruit. All kinds of stock grow fat when the beans begin to drop. Occasionally, however, horses die of impacted bowels from eating the pods. At the time of ripening the beans themselves are too hard to be digested and stock eating the pods easily disseminate the seeds. A broad trail of mesquites extends from Texas and Oklahoma to Las Cruces, New Mexico, where stock in early days were driven westward.

Prosopis juliflora. It has been stated that this species, which is very closely related to P. velutina, was introduced many years ago into the Hawaiian Islands and has become a tree of great economic importance. It is probable, however, that the tree of the Hawaiians is P. chilensis, a native of Chile.

Most everyone who has traveled through mesquite country has noticed the difference in the size and color of the mesquite pods on different trees. Some are very long, thick, juicy and sweet. Since the pods rather than the seeds constitute the food value, it should be possible to obtain good selections. The difficulty is that mesquites do not grow well from cuttings and valuable selections cannot be obtained through seeds. The propagation of these selections is evidently a problem for the Bureau of Plant Industry to undertake. Another problem is the hybridizing of the mesquite with other trees, such as the Carob or possibly some of the Acacias.

For those who have had a lapse of memory it should be recalled that the mesquite has been one of the chief sources of food for the Indians for perhaps several hundred years. They use the seeds as well as the pods. Mr. D. H. Gorsuch of the Wildlife Section of the Forest Service, reports the mesquite beans to be the chief food for quail for long periods in summer, fall and winter. They eat the seeds from the faeces of stock which consume the pods.

KRAMERIACEAE

Krameria glandulosa, Rhatany. The *Kramerias* are curious shrubs, so curious that taxonomists disagree about their relatives. Some say they go in with the peas and some say they are related to the milkwort. The flowers are pea-like but the sepals are the showy part and there are only four stamens. The fruit is almost like a nut and is covered with prickles. The above species is an excellent browse plant and is widely distributed: Western Texas through southern New Mexico and southern Arizona to southern Utah, Nevada and California. It also extends from Chihuahua to Lower California in Mexico. Dry rocky sites are most suitable to it. In the nursery it has proved curious. A large bed next to a plot of Parryella filifolia was planted to Krameria glandulosa. The young plants were uniform upon germination. Later, however, all the plants away from the *Parryella* bed died while those close to it began to grow rapidly. Shade? No, for the *Krameria* was south of the *Parryella* and when the *Krameria* plants began to show best growth the *Parryella* had been dug up. The *Parryella* sprouted from the roots. There is no evidence of damage to the *Parryella* and no apparent evidence of root parasitism. It seems likely that efforts to grow *Krameria* without proper association with certain selected plants of symbiotic importance to them, will meet with failure.

Krameria secundiflora strikingly resembles K. glandulosa. It, however, is woody only at the base and the top trails on the ground. As it is more herbaceous than K. glandulosa, it is much better forage. This ranges as far east as Florida but extends only as far west as central Arizona, whereas K. glandulosa extends into southern California but does not grow further east than western Texas. Both species extend far down into Mexico.

There are other species of *Krameria* which may prove to be important.

CASSIACEAE

Hoffmanseggia densiflora, usually called Hog Potato, is common in waste places and abandoned lands from southwestern Texas to southern California, southern Nevada and southern Utah. It is a low, herbaceous leguminous perennial with numerous thick, tuberous roots, finely divided leaves and yellow flowers. The roots have been used in the past for human food, especially by the Indians, and hogs are very fond of them. Since this plant occupies very poor wasteland and since it is a soil binder and a legume, it is worthy of considerable attention. It should be possible by selection and perhaps breeding, to produce plants which will fill a real niche in the economy of the southwest. There are several other species, some of which may be suitable for revegetation work.

CASSIACIUM

Caesalpinia gilliesii or Bird of Paradise, is a tall shrub with bipinnate leaves, very fine leaflets and large showy yellow flowers. It was introduced in the southwest at a very early date as an ornamental and has escaped from cultivation in many localities. Along rocky arroyos in the foothills it probably has some erosion control value. It is, however, valueless as forage and because of its disagreeable odor, not too desirable as an ornamental.

Cassia wislizenii. This is totally unlike the common Cassia of the southwest. It is a spreading bush with small dark green leaflets and large fragrant yellow flowers. It is confined to a narrow belt in southwestern New Mexico and southeastern Arizona within the United States but extends into Mexico. This should be used extensively as an ornamental in the warmer parts of our range. It is almost valueless for erosion control or for forage.

Cassia covesii is a low gray herbaceous perennial with rather large leaflets and yellow flowers. It is very common in southern New Mexico and southern Arizona in the foothills. It is of little value for erosion control and none for forage, and among other things has a very offensive odor. Closely related to this are C. lindheimeri, and C. roemeriana and C. bauhinoides, scattered near the Mexican border in Texas, New Mexico and Arizona.

Cassia leptocarpa is a rather tall bush-like herbaceous perennial with coarse green leaves, pointed leaflets and very long, squarish pods. It has an offensive odor and is of no forage value. It is sufficiently abundant, however, to be a fair soil binder. It ranges from western Texas, southern Arizona and southern New Mexico, south to South America.

It is highly probable that all of these Cassias are important bird food plants as they produce large amounts of small pea-like seeds.

Chamaecrista nictitans, Partridge Pea, is a sensitive plant which has an extremely wide distribution as a weed. It occupies waste places and over-grazed areas. Being a slender, short-lived annual with very small roots, it has but little value as an erosion control plant although it may prove to be worthwhile as a quick pea crop and as a nurse plant for grasses or other perennials. It can readily be recognized by its yellow flowers and distinctly sensitive leaves.

*Chamaecrista virgata is a perennial with a hard woody root and herbaceous top. It is sufficiently abundant in places to be a real factor in erosion control, and apparently it is a much better

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forage plant than the annual. It is confined in our region to southern Arizona and probably adjacent New Mexico.

Cercis occidentalis. When our Western Redbud is better known doubtless it will be more widely used as an ornamental. It closely resembles the eastern redbud which lends such beauty to the hardwoods regions in the east in early spring. With us the redbud is a large shrub or small tree found only in rather secluded places in canyons and rock crevices in southern Utah, Nevada, California and Arizona. It has been located in the Grand Canyon where it is abundant; in the Superstition Mountains and in the Baboquivari Mountains in Arizona. No experimental work has been carried on with this species to determine its adaptability for planting. It should be remembered that it is a legume that is drought resistant and that it is a beautiful shrub or tree.

*Gloditsia triacanthos, the Honey Locust, has been planted in many sections of the United States and elsewhere. Some years back contests were conducted in the schools and elsewhere to obtain the largest seed pods. Some experiments were conducted to determine the sugar content of the pods. In every way the tree shows remarkable possibilities. It is much hardier than black locust, not being subject to borer attacks but does not produce such durable wood. The pods constitute excellent food for stock and may be utilized for human consumption. If methods can be devised to grind the pods and seeds to add to their value for food for stock, the use of this species should be accelerated. As a tree for range planting in Region 8 its use has been at least for the present abandoned because of severe damage to the young trees by rabbits.

Parkinsonia aculeata is probably the most important of our Paloverdes from the standpoint of use. It is a handsome ornamental which has gained a place in street planting programs in our warmer sections. Under irrigation it is rapid growing. It has been introduced to South Africa and has escaped cultivation in many places. It can hardly be considered an erosion control plant as it is not sufficiently abundant. Its beans have been used in the past for human food and they are greedily eaten by animals when they can be reached.

Cercidium torreyanum, the large Paloverde, is one of the most common sights on the desert. Doubtless its roots play an important part in holding the soil along dry washes. Since our work thus far has been confined to regions in which none of the paloverdes will grow, this tree has not gained a place in our planting or nursery programs. It, however, plays a part in the economy of the desert. The beans are browsed by stock and were formerly eaten by Indians.



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It is hard to understand why more use has not been made of beans produced in such abundance as those of the paloverde. If they are digestible, as is evidenced by the fact that they were formerly used, it is high time some domestic science teacher or hill-billy school teacher learns how to stew them. The wood is of rather poor grade as the sap-wood decays quite rapidly and is soon honey-combed by termites. It, however, brightens many a camp fire and liberal quantities are mixed with mesquite and sold to the unsophisticated in the towns.

Parkinsonia microphylla, the small Paloverde, is very similar to Cercidium torreyanum. It does not commonly reach so large a size. The beans are comparable to those of the other paloverdes.

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Sophora secundiflora, Coral Bean, is reported in Sargent's Manual as a tree. It is, however, usually a shrub three or four feet high. It is limited in its range to western Texas and extreme southern New Mexico in rocky limestone canyons. The leaves resemble those of a Sumac but are light grayish green, thick and evergreen. The blue flowers grow on long, drooping spikes and are very handsome. The seeds contain a poisonous alkaloid and the plants are reported to be poisonous to stock. They, however, are extremely rarely browsed. This shrub is one of the most beautiful in the southwest and well worthy of extensive cultivation as an ornamental.

Sophora arizonica is very similar to S. secundiflora but has smaller evergreen leaves and shorter spikes of blue flowers. It is confined to very limited areas in Arizona, apparently having been reported only from the lower foothills at the base of the north end of the Graham Mountains and the desert regions south and west of Kingman. This plant should be used for ornamental purposes. Since it is probably somewhat poisonous it should not be used in any re-vegetation program.

*Sophora stenophylla is a very interesting perennial herb with finely divided leaves and capitate clusters of large blue flowers. It is a typical sand plant, confined to regions of drifting sand. It has long, horizontal roots which sprout freely and as it frequently forms a complete ground cover, it is an excellent sand binder. It seems to be unpalatable to stock. Its known distribution is confined to northern Arizona, southern Utah, southern Nevada and northern New Mexico.

Sophora sericea is a low herbaceous perennial with rather fine leaves. It is confined in its range to the foothills of the Rocky Mountains and adjacent plains from South Dakota to Texas and

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west to Utah. In Colorado and Wyoming it is frequently quite abundant and constitutes a fair erosion control plant. It is, however, listed among the weeds that are known to be poisonous and for this reason should not be considered in a revegetation program.

Crotalaria lupulina, Rattle Weed, has been suggested for a leguminous ground cover and nurse crop. With a little rainfall it makes a rapid growth, especially along sandy washes. It is quite palatable to stock. We have not used it in the nursery or on our observational plots up to the present. Seed is easily collected by hand.

*Trifolium fragiferum is the Strawberry Clover recently introduced through the Agricultural Experiment Station in Colorado to the west. It is reported to be a very excellent clover for damp, alkali ground. The small planting at Albuquerque is doing excellently. Thus far it has not been tried on the open range. It requires too much moisture for use except in selected sites in moist alkali regions.

*Trifolium brandegei is the Spruce Clover of southern Colorado. It is confined to the relatively high mountains in the belt of the spruces or just below it. According to Mr. Mann of the Rio Grande Project, Soil Conservation Service, this is a wonder plant as a soil binder and as forage in the mountains of southern Colorado. We plan to try this in the nursery at Albuquerque as soon as seeds or plants can be obtained.

Lotus spp., Deer Clover. This genus includes many of our very important erosion control and forage plants. It must be remembered also that they are legumes, and legumes must hold a vital place in any program of soil rehabilitation. There are numerous species in the southwest. Some of them are annuals of very little importance except for wildlife, while others are deep rooted perennials which are active in controlling soil erosion. Among the very common ones are L. rigidus, L. greenei, and L. longibracteatus. All of these are perennials. The first, L. rigidus, is common on dry rocky slopes of the southwestern ranges. It is rather stiff and almost leafless. In general appearance it resembles a shrub. The top, however, dies down during the winter. While it is an important forage plant, it is less palatable than many of the others and its root and crown habit do not recommend it so highly for erosion control. This and the other species are important bird food plants.

*Lotus wrightii has a much wider general distribution than L. rigidus. It is an important erosion control and forage plant on dry slopes in the Kaibab Region of Arizona, in the Mogollon Plateau, the mountains and plains about Prescott and Kingman, Arizona, the mountains about Cedar City, Utah, and those of southern New Mexico.

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It is probably our most valuable southern Lotus.

*Lotus greenii is a perennial with spreading habit and distinctly silvery colored leaves, found on our extreme southwestern ranges. It is comparable to L. wrightii and possibly can be grown at a somewhat lower altitude.

Lotus longibracteatus can readily be confused with L. greenii. It apparently is relatively scarce but has been reported from a wide range, for example, Zion National Park in Utah and the Graham Mountains in Arizona.

Two very rare species of Lotus have been recently reported from southern Arizona. One of these, L. lanatus, is a low spreading annual which occupies extremely dry sites. Annuals of this type should not be overlooked as they constitute excellent ground cover on waste sites. It has been found only on the flats northeast of the Baboquivari Mountains. Another Lotus which has every appearance of being a much worthwhile plant for erosion control is L. alamosanus*. It is abundant in rather moist situations in Sycamore Canyon, Santa Cruz County, Arizona. Until recently it had not been reported north of Mexico. It forms very dense turf and effectively holds the soil in canyon bottoms during flood periods. Its use will be limited to rather moist situations comparable with those where it was located. However, our erosion control program calls for work in many sites of this character. This is without question the best turf-forming Lotus we have indigenous to our territory.

○ *Vicia erigua is a native perennial Vetch which closely resembles in habit V. pulchella. It, however, grows in much drier sites at lower altitudes. It has been reported from the Baboquivari Mountains, the Coyote Mountains, from Sycamore Canyon and from the mountains south of Ruby, Arizona. These are all in Santa Cruz and Pima Counties, Arizona. This plant should prove of greater value for erosion control than V. pulchella because of its greater drought resistance. In general appearance it is strikingly like that species. There are doubtless other wild vetches, some of which may prove to be worth investigating. Some are annuals. One curious vetch, with very narrow leaves, V. sparsiflora, occurs in the mountains about Alpine, Arizona.

Indigofera sphaerocarpa, Indigo Bush, is a leguminous shrub, slightly resembling Aerophya and like it, having very short pods. In our range it is confined to southern New Mexico and southern Arizona. In the mountains west of Animas, New Mexico, it attains a height of three or four feet, grows in quite dry, rocky bottoms and on rocky slopes, and is quite heavily grazed. It is never in dense enough stands to constitute a good soil binder.

(°Correction: This should follow discussion V. pulchella, p.96.)

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Psoralia micrantha is a low, extremely glandular weedy herb with long rhizomatous perennial roots which occupies beds of almost pure sand. It is not infrequent in sites of this kind in the southern part of the Rocky Mountains from western Texas probably to California. The plant is too low to constitute a windbreak of importance. However, it is an excellent soil binder and probably could be used to advantage in stabilizing sand dunes. It is, however, quite unpalatable. In fact, it has been suspected of being poisonous and as a result cannot be recommended for revegetation work until it has been given a clear bill of health.

There are several other Psoralias in the West which are similar in growth habits to Psoralia micrantha. Most of them, however, are useless or nearly so for erosion control work and are valueless for forage. One Psoralia of a distinctly different type is P. esculenta, which is a low, somewhat spreading perennial with a large tuberous root which was formerly used extensively by the Indians for food. This is confined in its natural distribution to southern Arizona, southern New Mexico and western Texas. Since its spreading habit makes it a fair soil binder, its acquaintance should be courted in nursery practice.

Amorpha occidentalis and close relatives, are frequent but not abundant throughout the west. They are sometimes called Indigo bushes. Specimens from the Black Range in New Mexico are frequently large shrubs or small trees. To date we have not tried the Amorphas in any of our programs in the southwest but reports given at the Colorado Springs Conference regarding the use of this group in Regions Six, Seven and Nine are so favorable that nursery plantings will be tried at a couple of the nurseries in Region Eight from seed collected in the Black Range. The fruits and leaves of this plant have an odor similar to that of Parryella filifolia, a decoction of which is used by the Hopis to repel bed bugs. If, as is reported, Amorpha is resistant to jackrabbit and insect (including grasshoppers) attack, should it not be tested for substances which may prove useful in man's fight to the finish with the insect world?

The Amorphas produce seed in abundance and production in the nursery will doubtless prove easy.

*Eysenhardtia orthocarpa, Kidneywood, is a shrub or small tree confined in our territory to extreme southern New Mexico and Arizona. It, however, extends far south in Mexico and is widely distributed in the Tropics. It is a leguminous tree with spikes of small white flowers, very short pods and pinnate leaves. It is one of the finest browse shrubs in the southwest and since it grows on dry, rocky sites it is a worthwhile erosion control plant. If you will refer to Standley's Trees and Shrubs of Mexico you will see that the account

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of the uses of this plant reads like a fairy tale. It has been used for all sorts of medicinal purposes. The wood has been turned into many small articles, such as spindles and bric-a-brac. It gives water in which it has been soaked a peculiar iridescence.

*Galactea wrightii is a pea vine with grayish, somewhat silvery leaflets and heavy woody root and very numerous stems. The leaves are trifoliolate; the pods are rather long and narrow and quite hairy. It is an excellent ground cover and erosion control plant and probably is good forage although this has not been established. It is found in considerable abundance in extreme southern Arizona, especially in the foothills of the Baboquivari Mountains and in Sycamore Canyon. It is very drought resistant but not suitable for alkali land. This is a species well worthy of extensive trials in the nursery and observational plots.

Dalea spp., Pea Bushes. This genus includes some of our most valuable leguminous shrubs. Most of them are low spreading plants with heavy woody crowns.

*Dalea formosa is a low shrub (frequently owing to direct action by cows and horses, very low) with dark green small leaflets and handsome heads of purple flowers. It is not infrequently used as an ornamental. Its natural range is confined to the mountains of western Texas and southern New Mexico and Arizona. It is usually not sufficiently abundant to be considered of any great value on the range as a browse plant. Since, however, it is quite abundant in some localities, it should be used in our observational work with the thought ever in mind that a grass range without browse plants is never a good range.

*Dalea frutescens is similar in habit to D. formosa but is a lower, more spreading shrub. It is found in abundance in the region of Fort Stanton, New Mexico and in the canyons of the Guadalupe Mountains, New Mexico and Texas. Its habit of forming low spreading clumps on the slopes and in the dry bottoms make it an excellent soil binder. It is comparable in forage value to D. formosa.

Dalea sanctae-crucis is similar in habit to the last two discussed but is a somewhat taller and more widely spreading plant. It is confined to extreme southwestern ranges such as the Baboquivari and the Santa Rita and adjacent mountains. What has been said of the last two species applies equally well to this one.

*Dalea sp. A remarkable Dalea was recently found in the foothills south of the Guadalupe Mountains of southern New Mexico and adjacent Texas. It is often more heavily browsed than other

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species mentioned and forms much larger denser clumps. It has a widely spreading crown and a single plant frequently covers several square feet. The root system seems to be superior to other species discussed for the control of erosion. The leaflets are somewhat silvery and the flowers are rose colored. It is probable that this species is either one known previously only from Mexico, or one that has not been described. It seems to be one of our most promising plants for erosion control purposes.

Dalea spinosa. Within our range this is the only species of Dalea which becomes a tree. Its range is southwestern Arizona and adjacent southern Nevada, southern California and adjacent Mexico. Common throughout the southwest it is known as the smoke tree, and when in blossom is one of the most striking plants of the desert, being a solid mass of dark blue blossoms. The stems and twigs are almost leafless but are themselves green with a grayish tint. The density of these grayish green twigs on the plant give it a distinct resemblance to smoke at a distance. This plant requires a very hot dry climate and is doubtless unsuited for other sections of the country than those in which it grows naturally. It should be generally used in the dry southwest as an ornamental.

Dalea emoryi is another Dalea occupying extremely dry hot regions such as those about Yuma. It is a low straggling bush with beautiful flowers and extremely glandular leaves, stems and flower clusters. The oil or resin from this plant was formerly used by the Indians as a dye and this use suggests the possibility that the plant may contain valuable properties either from a pharmaceutical or commercial oil standpoint. Owing to site and climate requirements this shrub is not likely to gain a place in a distinctly erosion control program. One very curious fact regarding this plant in the region of Yuma is worth mentioning. It is subject to the attack of a very curious parasitic flowering plant, Pilosstylis. Frequently the stems are almost completely covered with this parasite, an individual plant of which is very little larger than the head of an ordinary pin. It consists almost entirely of the flower. Superficially the parasitized Dalea looks as though it has been attacked by a fungus disease or by a type of gall-forming insect. This parasite is closely related to a flowering plant in the tropics which produces the largest flower known to science, frequently two or three feet across and is exceptionally beautiful. In this case also, practically the entire plant consists of the blossom.

Dalea polygona in general habit resembles D. emoryi but on the whole it is a smaller more nearly prostrate bush. The glandular character of this plant suggests its use for dye and oil. In natural distribution it is confined to the extreme desert sections of southern Nevada and adjacent California.

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Dalea johnsonii is a straggling open bush often three or four feet high with very few narrow leaflets. The entire bush has a grayish green color similar to that of the smoke tree but the bush is far less compact and the branches more tortuous. It has rather long spikes of intensely blue flowers which make the bush very showy during the time of blossoming. This species is confined to the extremely dry desert regions of southern Utah and adjacent Nevada and California. It is too open to be of much value as an erosion control plant, and it does not seem to be browsed. It is possible, however, that the glandular leaves, stems and flower clusters may yield a valuable oil or dye, and the plant should be worthy of consideration as an ornamental in desert gardens.

Dalea amoena is a species closely related to D. johnsonii. It, however, is a smaller bush and has much smaller flower clusters. Its range is southern Utah and adjacent northern Arizona. What has been said of D. johnsonii is equally true of this species.

Dalea wrightii is a low spreading herb with a large woody root. The leaves are silvery gray and the plant for the most part is prostrate or nearly so. Commonly the growth is sparse on the range, possibly due to over-grazing. It occurs on the dry rocky slopes and hilltops of southern Arizona and southern New Mexico. Owing to its woody, much divided caudex and its prostrate habit, it would make an excellent erosion control plant if it could be obtained in adequate stands. This probably should be considered a browse plant though it can hardly be thought of as a shrub.

Dalea pegonantha is a plant resembling superficially the plant last discussed. This one, however, is commonly erect, and for that reason may not be as good an erosion control plant. However, it is one of the important browse plants in certain sections of the foothills of the Santa Rita and Baboquivari Mountains. Its general range is southern New Mexico and southern Arizona. This plant should be given a careful trial in the nursery and in observational work.

Dalea parryi is a low suffrutescent perennial with widely spreading branches. It grows in extreme southern Arizona and adjacent Mexico. On the west slope of the Baboquivari Mountains it forms an appreciable part of the ground cover in small areas and constitutes a fair soil binder. A plant growing in the nursery at Tucson has formed a beautiful, wide-spreading plant with an abundance of spicate blue flowers and seed pods. Nothing is known at present about its palatability but otherwise it is a plant of promise for revegetation work.

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Petalostemon albiflorum, Prairie Clover, is a perennial legume with woody root and caudex and tough, wiry stems. In general appearance it resembles a Dalea but the heads of flowers are very compact and the leaves and stems less glandular than most of the Daleas. Its range is very wide in the Rocky Mountains and the west generally. Commonly it is considered rather unpalatable but in certain quarters of New Mexico and Arizona it seems to be quite heavily browsed, especially by sheep and goats. It is doubtful whether the plant can be made to grow in sufficient abundance to constitute a real agent in controlling erosion. However, it frequently occurs naturally in some abundance.

Tephrosia spp. There are several species of Tephrosia in extreme southern Arizona and in New Mexico. An eastern species, T. virginiana, is cultivated for the rotenone content of its roots. Thus far the southwestern species have not shown sufficient rotenone content to be of commercial significance. Most of them are rather low in forage value but probably constitute fair erosion control agents. T. tenella is one of the best species from this standpoint as it forms widely spreading clumps on loose rocky slopes. It is particularly abundant in the Baboquivari Mountains where it grows to be perhaps two feet in height and produces immense quantities of pods and small beans. It is probable that it is a significant bird food plant.

*Benthamaantha edwardsii has been frequently mistaken for Tephrosia in the southwest. The long slender pods closely resemble those of T. tenella except that the pod has a peculiar cross-lined appearance. The plant itself is low and has silvery leaflets. It forms pure stands in rather sandy dry bottoms where the grazing is not too severe. It seems to be quite heavily browsed. Because of the rhizomatous character of the roots and the fact that it forms a dense carpet on the ground, it should be tried in the nursery and in observational work.

Alhagi camelorum, the Camel Thorn, was introduced into the United States from Asia Minor in comparatively recent years. The State of California has spent large sums in an attempt to eradicate it. The plant has been introduced into several parts of New Mexico and Arizona. North of Albuquerque it has become well established on sandy bottom land and has become a very distinct pest because of its persistence in cultivated lands. It has long slender horizontal roots which sprout and which are very difficult to thoroughly eradicate. The tops are slender and quite thorny. While this plant is considered a distinct pest at the present time, it has its good points, and like the Russian Thistle, may sometime be considered a godsend in certain sections of the country. It is also relatively

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drought resistant and in spite of many reports to the contrary, it is fairly good forage. Horses and mules particularly, give no evidence that they object to the thorny character of the plant and eat it with avidity. One farmer near Joseph City, Arizona, showed a large area of this to one of our seed collectors and went to some length to explain what a wonderful plant it was as a stock food. He did not know the plant or surmise that thousands of dollars were being spent to eradicate it in California. At the present time its use is not to be advocated even under restricted conditions.

Poteria scoparia is a leguminous plant with the habit very much like that of the camel thorn. It is nowhere abundant, being reported only from eastern New Mexico and adjacent territory, and recently from the Petrified Forest in Arizona. It is not impossible that with a little human encouragement it might be of value as a sand binder.

Coursetia glandulosa is a tall shrub with abundant white to yellowish pea flowers and rather small pinnate leaves. It is usually found growing in dense clumps. This is confined in our range to canyons and dry rocky slopes in southern Arizona at altitudes of 3,000-5,000 feet. It is a fair erosion control shrub, is quite heavily browsed and can be grown readily in the nursery from cuttings.

Robinia pseudo-acacia, the common Black Locust, is not native in our region but has been extensively introduced in all but the warmest sections. Formerly it was used for woodlots and shade trees in eastern New Mexico, more extensively than at present although the species is still used for street plantings in most of the towns and cities. The trees are rapid-growing where water is available, very drought resistant and not subject to diseases. The borer, however, damages the trees seriously and frequently discourages ranchers from planting this species. Special strains are gradually replacing the more common types. The Shipmast Locust is one of these. It has not come into use in Region 8 but is being used in Soil Conservation Service work in the east quite extensively. The Hill-culture Section of the Soil Conservation Service has done special work with the Black Locust. At present it is having remarkable success in growing locust hardwood cuttings after treating them with growth hormones. This method should make the propagation of desirable selections easy. It is hoped that the same or a similar treatment can be applied to propagating other trees and shrubs.

Robinia neo-mexicana, New Mexico Black Locust. This small, very thorny tree is not uncommon in the mountains in the southwest. Frequently north-facing slopes have almost pure stands. This is true on the mountains north of Raton, New Mexico; on the north side of Rose Peak on the Coronado Trail, Arizona; and the slopes of

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Baldy in the Santa Rita Mountains of Arizona. Usually, however, it is an undershrub, exceedingly annoying to the one who wanders off the mountain trail. Because of a horizontal root system and a tendency to sprout, it has a distinct erosion control value. The seeds are rather expensive to collect because the trees are too thorny to climb, too tall to permit picking pods from the ground, and after the pods are ripe striking them with a stock scatters the seeds in all directions. The seeds and young plants are not difficult to handle in the nursery. The young plants furnish good forage (not poisonous). The flower clusters are choice morsels, being eaten raw even by the Indians. Thornless forms of this species probably exist. A report of any such form to the Nursery Section will be greatly appreciated.

*Olneya tesota, Ironwood, should be considered along with the paloverdes. It is commonly said that where it grows Citrus fruit will grow. It may well be considered the most noble tree of the desert, - evergreen, symmetrical, long-lived, extremely drought resistant. Its wood is dark, hard, very heavy and burns like a high-grade coal. Normal years the beans are produced in abundance. These have been used extensively for food by the Indians.

*Parryella filifolia. Dune Broom. This plant is common in northern Arizona and northern New Mexico in the dry sand-blown regions. It is one of our best sand binders. Many of the plants in which we become interested prove useless because they do not respond to nursery practice or the seed are too expensive to collect. This plant, however, produces seed in abundance. These germinate readily and plants are easily produced even at Tucson which is 2,000 or 3,000 feet lower altitude than that in which the plant normally grows. When plants are taken up the small roots remaining promptly sprout.

The Hopi Indians claim that they use a decoction of this plant to drive out bed bugs. For this reason we had Dr. Sievers of the Food & Drug Office, United States Department of Agriculture, test its insecticidal properties. It was learned that while it had insecticidal properties, its value was low. It is highly probable that this plant and the related Paroselas contain oils which may prove of economic importance. Among the Paroselas rich in oils and possibly dyes are Parosela scoparia, P. emoryi, P. johnsoni, and P. spinosa.

Erythrina flabelliformis, Western Coral Bean, is a shrub or occasionally a small tree with large heart-shaped grayish leaves, abundant curved spines and long, scarlet flowers. It is confined to warm canyons and foothills in our extreme southwestern ranges but extends far south into Mexico. Other members of this genus are highly prized as ornamentals in the Tropics. This shrub is tender,

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very frequently freezing back to the ground during the winter. It has possibilities as an ornamental but has very little value for erosion control and none as forage. The large, red, very hard seeds are poisonous.

Phaseolus spp. Beans. There are several true beans in the southwest. Some of them are perennials and are among the most promising of our legumes. Like most other plants they have definite requirements as to site and altitude and probably soil.

*P. metcalfeii, Metcalf Bean, is a vine with a very large woody root and numerous prostrate stems. It has trifoliate leaves of rather large size which makes the plant quite conspicuous. Many years ago this plant was successfully cultivated by Dr. Metcalf at Silver City, New Mexico. He found it to be very satisfactory as a stock food but strange to say this lead was never consistently followed up and nothing worthy of note has been done with the plant. It produces rather large pods and large beans, which are palatable to stock. This plant is found growing on rather loose soil on steep slopes and recently made road grades. It frequently forms almost a solid ground cover and while the stems do not root, the prostrate vines prevent erosion quite effectively. It is not at all improbable that this plant with proper selection and possibly proper breeding could be made not only useful as an erosion control and forage plant, but even for the production of very palatable beans for human consumption.

P. rhizensis and P. retusus for our discussion here can well be considered the same as P. metcalfeii. They are very similar in growth habits and soil requirements. While these three species seem to be limited in their natural range to central and southern New Mexico and Arizona, it is not at all improbable that they can be used far beyond their natural range. These beans are not suitable for use in alkali land or in extremely dry situations.

*P. dilatatus is a very promising vine bean with large woody root found in our range only in southern New Mexico and southern Arizona. It is a much smaller plant than the Metcalf bean but forms a good ground cover and is effective in controlling erosion on dry steep slopes. It is usually found, however, on partially wooded or north-facing slopes. It can be distinguished from the Metcalf bean by its lobed and smaller leaflets contrasted with the entire and large leaflets of the Metcalf.

*P. macropoides closely resembles P. dilatatus. It has a large woody root and grows in comparable sites. In the southwest it seems to be more abundant but is confined to our extreme southwestern ranges. Like the last, it forms excellent ground cover on rather dry rocky slopes.

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There are doubtless others of the true beans which are worthy of some attention. For example, P. acutifolius, a bean with trifoliolate but very narrow lobed leaves, looks promising. Also P. angustissimus, another one with narrow lobed leaves which is a trailer or twiner. These beans should first be raised in the nursery and if they prove promising, tried in our observational plantings. In no case should we overlook the role of legumes in our program of revegetating the range.

*Rhynchosia texana. This plant resembles a true bean in its vinelike character. It has rather small trifoliolate leaves and very numerous stems from a woody spreading root system. In many places in draws, swales and canyons in the southwest it forms a considerable part of the vegetation and is an active erosion control agent. It is apparently somewhat less palatable than the true beans. From the standpoint of legumes, however, this is one of our most promising.

Nissolia schottii is a true climber with woody perennial root but herbaceous top. Frequently in warm sites, however, the stems become perennial, only the leaves dying in the winter. In many parts of its range it freezes to the ground each winter but makes a vigorous growth during the summer. It is a delicate, beautiful vine suitable for use as an ornamental on trellises. While this is a legume, the pods form a samara similar to those on the maple or ash, and the vine can readily be distinguished in fruit by these pods. This vine is confined in our range to southern Arizona but probably will survive much more severe winters than those of regions where it occurs. It can be used as an ornamental, as a windbreak, on trellises or in the absence of something on which it can climb, as a spreading vine or erosion control in draws and on deep slopes.

Aeschynomene virginica, or a very close relative, was recently found in southern Arizona and Sycamore Canyon. This is a plant which closely resembles the sensitive pea and is sometimes called sensitive joint vetch. The interesting feature of the plant in that region is the abundance of nodules on the roots. In this respect it is more outstanding than most peas, indicating its possible use as a nitrogen fixer. It is not sufficiently abundant in southern Arizona to be of significance at present but it should be tried in the nursery because of its possible use as a nitrogen soil vitalizer.

Clitoria mariana, the Butterfly Pea, which is not uncommon in the woody sections of the East has been reported from Santa Cruz County, Arizona. In that section it grows on dry rocky or semi-timber slopes and in places is quite abundant. It is a low perennial bush bean, the tops of which have a slight tendency to become vine-like. Its pods are rather short and thick and are quite sweet.

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Apparently the plant, judging from its condition where found, is highly palatable. Its root system and its abundance in the site where found suggest it as an excellent erosion control plant. It should be mentioned also that it has been used as an ornamental, and the seed of it is probably available from seed houses in the East. It is possible, however, and even probable, that our southwestern plant is either a different species or a remarkable drought resistant strain.

Astragalus spp., Milk Vetches. This genus is a Dr. Jekyll and Mr. Hyde. Several species are excellent forage and good or fair erosion control plants, besides being legumes which build up the nitrogen content of the soil. Many others are weeds, some of them locos of the worst type. In recent years much study has been given to the element Selenium. First it was studied because of its peculiar electrical properties, a study of which led to the invention of the Selenium cell, the light-directed torpedo and similar devices. The element was suggested for use as an insecticide and as such proved very effective but it was soon learned that it was readily absorbed by plants and that it rendered fruits and grains poisonous to stock and to man. For a time it was used as a depilatory but it was soon learned that the hair disappeared from the crown of the head as well as from the arm pits. But what has this to do with Astragalus? Only this: Some species of Astragalus, and some other plants as well, absorb selenium from soils containing it in the inorganic form and upon decaying, return it to the soil in organic form, in which condition it is readily absorbed by many plants which are unable to absorb it in the inorganic form. Thus many plants palatable to stock are rendered poisonous. Fortunately not all soils contain selenium in sufficient quantities to produce serious results. It is highly probable that some of the poisoning ascribed to loco in the past has really been due to the selenium in the Astragali or to that passed on by them to other plants. It can be seen by this that the Astragali must be investigated thoroughly before they are recommended for use for erosion control or as forage.

At least two Astragali have recently come into prominence not only as forage and erosion control plants but as crops. These two, A. rubyi and A. mortoni, have not been given adequate trial in our region to warrant conclusion regarding their value. Several species Onobrychis, legumes similar to Astragalus, have been introduced from Asia Minor and are being grown at the nursery at Tucson. Before these can be planted on the range feeding experiments will need to be conducted to determine their palatability, their relation to the selenium of the soil and of first importance, whether they are locos or not.

Among the Astragali in the southwest which look promising for forage and erosion control are A. lonchocarpus and A. nuttallianus.

PAPILIONACEAE

Both of these are good erosion control plants which form a good ground cover and are frequently heavily browsed. Before they can be recommended for range use, however, it will be necessary to learn more about their properties in relation to alkaloids and selenium.

Aragallus spp., Locos. This genus contains some of our most serious locos. In some regions, particularly within National Forests, eradication campaigns have been attempted. It is probable that the best control, however, is careful range use. An abundance of Aragallus is an almost certain indication of overgrazing and range abuse.

*Lathyrus decaphyllus, Wild Pea, is closely related to our native vetches. It is often abundant in ground that has been disturbed either through road building or by floods. In northern New Mexico, particularly in the region of Wagon Mound, New Mexico, Canyon Padre, Arizona, and in Zion National Park in Utah, it forms quite dense plants with abundant perennial rhizomatous roots. It has handsome blue flowers and rather narrow leaflets. For situations in which it will grow, mainly those on freshly made road grades and in places where there is likely to be considerable erosion from flood water, this plant makes an ideal erosion control plant. It also has a value for forage.

Lathyrus leucanthus is a plant closely allied to L. decaphyllus. In the south west it is relatively scarce and apparently is suited only to considerably higher altitudes and more shady places.

Lathyrus americanus is widely distributed in the west at relatively high altitudes and in timber or shady situations. It is an excellent forage plant and where sufficiently abundant is an active erosion control agent, being a perennial with widely spreading rootstocks. Its use in erosion control practices is distinctly limited because of its altitude and soil requirements.

Lathyrus graminifolius is another species found at relatively low altitudes in Santa Cruz County, Arizona. Judging from its distribution and relative scarcity, it is probable that it will be of little value for erosion control or for forage. Owing to its habit, however, and abundant foliage, it will be grown in the nurseries and if promising results are obtained, will be tried in observational plantings.

*Vicia pulchella is one of our most promising perennial vetches. It is abundant on the slopes and in draws in the lower yellow pine belt of our mountain ranges in central New Mexico and Arizona. Where bushes, or rather upright plants are available for attachment, this plant is a climber. Commonly, however, it trails on the ground.

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Each root produces numerous long, lax stems with abundant leaves. It has short spikes of white flowers. Its spreading habit and perennial roots make it a desirable erosion control plant. It must also be considered excellent for forage and wildlife. It produces an abundance of small peas.

Desmanthus illinoiensis is not uncommon as a weed in some parts of the southwest. In general habit it closely resembles wild licorice (Glycyrrhiza lepidota), forming as it does dense stands of erect stems and numerous horizontal roots. It, however, has clusters of smooth curved pods instead of the burs produced by the licorice. The leaves of D. illinoiensis are very fine and are bipinnate. No work has been done to prove the value of this plant for erosion control. It doubtless requires sites which receive some overflow during the summer but the root system is excellent and the fact that the plant is a weed, though not a bad one, should not preclude its use at least on some demonstration areas. It produces an abundance of small peas which suggest it for wildlife. Its forage value is low.

*Desmanthus jamesii is a small, almost prostrate plant with a woody base and fine bipinnate leaves. It has clusters of rather long, somewhat curved pods and grows on very dry, rocky sites in the foothills in the southwest. It is fair forage and doubtless excellent for wildlife, such as quail. The field worker is likely, if not careful, to confuse this with Calliandra eriophylla. The latter, however, is a true shrub and has purple flowers with very long exerted stamens contrasted to the yellowish flowers with rather short stamens of D. jamesii.

*Desmanthus virgatum was discovered recently in southern Arizona and southern New Mexico. It doubtless is not uncommon in northern Mexico. In general habit that from southern Arizona resembles D. illinoiensis but is much taller, often being four or five feet high and much more showy. The specimen from southern New Mexico grew in a very dry site and was almost decumbent. The bipinnate leaves are large in outline but the leaflets are very small. It has a good root system, evidently is eaten by stock and must supply abundant peas for bird food. It may prove to be a worthwhile plant on the range in warm situations.

GERANIACEAE

*Erodium cicutarium, Alfilarree, is an exotic which has become thoroughly naturalized and has made a very desirable citizen. It has spread into out-of-the-way places almost throughout the southwest and when there is a reasonable amount of rainfall during the winter it produces abundant forage. Two or three other species of

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Erodium have been introduced into this country and we have one native one. All of these are inferior to *E. cicutarium*. It is worthy of note that *E. texanum*, our common native species, is frequently attacked by what appears to be an erinose mite, or at any rate by an organism which makes maple leaves. *E. cicutarium* seems to be free of this trouble.

ZYGOPHYLLACEAE

Choisya dumosa, Starleaf, is a low shrub growing in protected places in canyons and on steep slopes in west Texas, southern New Mexico and southern Arizona and extending into Mexico. It has finely divided remarkable glandular leaves and fragrant white flowers capable of perfuming whole canyons. The bushes are rather tender and difficult to propagate. They are suited for erosion control work in partially shaded north-facing slopes. They should be excellent ornamentals, particularly in shaded rock gardens. Studies should be made of the oil and resin content of the foliage.

Thamnosma montana is a very curious, nearly leafless shrub with green, extremely glandular stems and purple flowers. It is not uncommon in the foothills of the southwest. Since it has a foul odor and is so extremely glandular, it may contain valuable oils or resins. Nothing larger than a bug will condescend to eat it and it is of no value for erosion control.

Thamnosma texana, slightly resembles *T. montana* but is a much smaller plant and less offensive. It has a more limited range, being confined in this country to western Texas and southern New Mexico and Arizona. It is valueless for forage and practically so for erosion control.

Ptelea trifoliata, Trefoil, is a shrub very widely distributed in the west and southwest. The name, *P. trifoliata* covers a great variety of forms and it is probable that it should be considered two or more distinct species. These shrubs are frequently abundant on north-facing slopes and in canyons. In no place, however, can they be considered of distinct value for erosion control. They should be interesting additions, however, to shrub arboreta and for ornamentals in yards. The trifoliolate leaves are rather foul-smelling and the fruits have wide wings somewhat similar to those on the Elm. The plants are not palatable to livestock.

Larrea tridentata or Creosote Bush is one of the most common shrubs in the southwest from western Texas to southern Utah, Nevada and California. It extends also into Mexico. It occupies hundreds of square miles in almost pure stands today where it was only scattering fifty years ago. This is commonly the result of overgrazing.

ZYGOPHYLLACEAE

The Creosote Bush is unpalatable and a very poor erosion control plant. The leaves of the plant have been used medicinally by the Indians and attempts have been made in the past to commercialize it as a medicinal plant. The leaves are rich in resins and oils and attempts to analyze it by destructive distillation have resulted in rather serious poisoning to the men conducting the work. If the plant were less common it would be highly prized as an ornamental as the leaves are dark, shiny green and the flowers are a showy yellow. One of the pleasant memories for the traveler in the southwest is the odor of creosote after a shower.

Peganum harmulum, African Rue, is a low spreading shrub with an abundance of fleshy narrow green leaves which are unpalatable to livestock. The plant was introduced from Asia into the valley east of Deming, New Mexico some years ago and has spread over considerable area since that time. It has a root system which grows a fraction of the distance between here and China. It seems likely that the plant is one which should be eradicated. In valleys of the type of that around Deming it is a serious competitor of the more palatable shrubs such as Chamiza, and it seems likely that the extremely deeply bedded roots will eventually cause a serious depletion of the lower ground water. The plant has practically no superficial roots and for that reason is not an ideal erosion control plant and since it is unpalatable and seems to be an ideal pest, not only should it not be distributed but it should be eradicated if possible.

SIMARUBACEAE

Holacantha emoryi, one of our Crucifixion Thorns, is one to which the term seems most applicable. The bushes or small trees are not only all thorns but the thorns are stiff and point in all directions. In the United States it is confined to a small portion of Maricopa, Pima and Pinal Counties in Arizona. It has been reported doubtfully from Mexico. Though it is usually a small tree with a distinct trunk it frequently forms thickets which collect wind-blown dirt and tend to form dunes. These are usually a harbor for some plants which do not thrive under our intensive civilization with its attendant land abuse. It is of little value as an erosion control plant.

Ailanthus glandulosa or Tree of Heaven, is an exotic from China which has been planted practically all over the United States. The fact that it produces wood unsuited for use as posts, lumber or even firewood, and sometimes becomes a weed, has put this tree in an unfavorable light with most of the Soil Conservation people. The tree, however, has its favorable points, among them drought resistance, ability to seed itself in an area and form thickets which are good soil binders and which supply abundant shade for

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stock; and ability to withstand severe abuse. The Tree of Heaven has been planted along the highway in eastern Oregon as an ornamental with complete success and it is used as an ornamental shade tree along city streets. Thus far it has been used to a very limited extent, if at all, in erosion control work in the southwest.

BURSERACEAE

Elaphrium microphyllum, Elephant Tree. In the early days of the Spanish invasion of the southwest this small tree supplied vast quantities of bark which was shipped to Spain for its tannin. The tree is much more abundant in Sonora than it is in Arizona. In the hills southeast of Yuma, along the Mexican border, however, this curious tree is rather abundant. It resembles a pepper tree except that the compound leaves are very small and the fruits are borne singly on the twigs instead of in long panicles. The trees are low and squatty with trunks which are very thick at the base and which taper abruptly upward. The small fruits and leaves are very glandular and quite fragrant with a pungent odor. When and if our activities spread into the hot regions south of the Gila, this tree should occupy a place in our program. Wherever it grows oranges and probably avocados will grow if given water.

POLYGALACEAE

Polygala spp., Milkworts. Most of the Polygalas are of no significance for forage or for erosion control. Some are annuals with possibilities as ornamentals in cultivation. One, P. polycladon, is a rather abundant shrub in the region of Vermillion Cliffs, Arizona, but it is very thorny and apparently not browsed. P. rusbyi is a low perennial with a deep root and very short, somewhat spreading woody caudex which has handsome creamy, pinkish purple flowers rather large for a Polygala. This might be a good erosion control plant if it grew abundantly enough. It is a rare plant found on the flats between Kingman and Seligman in Arizona, and doubtless elsewhere. P. macradenia, however, is an important browse shrub which has a rather wide distribution in northwestern Arizona and adjacent regions, and in the Santa Rita region of southern Arizona. It is a deep-rooted, very low shrub with spreading caudex, small leaves and purplish flowers. At the base of the Kofa Mountains it is abundant and is always browsed very close by mountain sheep. Professor Thornber reports it to be a good browse plant in the Santa Ritas. This plant has not been grown in the nurseries and nothing is known of its propagation possibilities.

EUPHORBIACEAE

Bernardia myricaefolia is a shrub three to five feet high with small, thick grayish leaves with irregular dentate margins and

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inconspicuous flowers. It is abundant in extreme southern New Mexico, southern Arizona, southern California and Mexico, in low rocky foothills where the temperature in the summer becomes very high. Though it is a good erosion control plant where it grows naturally, it probably is not well adapted to nursery practices and its range is very limited. Its forage value is low.

Ditaxis sericophylla is a low shrub with narrow gray, silky leaves and similar gray silky stems. It grows only in the extremely dry, hot low ranges of southwestern Arizona and adjacent Sonora. As an erosion control plant it can never be considered unless revegetation work is undertaken in these extreme desert sections. It is an erosion control plant and is relished by mountain sheep.

Acalypha pringlei is a very tender shrub confined to Pima and Yuma counties in Arizona and adjacent Mexico in extremely dry situations. In the nursery at Tucson it makes a handsome shrub but without protection freezes to the ground in the winter. It is suitable only for an ornamental at present but at such time as our work is extended into the Phoenix and Yuma regions it may have its place.

Sapium biloculare is abundant in southern Pima County, Arizona and is widely distributed in Mexico. It is a tall shrub with narrow leaves and milky juice which has been used medicinally for probably hundreds of years. It is viscidly poisonous. The leaves are used by the Indians for stupefying fish. The milky juice gotten into the eyes even in the minutest quantity, as by rubbing the eyes after handling the plant, causes extreme pain for hours. It is not improbable that this plant will be found to have commercial importance when its latex is studied carefully.

Ricinus communis, or Castor Bean, is an introduction into all the warmer portions of the United States. In many places it is raised as an annual ornamental because of its rapid growth and showy leaves and flowers. Attempts have been made to raise it commercially in this country but without success, probably because of high cost of labor here. It is unsuited for use for anything except an ornamental.

Manihot angustiloba may be considered a rare plant in the United States, occurring only in a very limited area in Pima and Santa Cruz Counties in Arizona. It is probable that it will never become an erosion control plant of significance but the great importance of this plant and its near relative, M. esculenta in the Tropics for the production of cassava and starch, make it worthy of mention. In Arizona it grows as a perennial herb in extremely rocky sites. The growing tubers push their way into all sorts of

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crannies and cracks and are very effective in opening up the rocks. While this plant may not, or may be important in erosion control in warm parts of Arizona, it is worthy of careful experimental work as a crop not only for Indians but for whites as well.

Jatropha cardiophylla occurs only in Arizona within the United States but is common in Sonora. It is a low, very tender shrub likely to freeze to the ground in winter even in the foothills about Tucson. The leaves are rather small and heart-shaped and the stems peculiarly pliable, giving one the impression of being rubbery. The plant grows in the driest, rockiest of sites. It is never eaten and has little value as an erosion control plant but the dried roots, according to Standley, contain much tannic acid, thus suggesting the use of the shrub as a commercial crop in the extreme desert regions of Arizona. It has long been used for tanning and probably for dye. Owing to the color of the juice the plant has been called Sangre de Cristo.

Jatropha spathulata is a tall shrub somewhat resembling in habit the Sapium described above. It occurs in western Texas and southwestern Arizona and far south into Mexico in the driest, rockiest of sites. It will withstand very little frost. As an erosion control plant it is probably of little value but owing to the various uses to which it has been put in the past it is possible that it may prove of value as a commercial crop in regions which produce curious things but which take their own sweet time in which to do it. It is almost a foregone conclusion that crops cannot be grown in regions of two to five inches of rainfall and harvested every year. It is not evident, however, that valuable crops such as tannin, dyes, alkaloids, gums and resins cannot be harvested every five or ten years and the plants not exploited to the point of extermination. Weeds and diseases are not troublesome in the desert and frequent cultivation is hardly desirable. All that is necessary is to give God and the desert a chance. The branches of this plant have been used in basketry and the bark was formerly exported from Mexico for tannin and for a dye. The plant has been used medicinally for everything from toothache to syphilis. It is highly probable that the chief product worthy of investigation is the tannin.

Jatropha angustidens, Mala mujer, is not reported by Standley as occurring in Arizona. It is, however, very common in Pima and Santa Cruz and Cochise Counties in the foothills. With us it is herbaceous, dying down completely to the roots each fall but forming in the summer a dense bush-like plant one to three feet high. Once seen it can never be confused with another plant. The leaves are clothed with white shiny, stiff hairs above, below and along the edges; the stems are similarly clothed and even the flowers and fruits. The leaves are large and the whole plant makes a striking

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ornamental. The "mala mujer", or bad woman, as the plant is called, is best observed at a respectable distance as the stinging hairs are very painful to the touch. The plant is never browsed and its erosion control value is questionable. It should, however, be investigated for its latex and possible medicinal alkaloids.

Jatropha macrorhiza is similar in growth habit to the last. Its range is southern New Mexico and Arizona and south into Mexico. It is herbaceous and coarse and bushy in appearance, with large green leaves without spines. It has a very large, fleshy root of pleasant flavor not unlike new potatoes. Children occasionally dig it up and eat the roots with serious results, as it is violently purgative. The purgative properties have long been recognized by the Mexicans, who frequently use it for this purpose. The root is occasionally sliced and dried. A thin piece the size of a quarter, is ample, and then some, according to reports. The only possible interest in this plant is an ornamental and for its medicinal properties.

Croton spp. With us the Crotons are for the most part worthless weeds. They are commonly erect or spreading, matted plants with grayish leaves and stems. The gray appearance is due to the peculiar stellate hairs covering the surface. Great fields of these plants occur along the highway where there has been heavy grazing and the plants "stink to high heaven". On such sites the plants doubtless serve to bind the soil during heavy rains but the root system is not suited for the best erosion control and the plants themselves rob the soil of moisture which might be available for other plants. All the Crotons are unpalatable to stock. The seeds, however, are eaten in great quantities by doves, in spite of the highly purgative oil they contain. A very exceptional Croton, C. sonorea, is found in Santa Cruz and Pima Counties in Arizona. It is a shrub three to four feet high with grayish green leaves and large seeds. It is not weedy like many of the Crotons and may make a desirable ornamental in the warm dry sections of the southwest. Nothing is known of its properties.

BUXACEAE

Simmondsia californica, Jujube or Deer Nut Bush, is one of our most common shrubs in the mountains and foothills in central and southern Arizona, southern California and adjacent Mexico. The account of it in Standley's Trees and Shrubs of Mexico reads much like a fairy tale. The plant is extremely drought resistant, forming almost pure stands in many places. As an example, some of the north-facing slopes of the hills between Roosevelt and Globe, Arizona are almost completely covered by it. The plant is excellent browse, the leaves and nuts both being eaten by all kinds of stock and game. According to the account in Trees and Shrubs of Mexico the nuts contain 48 percent oil. This oil is medicinal and is good even for cancer, according to reports. It is also used as a salad oil. The

BUXACEAE

nuts are eaten raw or parched and used for making coffee and other nutritious drinks.

Recently the *Simmondsia* has been suggested as a commercial crop for the Pima and Papago Indians. It is being investigated by commercial companies to ascertain the oil available and uses for it.

The seed germinates quite readily but the plants are rather slow-growing at first. Since it is dioecious only a portion of the bushes bear. Some work has been done at the Boyce-Thompson Nursery at Superior, Arizona, in growing the bush under cultivation. Results have been satisfactory. This nursery has also sent nuts away to have them treated. When the tannin is removed the nuts are tasty and wholesome. A problem facing the Bureau of Plant Industry should be to learn how to propagate selections made by our seed collectors and others so that plants of superior quality can be used at least for experimental and commercial plantings in the future.

ANACARDIACEAE

**Rhus cismontana*. This is our common Sumac of the southwest. It is confined to relatively high altitudes along streams or on moist slopes in the yellow pine type, and extends slightly below this zone. It forms thickets, new plants springing up from long horizontal roots and very effectively holds the soil. It is valueless as forage and limited in soil erosion control value because of the soil, moisture and altitude requirements. Where it is suitable, however, it is a plant of high merit.

**Rhus microphylla*, the Small-leaved Sumac, is abundant in the foothills about Socorro and to the south and west. The bushes are commonly larger than the squaw bush and are often almost tree-like with less tendency to spread out at the base. It is comparable to the squaw bush in erosion control value. It is browsed slightly and the berries are used the same as those of the squaw bush by the Indians. It is easy to handle in the nursery but must be grown from seed.

**Rhus trilobata*, the Squaw Bush, is widely distributed in the Rocky Mountains, the Sierra Nevada and the Cascade Mountains. Its various forms extend from low altitudes to quite high altitudes. It is not a good forage plant though it is a starvation ration for sheep and goats. It grows singly or forms thickets of considerable size. Frequently it is sufficiently abundant on steep slopes to constitute the chief factor in erosion control. In the White Sands of New Mexico this becomes covered in dunes and seems to be holding the sand but where the wind begins to cut around the base, the bases are left high and dry with naked roots holding the bushes in mid-air,

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In many places the Indians gather the fruits which they use in various ways. The berries are added to water to make a sour drink, used fresh for seasoning or as an appetizer, or dried and ground to a meal which is used in various ways. It is quite easy to handle in the nursery. The seed, however, are often blank and germination for that reason low. The best method is to immerse the seeds in water and float off the poor ones before planting. This will not grow from cuttings.

We have at least eight other species of *Rhus* in our region. The single-leaf squaw bush (*Rhus utahensis*), resembles *R. trilobata*. It grows in the extreme desert sites of northern Arizona and southern Utah. While it is more drought resistant than any of the others, the difficulty in obtaining seed has thus far prevented the nurseries from growing it.

Rhus virens, Evergreen Sumac, is confined to the mountains of southern Arizona, within our range but is common in Texas and Mexico. It has possibilities as an ornamental evergreen tree but is hardly suitable for erosion control work.

Rhus ovata is a small handsome round-topped evergreen tree with large ovate leaves, found in central and southern Arizona. It is even less hardy than *R. virens* and suitable for ornamental work.

Rhus integrifolia got lost from its headquarters along the coast about San Diego and established itself in the Tinajas Altas Mountains of Arizona. It is an evergreen suitable only to frostless regions. Unlike most *Rhus*es, it layers quite readily but it refuses to grow from cuttings.

Rhus choriophylla is confined to the mountains of southeastern New Mexico and western Texas. It is a handsome evergreen sumac probably suited only to ornamental work. It closely resembles *R. virens*.

Rhus lanceolata, associated with *R. choriophylla*, is a small tree resembling a common sumac but with very hard wood. This is suitable for ornamental work and may prove to be worthwhile for erosion control.

Rhus glabra forms thickets in the mountain valleys of the Huachuca Mountains of Arizona and doubtless is to be found elsewhere in the southwest. It has a wide distribution in the west. This species is probably the most promising of our sumacs for soil erosion control work and its other uses are important. The bark and leaves are used for tannin, the roots yield a yellow dye, the fruits are edible and have medicinal value. Incidentally, the shrub is a

ANACARDIACEAE

handsome ornamental.

*Rhus rydbergii, Poison Oak, is widely distributed in the Rocky Mountains. It is similar to the Poison Oak of the east and the Pacific Coast states. Its sprawling habit where it does not have trees to climb makes it ideal for erosion control in moist bottoms of canyons. Its use of course cannot be advocated. If the economic importance of the Poison Oak and Poison Ivies could be accurately computed it would doubtless run into the millions in the United States every year, on the debit side. The first cost is in medicine and doctor bills which the United States over is enormous; the next is in lost time which is doubtless much greater.

CELASTRACEAE

Mortonia scabrella. The traveler in the southwest who visits the old mining town of Tombstone, Arizona, is likely to become curious regarding a shrub which is very abundant on the rocky slopes in that region. This shrub is stiffly erect and has curious, very thick, hard oval leaves. In fact the leaves look like little pieces of leather with rolled edges. They are grayish green. This shrub is confined in our range to southern Arizona. It is valueless as forage but owing to its abundance does play a worthy part in binding the soil.

Canotia helacantha is sometimes called Crucifixion Thorn although it is a very different plant from the Crucifixion Thorn of Palestine. This term is also applied to two other southwestern plants, each representing a distinct family of plants. As the common name implies, the plant is a mass of thorns. These in common with the stems, are green. There are no leaves. The plant is a large shrub or small tree of erect habit. It has been reported from a limited area in southern California but is most common in central Arizona where it forms forests of limited extent. Growing as it does in very rough, rocky slopes of rather loose soil, it is a good soil binder. Owing to the fact that the plants are utterly useless for browse and of little value as fuel, no attempt has been made to propagate the species in the nursery.

Pachystima myrsinites, Myrtle Boxleaf, is a low shrub found in the high forests throughout the west. It has beautiful small, shiny leaves and inconspicuous flowers. It is a good erosion control plant in regions where erosion control is not a problem. It is totally unsuited to arid regions or low altitudes.

ACERACEAE

Acer negundo or common Box Elder, is widely distributed in Region 8 as well as elsewhere in the west. It is reasonably drought

ACERACEAE

resistant but it is not suited for use on sites where water is not available while the trees are becoming established, nor for use in our low and extreme desert regions. As it is a fast growing tree it has been used extensively in the past for ornamental and street planting. It, however, harbors a bug which becomes very annoying about dwellings and for this reason such trees as the ashes, elms and walnuts are much to be preferred even though they require a much longer time to become shade trees. The box elder is probably better for erosion control along mountain streams than the cottonwood, being less likely to be toppled over by flood waters.

Acer grandidentatum may well be called the Western Sugar Maple. It resembles the eastern sugar maple and has been used, though not extensively, for the production of maple sugar. It is not uncommon in canyons in the mountains throughout the Rocky Mountains. Commonly it is a small, symmetrical and very handsome tree which grows singly or forms dense thickets. It, however, occasionally grows to a height of 40 to 50 feet and reaches a diameter of a foot or more. This is worthy of a much wider use both as an ornamental and for erosion control. Its small size and comparative scarcity probably precludes its extensive use as a sugar tree.

Acer glabrum, Rocky Mountain Maple, is abundant in many parts of the Rocky Mountains. It becomes relatively scarce in our southwestern ranges. It can be classed as a large shrub, never becoming a real tree. Dense clumps of it form excellent soil binders but it can hardly be considered an erosion control plant of significance as it grows at altitudes and under moisture conditions where erosion is not so seriously considered at present. It is probable, however, that in the not distant future our erosion control program will extend up into the high summer sheep ranges much more than it is at present. At this time this shrub maple may prove a boon. It should be mentioned that this plant is used successfully as an ornamental in the western plains regions and in the Rocky Mountains. Its leaves turn scarlet in the fall.

Since the maples generally, produce wood of excellent quality, are usually fairly rapid-growing, beautiful ornamentals and are good soil binders, they should recommend themselves for selection work and even extensive hybridization. The work of the Chinese and Japanese with the maples might well be emulated by nurserymen in this country.

SAPINDACEAE

Dodonea viscosa, Hop Bush, is an abundant shrub in southern Arizona. Along the Apache Trail it covers whole hillsides in almost pure stands. Outside of our boundaries it is practically world-wide in the Tropics. Being quite sensitive to cold it is found only

SAPINDACEAE

in the foothills in the southwest. In the winter of 1936 most of the bushes were frozen to the ground. The plants, however, were not killed and soon new shoots sprang up from the roots. This is an excellent erosion control plant but is worthless as forage. It is interesting, however, from the standpoint of the uses to which it has been put in the past. The seeds, which are borne in abundance, are said to be edible. The winged fruits were formerly extensively used in Australia as a substitute for hops in the making of yeast and beer. The bark and leaves have been used medicinally for practically everything from corns to TB. It is a plant well worthy of careful study to ascertain its medicinal value and possible use of the seeds for food.

*Sapindus drummondii, Soapberry Tree, is a small tree extending from southern New Mexico to southern Arizona. It has leaves which resemble the Sumac but fruits which resemble those of the Umbrella Tree. Occasionally along rocky washes this tree is a desirable erosion control plant. At times thickets of it occur on rather steep slopes and on such sites is an excellent soil binder. The leaves are unpalatable to stock and the fruits are definitely poisonous, containing an alkaloid saponin. In fact the fruits are richer in this drug than any other plant in the west. For this reason the berries have been used as a substitute for soap. This small tree seems to suggest itself for study as an erosion control plant and as an ornamental. Doubtless selections of it can be made which are rapid-growing and which attain considerable size. For example, trees along the Upper Mimbres in New Mexico are magnificent specimens, frequently 25 to 30 feet high and a foot or more in diameter. These are a distinct contrast to the usual run of trees in southern New Mexico and southern Arizona, which are usually 10 to 15 feet high and four or five inches in diameter.

Ungnadia speciosa is called the New Mexican Buckeye. It is confined to deep, rocky canyons of extreme southeastern Texas and southern New Mexico. It is a large shrub or a small tree of rather sprawling and ungraceful habit. The leaves resemble those of the Eastern Buckeye. The fruit is a somewhat triangular three-culled husk containing three seeds. It is a very rare plant with us and should constitute a novelty in arboreta. It probably has no value for forage or for erosion control.

RHAMNACEAE

*Ceanothus fendleri, commonly called Buck Brush or sometimes Soap Bush, is a low spreading shrub with small grayish leaves which are darker green above than below. It is common throughout the yellow pine region in our territory and far to the north and west. Its low sprawling habit combined with its tendency to form complete

RHAMNACEAE

ground cover, make it an ideal erosion control plant. Owing to its altitudinal range, however, this is not being used on any of the erosion control projects at present. When our work takes in yellow pine regions not within the National Forest, it is not unlikely that this shrub will be found useful. The leaves and twigs are heavily browsed by deer and less extensively by stock. The blossoms particularly, contain saponin and have been used in the past as a substitute for soap.

Ceanothus greggii is also called Buck Brush locally. It should be remembered, however, that most any kind of brush may be called locally Buck Brush. It is a more erect and taller shrub than C. fendleri with much stiffer branches and with thick, leathery leaves. It normally grows at a lower altitude than C. fendleri, in fact in western Texas and central and southern New Mexico and Arizona it is associated with the Junipers and Oaks. It has some value as an erosion control plant but very little as forage. The blossoms are sweeter than most of the Ceanoths and the shrub can be recommended as an ornamental chiefly because it is unusual.

Ceanothus integerrimus is a very uncommon shrub in Region 8, being more typically a northwestern shrub. It occurs in the Oak Creek region and perhaps elsewhere in central Arizona. It is hardly significant as an erosion control shrub but should be used as an ornamental because of the dark green foliage and the large panicles of white flowers. It commonly grows in sandy rocky, very dry sites.

*Ceanothus martini is common in the Grand Canyon and in Zion National Park. It is reported to occur in the Pinyon (pinon) Belt of Utah and Nevada. It is a low spreading shrub which layers readily and since it is highly palatable it should prove to be a valuable plant in erosion control. It is best suited to sandy, rocky sites which are relatively dry and hot.

Rhamnus californica var. toментella, Buckthorn. It is possible that both the species, R. californica and the variety, grow in our range but they are at best not extremely different. This buckthorn is rather common but scarcely abundant in central and southern Arizona in the foothills of the larger ranges. It is much more common in California. It sometimes grows to be a small tree but more frequently with us it is a large shrub, often very symmetrical and handsome with grayish green leaves and black berries. The shrub has some value for erosion control along sandy rocky arroyos at the mouth of canyons. It is valueless as forage but should be worthy of cultivation as an ornamental. The berries are relished by birds.

RHAMNACEAE

Rhamnus crocea is often called Holly though it is not related to it. It is a shrub with holly-like leaves and bright red berries. This is much more common in California than in Region 8 but in central Arizona about Jerome and Oak Creek and in the Baboquivari Mountains, it is rather abundant. Its value as a soil binder is doubtful but as an ornamental and for bird food it should rate high. According to Standley, the berries if eaten in quantity by humans, give a reddish tinge to the skin.

Rhamnus betulaeifolia is a rather tall shrub or small tree with large, bright green leaves which somewhat resemble elm leaves. It is very widely distributed in sheltered places in the mountains throughout our range, as well as southwest and north of us, but may be considered rare at that. It may have value as an ornamental. Its bark may be expected to have medicinal properties.

*Sagerotia wrightii is a very thorny shrub with recurving branches which root readily, and small bright green leaves. It is to be found in the foothills and canyons from west Texas to southern Arizona and southward. It is a good erosion control plant owing to its drought resistance and its layering habit. Seed are hard to obtain chiefly because they are hard to collect from so thorny a bush and because they are too highly prized by birds. The plant is worthless as browse.

*Condalia spathulata, small-leafed Jujube, is an extremely rigid, spiny shrub found in western Texas to southern California on very dry, rocky slopes. It frequently forms small but very dense thickets which are almost impenetrable to anything bigger than a small bird. In the Tucson region and doubtless throughout its range berries of distinctly different color are produced on different plants. One bush will produce berries which are white and translucent when ripe while an adjoining plant may produce jet black berries. The berries are very small but are juicy and sweet and relished by birds. In the Kofa Mountains in western Arizona a plant which has been called C. spathulata usually grows taller. It produces berries which are very bitter. C. mexicana is a similar shrub reported from southern Arizona. It is much rarer. All of these are fair erosion control plants and are good for bird refuges. The berries last for but a short time.

*Zizyphus lycioides, Southwestern Jujube, is related to Condalia, - in fact some authors place Zizyphus in the genus Condalia. It is a coarser shrub or small tree with grayish bark and leaves, large thorns and black berries as large as peas. This is one of the commonest shrubs in the extreme southwest. It forms thickets along the bottomlands and in the canyons in the lower mountains, and is a good soil binder. It is worthless for forage but excellent for birds as the fruits are edible and the thickets afford protection.

RHAMNACEAE

*Microrhamnus eriocoides is a densely branched, low spreading shrub common on some of the foothills of western Texas and southeastern New Mexico. The branches are very stiff and the clumps of brush rather forbidding. It has fascicles of rather small leaves and black fruits. This shrub has excellent erosion control value but is worthless as browse. We have no reports regarding it as a bird food plant although the fruit suggests that it may be eaten by birds. (Note: This should be considered along with Condalia and Zizyphus).

VITACEAE

Vitis spp. There seems to be considerable confusion about the names of our native Grapes. For convenience we have been calling them all V. arizonica. We are making an effort to grow the different species and variations in the nursery for comparison and identification. We hope to be able to select one or more of these for propagation. From work already done it seems there is great difference in the response of cuttings and roots. For example, a collection made below Ruby, Arizona, responded readily, while a similar collection made a little earlier on the west slope of the Black Range did nothing. While possibly some attention should be paid to the fruit on collections made, the chief aim is to obtain erosion control plants and not fruit bearing plants. We, however, bear in mind the possibility of obtaining plants which supply bird food.

Parthenocissus vitacea, Virginia Creeper, is widespread, almost, throughout the United States except in the extreme west. In regions where it is not native it is extensively cultivated. It should prove suitable for use as a soil erosion plant in upland valleys with some moisture. It is doubtful, however, whether it will prove as satisfactory as our native wild grapes which are suitable for use in the same sites. This vine, like the grapes, supplies considerable food for birds.

Cissus incisa, Treebine, with us is a rare woody vine confined to draws and canyons of the southern part of New Mexico and Arizona within our range but extending eastward to Florida and south to the Tropics. It has thick, fleshy three-foliolate leaves and tendrils and is suitable for an ornamental. The fruits are eaten by birds and the thick leaves have been used for salads. The plant has been accused of being poisonous to the touch, like poison ivy. This is probably a gross exaggeration.

MALVACEAE

Abutilon spp. Several species of Indian Mallow occur in the west and southwest. Some are interesting erect herbs with large,

MALVACEAE

soft velvety cordate leaves. None are of importance for forage. An introduced species, A. theophrastii, has been suggested as an erosion control plant. It is a tall velvety annual with small yellowish flowers, of little value (because of its erect habit) as a soil binder, and capable of becoming an undesirable weed. Its use cannot be recommended.

Thurberia thespesioides is the common wild cotton plant of the extreme southwestern ranges. It closely resembles the tame cotton and is chiefly interesting because it is a host to a weevil very similar to the common cotton boll weevil and one which is known to attack cotton. Thousands of dollars have already been expended in the eradication of this shrub from the canyons and mountains adjacent to the Santa Cruz, Gila and Salt River valleys. If it were not a host it might readily be considered favorable as an ornamental. It has a little erosion control value.

FRANKENIACEAE

Frankenia jamesii is a low shrub from a few inches to thirty inches high, occurring in southern Colorado, New Mexico and western Texas, in very sandy, alkaline soil. It has rigid branches and short, slender hairy leaves in small crowded fascicles. It is heavily browsed in the Navajo region and probably elsewhere. Its low spreading habit suggests that it may have value for erosion control work.

TAMARICACEAE

*Tamarix gallica or Salt Cedar, is not a native of this country in spite of its wide distribution and abundance. It was introduced from Europe many years ago. In the Southwest it is variously rated as an excellent erosion control plant and as an obnoxious weed. It may well be considered a godsend in portions of the Rio Grande valley and in the Pecos valley where the dense stands are very effective in stopping erosion. It occupies alkali flats and bottomlands where there is some overflow and where erosion, without it, might be severe. During starvation times stock browse the green twigs and leaves. This shrub or small tree is hardy in all but high altitudes in the southwest. Along water courses it spreads rapidly by seeds. In cultivation it is most easily propagated by means of cuttings or young plants taken from sandy bottoms. ✓

*Tamarix articulata, often called Evergreen Tamarix, is an extremely rapid-growing tree introduced perhaps forty years ago to the warm portions of the southwest from north Africa. It resembles a cedar, remains green throughout the year, produces an abundance of shade, posts and wood, and is readily propagated by cuttings. ✓

TAMARICACEAE

It is, however, not hardy except in regions comparable to those at Tucson, Phoenix and Yuma. In the lower Colorado River Valley cuttings will produce trees 30 to 40 feet high and one and one-half feet in diameter in seven or eight years. In the Coachella Valley in California the trees are accused of harboring small gnats which cause serious eye troubles with children. While this tree is not suitable to extremely dry sites, in bottomlands or where it can receive a little irrigation in warm regions, it produces perhaps the quickest growth of any of our trees and provides abundant shade. The trees can be planted sufficiently close together to make a very effective check or diversion for floods.

FOUQUIERIACEAE

Fouquieria splendens, Ocotillo, is one of the commonest shrubs of the deserts from Texas to California and south into Mexico. Its clumps of tall, straight, very thorny stems are familiar to everyone who has traveled through the southwest. It is sufficiently abundant on many dry, rocky slopes to have considerable beneficial effect as a soil binder. It is valueless for forage but the stems are used extensively for building fences and for roofing adobe shacks. The freshly cut stems when placed in the damp ground root readily. The bark contains considerable rubber and attempts were made in the past to commercialize the plant for this purpose. The bark of dead Ocotillo is a godsend to the camper during rainy times, which in spite of everything to the contrary, do occur in the desert. Shreds of this bark burn freely in spite of any amount of soaking. It is said that sheep and goats occasionally become entangled in the butts of the Ocotillo and being unable to extricate themselves, die of starvation.

BIXACEAE

Amoreuxia pinnatifida is chiefly interesting because of the beauty of its flowers and its comparative rarity. In our range it is confined to extreme southern Arizona in the rocky foothills. It is a low herb, six to ten inches high with palmately divided leaves and large, slightly irregular yellow flowers. It forms a very large, starchy root and a fruit slightly resembling that of skra only shorter and smoother. Mr. Gentry, who has done considerable collecting in Mexico, reports that the fruits of this plant are considered a delicacy in southern Sonora and Chihuahua. There seems to be no record that the roots are used for food.

KOEBERLINIACEAE

*Koeberlinia spinosa, another of our Crucifixion Thorns, has a much wider range than Canotia, extending from western Texas to



KOEBERLINIACEAE

southern Arizona and southwest into Mexico. Occasionally or in certain localities, it forms a small tree but usually only a low spreading mass of shrubbery or better, mass of green thorns. These shrubs usually occupy low heavy alkaline stretches frequently where erosion may become active. The bushes harbor grasses which cannot withstand grazing in the open and collect the top soil blown or washed from the surrounding areas. Up to the present this plant has not been used for erosion control practices but seems well adapted to such use. It should of course only be used in strategic places and then only in limited quantities because of its impenetrability as well as unpalatability.

PASSIFLORACEAE

Passiflora mexicana is a perennial vine with a woody base. It seems to be confined in our range to extreme southern Arizona but extends into Mexico. In a region southeast of Fort Huachuca it grows in such abundance in small mesquite trees that it kills them. The entire tops of the bushes become a solid mass of the leaves and later of the fruits of the Passiflora. The flowers of this species are typical of the Pasque flowers but are seldom more than one inch wide. The fruits are jet black and about one-quarter inch in diameter. This species is worthy of some careful investigation as the immense amount of vine produced may prove to be helpful in certain locations for erosion control. The fruits are probably edible for birds.

There are at least two other species of Pasque flowers in southern Arizona, - one in the Baboquivaris and one in Santa Cruz and Cochise Counties. The fruits of both of these are edible (if you like them) but the plants are apparently exacting as to site. Both are very drought resistant.

LOGANIACEAE

Petalonyx thurberi, the Sandpaper Plant, is unusual in our range but more abundant in the desert regions of southern Nevada and southern California. It is rather abundant in draws west of the Catalina Mountains of Arizona where it is a fair erosion control plant. It can be recognized by its rather strict habit, showy heads of small white flowers and its small, very thick harsh leaves which have a sandpaper finish.

CACTACEAE

Cactus. At the present time Cactus is not being used in our soil conservation work. Certain species, however, seem to offer possibilities. In fact a few were tried with some success several

CACTACEAE

years ago. Several of the round stemmed *Opuntias* form bushes of small trees and propagate themselves mostly by means of the broken and detached joints. By building retaining structures of these, growing masses of Cacti are formed. Prickly pears have been used in the same way. Cacti on the range, however, are never exactly popular and such practices as planting them where they are already too numerous has been discouraged. For the most part the jointed Cacti or chollas and the prickly pears may be considered weeds, the growth of which is promoted by heavy grazing. Many of the Cacti play an important part in the life of the Indian. The fruits of such Cacti as the Giant and the Organ supply fruits which are eaten raw or made into preserves. The fruits of the prickly pears are similarly used though not so highly prized. The woody portions of the Giant Cactus are used in many types of construction such as in building fences and in thatching houses. The commercial value of the Cactus for ornamental planting cannot be overlooked. Thousands of dollars are spent every year in the purchase of Cactus for Cactus gardens and curiosity window plantings.

ELADAGNACEAE

**Elaeagnus argentea* or Silverberry, is a shrub one to three meters high with silvery leaves and fruits. It closely resembles *E. angustifolia* but is smaller. It is confined to the mountains and plain regions, mostly in the northern part of Region 8 and northward into Utah and Colorado. It has been cultivated as an ornamental and as a windbreak in the plains country east of the Rocky Mountains. It is well worthy of more extended use than it is receiving today as it is an excellent erosion control plant, as well as an ornamental.

**Elaeagnus angustifolia*, Russian Olive, is a small tree of such excellence for the Rio Grande region and for Utah that it deserves careful consideration on any revegetation program in these regions. Its range extends from northern Arizona and New Mexico, far to the north and east. It grows in practically any type of soil where there is a reasonable amount of moisture. It is rapid-growing, produces a high grade post wood and fruit much relished by birds. It is hard to understand why fruit with such a high degree of sugar has not been commercialized in some way. This tree has been planted on some of the projects with promising results. Seed are produced in abundance and are easily collected. Direct seeding on the range may prove to be feasible.

**Shepherdia argentea*, the Buffalo Berry, is much more common in Wyoming, Utah and Colorado than in New Mexico and Arizona. It is a tall silvery-leafed shrub which bears bright red berries. The bushes are excellent erosion control plants in somewhat moist swales



ELAEAGNACEAE

at moderate altitudes. They are frequently cultivated for wind-breaks, ornamentals and for their fruit which makes very good jelly.

Shepherdia rotundifolia, the Round-leafed Buffalo Berry, is a rare shrub found along the San Juan River, in the Grand Canyon in Arizona and in Zion National Park. Scouting will doubtless give it a wider distribution. It is an interesting shrub of a prostrate or nearly prostrate habit, which grows in dry sites below cliffs as well as similar sites where there is a little seepage. Its habit suggests its use for erosion control work. Up to the present we have not grown it in the nurseries.

A third Buffalo Berry, Shepherdia canadensis, grows in the high mountains. It has no significance for erosion control work but is sometimes used as an ornamental. The fruits are bright red and as bitter as quinine.

ONAGRACEAE

The Evening Primrose family contains many showy annuals and perennials, some of which are fair forage. The low creeping type may even have some value for erosion control. Most of the important ones can be classified in the large composite genus, Oenothera, which contains both the large white-flowered forms and those with small or large yellow flowers. All of these can be recognized by their four petals and inferior ovary. Zauschneria californica goes in this family but has a strikingly different flower. It is red and somewhat irregular. The leaves are clammy. The plant has a rhizomatous root system and is an excellent soil binder in draws and in the mountains at about 4,000 feet elevation. This plant has a wide distribution in the southwest.

ARALIACEAE

Aralia humilis is a very uncommon shrub occurring in the United States only in southern Arizona. It has large bipinnate leaves and umbels of flowers and black fruits. It occurs only in rocky canyons and on steep rugged north-facing slopes. It is a tender shrub of no erosion control value but one which may prove to be of value for an ornamental and for medicine.

CORNACEAE

Garrya spp. These tall shrubs are sometimes called Coffee Berries because of the peculiar odor of the plants. They have rather large, ovate to oblong, thick hard grayish leaves. There are three species in the southwest which quite closely resemble each other, the chief noticeable variation being in the pubescence or hairiness of the berries. These occur in spikes and are black

CORNACEAE

upon ripening unless the color is obscured by the thick covering of hairs. These shrubs are valueless for forage and because of their upright habit not particularly suitable for soil binders.

Garrya flavescens, probably the best one of the group, would make an interesting addition to shrub arboreta. The most common one in the southwest is G. wrightii.

Cornus stolonifera is the common stream Dogwood of the west. It is widely distributed and very abundant along mountain streams. The branches bend over and often become tangled masses. These are not infrequently the consternation of the fisherman. These shrubs are good stream bank binders but where they will grow they are usually present and as they are neither drought nor alkali resistant, they are of little or no value in any of our work as now formulated.

ERICACEAE

*Arctostaphylos pungens is the common Manzanite of the southwest. It forms almost pure stands at medium altitudes in many places throughout New Mexico and Arizona and extends into California, Utah, Colorado and Mexico. It occasionally reaches almost tree dimensions but has such a spreading habit that it is always bush-like. In the extreme southwest it occasionally reaches a height of twenty feet or more and a single plant may spread fifty feet. Where the prostrate branches touch the ground they root freely, making this shrub one of our best erosion control plants. Up to the present it has not been grown successfully from cuttings and seed germination is very unsatisfactory. It is more than likely, however, that the possibilities of this shrub for our use have not been exhausted. Its growth habits should warrant extensive and careful work in its propagation and even in the selection of rapid-growing and vigorous strains. While the leaves of the manzanites are not extensively eaten the fruits which are produced in abundance constitute the main food for wildlife during extensive periods. Turkeys in northern Mexico grow fat on the berries and foxes and bears are fond of them.

Arctostaphylos patula. While this species does not occur in Region 8 it should be discussed here because of its pronounced value as an erosion control plant and because of its economic value for fuel. It covers very wide areas of loose volcanic soil in California, particularly on Mt. Shasta. When fires sweep over the region the crowns and roots remain uninjured and continue to hold the soil. Locally the crowns are dug out or chopped out and used for fuel.

Arctostaphylos platyphylla is abundant in our region only in southern Utah. It is the common Manzanite in Zion National Park.

ERICACEAE

It resembles A. pungens but is a lower shrub with a more prostrate habit. It is an excellent soil binder and should receive attention along with A. pungens.

A. pringlei is confined to Arizona and Mexico. It reaches its maximum development in the Pine and Payson region where it is an erect shrub often ten feet or more in height. It does not constitute as good an erosion control plant as A. pungens but is comparable as a wildlife plant.

Arctostaphylos uva ursi, the common Kinnickinnick or Bear-berry, occurs at high altitudes in northern New Mexico but is much more common northward, occurring in Canada and across the continent. While its habit suggests it as an ideal erosion control plant (it is creeping and forms dense mats), its altitude and moisture requirements preclude its use except possibly in unusual cases in our erosion control program. The leaves of this shrub constituted one of the chief substitutes for tobacco for the Indians a half century ago. It was commonly used also to mix with tobacco until the white man substituted the lowly cabbage.

*Arbutus arizonica, our native Madron, is a handsome tree often forty feet high or more and two feet in diameter with bark which exfoliates from the young branches and dark evergreen leaves. It is hardy from 4,000 to 8,000 feet altitude in the southwestern ranges, not occurring at low altitudes and may well be considered a woodland species. It is very slow growing. The bright red berries which remain on the tree for a long time are very ornamental and are good bird food. The flowers also, are beautiful, resembling those of the Manzanite. This valuable tree has not been grown in the nursery.

Arbutus texanus is a tree similar to A. arizonica, which occurs in the mountains of western Texas and southeastern New Mexico. It has broader leaves, somewhat larger fruits and is a smaller tree. It has not been grown in the nursery.

SAFOTACEAE

Bunelia rigida, or Chittinwood, is common in the south and Mexico. In Region 8 it occurs in southern New Mexico and southern Arizona in rocky canyons and occasionally on dry, steep rocky north-facing slopes. It is a small tree with very stiff branches and vicious stiff thorns. Groves of it are very effective soil binders as the horizontal roots are abundant and sprout freely. It is valueless as forage. The wood with us is too small for anything but small tool handles. The exuded gum is interesting to children

SAPOTACEAE

but of no commercial importance. This tree is not being grown on the nursery. The root cuttings germinate readily but seeds are difficult to germinate. It is not to be recommended except for canyon bottoms and steep slopes where grazing is to be discouraged.

CLEACEAE

Menodora scabra is not uncommon almost throughout the southwest. It ranges from 2,000 feet or less to 5,000 feet or more, on the very dry sites. Although it is hardly significant as an erosion control plant because of its root and top habit, it serves to extend grazing far beyond the usually severely overgrazed bottoms, swales and canyons because of its high palatability. On observational plantings in the Tucson region this plant showed the best results of all the plants direct seeded. It is a perfect plant for nursery use - it germinates well, survives well and produces about three good crops of seed each year at Tucson. In harvesting seed in the nursery the tops of the plants are cut and piled on a canvas or floor and allowed to dry. After drying the seed shatter readily. Seed can be broadcast or used in a planter. The sites for which the plant is best adapted, however, preclude the use of machinery. Since a pure stand is never desirable, the amount of seed per acre should be relatively small, perhaps two to five pounds, depending upon conditions.

Menodora scoparia. Our initial crop of seed for this species was collected near the Natural Bridge, Arizona and near Prescott, Arizona. In both places it constitutes a significant portion of the forage. It is even more widely distributed in the southwest than M. scabra. Its root system makes it a much better erosion control plant than M. scabra but its altitudinal range is higher and it is not so well adapted to lower elevations. At Tucson it is not quite so good in nursery production. On the range it germinated equally well. A strain of this species from the Kofa Mountains is being tried. It grows naturally in a much drier site at a lower altitude. We do not have seed for increase at present. At Tucson M. scoparia produces two crops of seed per season. The collection and handling is similar to that of M. scabra.

Menodoropsis longiflora and Menodora laevis are comparable to the Menodoras discussed. We plan to grow these for comparison. Menodoropsis longiflora is a larger plant, is much more bushy and may prove to be a better erosion control plant.

Syringa vulgaris, the common Purple Lilac, is used only as an ornamental in the southwest at the present time but in regions to the east and north of us it has come to be a favorite for use as low windbreaks and as such seems very desirable. Observational

OLEACEAE

work may prove to be a worth while erosion control shrub in the eastern portion of our region.

*Forestiera neo-mexicana. Considerable attention has been paid to our New Mexico Wild Olive because it forms dense clumps and its branches root readily where they bend over and touch the ground. It has considerable erosion control value but generally grows in scattered clumps instead of stands, thus preventing it from playing a very important part. Occasionally it is found in the beds of washes where floods have flattened out the trunks and branches. Here it sprouts abundantly and forms effective gully plugs. It grows quite readily from cuttings but since seed is produced abundantly and germinates readily, the cutting method has been abandoned in our nurseries. This wild olive is sometimes browsed, even heavily, but it is always when stock have been starved to it. Apparently nothing has been done with the fruit to determine its oil content. It is possible, even probable, that the berries are rich in oil and since they are frequently produced in great abundance the plant may have some economic importance other than that of erosion control.

Forestiera phillyreoides. This Wild Olive has a very limited range in our territory, being confined to the extreme southern and western portions of Arizona. It is highly probable, however, that its range can be considerably extended since it grows well up in the Baboquivari Mountains where it gets quite cold. It is a handsome small tree often found in small dense thickets which shade out all underbrush and the lower limbs of the trees leave clean boles and a dense canopy above. In contrast to the New Mexico wild olive this drops its fruits about as soon as they ripen. It grows readily from seeds and for this reason cuttings have not been tried. The wood of this, which is very hard, may be of some economic use as well as the berries.

Fraxinus spp. Our Southwestern Ash trees differ so much from each other that they cannot be well compared. Some are very small trees while some are large enough to be considered excellent shade trees or even to furnish wood and small dimension lumber though apparently they are never used for the latter.

*Fraxinus anomala, Single-leafed Ash, is a small tree which grows in abundance but not in pure or dense stands in southern Utah and northern Arizona in extremely dry sites on rocky slopes. It can readily be recognized by its single leaflet to a leaf, in contrast to the others with three to several leaflets. It is a fair soil binder and a good browse plant.

Fraxinus cuspidata, Flowering Ash, should perhaps be classed as a soil erosion control plant. It, however, forms thickets (growing singly at times) and may have some value for erosion control.

OLEACEAE

It should be more extensively planted as a street ornamental as it has showy fragrant flowers and small glossy green leaves. It is to be found only in isolated spots in New Mexico and Arizona and western Texas.

Fraxinus greggii, Gregg Ash, occurs in Texas and Arizona. It is a small handsome tree or tall shrub which grows on very arid sites on rocky slopes, not along streams. Its value is probably as an ornamental only though it may be of some use in erosion control and it may be browsed to some extent.

In New Mexico much of the ash for ornamental purposes has apparently been supplied by nurseries in the mid-west, the most common one being Fraxinus lanceolata.

Fraxinus lowellii, Lowell Ash, is closely related to F. anomala. Its range is further south in Arizona. It grows on steep, dry, usually north-facing slopes. The trees are somewhat larger than F. anomala, and there are three leaflets commonly to the leaf. The seeds and general aspect of the tree are similar to F. anomala but it usually forms dense thickets of small size.

Fraxinus standleyi, Standley Ash, is one of the common native ashes of large size of Arizona but apparently it is not usually cultivated.

In our erosion control work we are more concerned at present with the small ashes which are fair erosion control plants and which supply considerable forage. With all of these our experience is limited.

Fraxinus toumeyii, Toumey Ash, is our most outstanding large ash and the one most commonly used for shade and street planting in southern Arizona.

GENTIANACEAE

Eustoma russelliana is a perennial herb closely resembling the gentians, -in fact it belongs to the gentian family. It is widely distributed from Nebraska and Colorado to New Mexico, Louisiana and Mexico. In our range, however, it is rare, being confined to alkali soil such as regions adjoining the White Sands and the Bottomless Lakes in New Mexico. It is valueless for erosion control and forage but is a very handsome flowering plant suitable for flower gardens.

Frasera speciosa, sometimes called Deer's Ears, is widespread in the west at comparatively high altitudes. It has large, basal

GENTIANACEAE

rosettes of grayish green leaves, tall leafy stems and spikes of greenish flowers. It is listed among the poisonous plants.

Frasera paniculata is a curious plant, related to F. speciosa, and found only in desert sands of New Mexico and Arizona. It has a large, fleshy root that grows deep into the sand. The stems are slender, the leaves rather narrow and white margined. As far as is known it is valueless.

APOCYNACEAE

Haplophyton cnicoidum is a very rare plant in our region, being confined to extreme southwestern ranges in Arizona. It, however, is more abundant southward, becoming a plant of some importance in portions of the Tropics. It is an herbaceous perennial with very slender stems and leaves, bright yellow flowers and long, narrow fruits which are always in pairs. This plant seems to be quite heavily browsed where it occurs in stock ranges and is a good erosion control plant. Its use as a soil binder or for forage, however, should be questioned until further investigations of it have been made. The Mexicans apply the term "deer-killer" to the plant, indicating that it is poisonous and it has been used for many decades in Mexico to prepare a solution for killing insects. Our chief interest in the plant is its possible use for the manufacture of a commercial insecticide. A beautiful bed of it is growing on the nursery at Tucson and seed has been sent to Mr. Russell at Texas A. & M., and to Dr. Sievers at Washington, D. C., for experimental work.

*Macrosiphonia brachysiphon is a low shrub confined in our region to southern Arizona but common in northern Mexico. It has a wide-spreading root system in which the roots sprout freely and as it occupies the heads of small draws it constitutes a good, in fact one of the best, erosion control plants in regions where it grows. Funnel-shaped flowers and opposite leaves suggest the Periwinkle, which is common in many flower gardens. Macrosiphonia is related to the Periwinkle and has a similar habit. The flowers, however, are white or occasionally have a pinkish tinge and are very fragrant. The shrub is quite heavily browsed but withstands grazing well. Up to the present it has not been used in revegetation work but its qualities recommend it for this and for use as an ornamental.

ASCLEPIADACEAE

Asclepias albicans. Several of the Milkwoods have been tested for their rubber content. This and the following two species appear to be our best rubber producers. A. albicans is confined

ASCLEPIADACEAE

to the very hot dry regions of the extreme southwest. It often grows in large clumps with many stems to the plant. The stems are unbranched, straight and three to seven feet long. The rocky dry sites in which this plant grows suggest the possibility of raising it for rubber in the worst desert regions in the southwest. Its value for erosion control purposes on any of our projects as they exist at present is out of the question.

Asclepias crosa is reported to be our best Milkweed for latex. It is nowhere abundant in our region and its range is limited to the hot dry sections of the extreme southwest. In the Tule Tank country in western Pima County, Arizona this plant occupies the beds of sand washes and has an intricate system of horizontal roots. Plants are frequently five feet high. On cutting the stems a stream of juice exudes. If this is rich in rubber this species should be worth planting in sites of this kind.

Asclepias subulata resembles A. albicans and has about the same range. It is a somewhat smaller plant. Experiments indicate that it is valuable for rubber. None of the above Asclepias plants have been grown in the nursery at Tucson.

CONVOLVULACEAE

Dichondra argentea is too rare to have a common name and too unusual and pretty to leave unmentioned. Where it grows it is frequently abundant but it is suited only to very dry, rocky warm situations. Naturally, it is confined to western Texas, southern New Mexico, southern Arizona and adjacent Mexico. The leaves and stems of this plant are silvery gray and the stems cling close to the ground and root freely. Where it will grow it is an ideal erosion control plant and should prove a novelty in rock gardens,

POLEMONIACEAE

The Gilia and Phloxes are abundant in the southwest, mostly in the mountainous sections. Some of the former are annuals. Many, however, are perennials. All of our Phloxes are showy perennials and some are fair erosion control plants which may sometime find a place in our work. They resemble the cultivated phloxes and are interesting as ornamentals.

HYDROPHYLLACEAE

*Eriodictyon angustifolium or Yerba Santa, is a shrub which is abundant in many of the mountains of the extreme southwest from southern Arizona to southern California, Utah and Nevada, at altitudes of about 3,000 to 5,000 feet. The traveler between Superior and Globe, Arizona is likely to observe the large patches of this shrub along the highway embankments. It forms dense stands, sprouting

HYDROPHYLLACEAE

freely from the roots and the caudices. For this reason it is an excellent soil binder. It is probably browsed to some extent, particularly by sheep and goats. The leaves contain a balsam-like resin which is not unpleasant to the taste. The balsam has been utilized for cough preparations. The dried leaves are official in the U. S. Pharmacopoeia.

BORAGINACEAE

Coldenia canescens is a low spreading suffrutescent perennial common to the hottest, driest sections of the southwest, from Texas to California. It doubtless has some value as a soil binder but as it never makes a complete ground cover and as it is valueless as forage, its only place is to excite the curiosity of the traveler.

Coldenia greggii is a shrub with small gray ovate hairy leaves and white flowers. It is very common on some of the dry limestone hills of western Texas and southern New Mexico. Its value for forage is not known and its value as an erosion control plant is slight. It should make a hardy ornamental for rock gardens.

Coldenia hispidissima is a common sight in the White Sands region, the sandy deserts of Central and Northern Arizona and those of southern Utah. It is a true shrub but the stems are almost always buried in sand and only the ends of the branches with their small hispid leaves are visible. This plant has a marked value as a soil binder and should be suitable for propagation on sand dunes and in rock gardens.

Euploca convolvulaceae is an annual confined to the sand dunes or very sandy land from Nebraska to Arizona. It is a creeping vine with rather small, ovate-lanceolate leaves covered with long, stiff appressed hairs, giving the leaves a grayish appearance. This plant grows in profusion and in spite of being an annual is an effective sand binder. It is valueless as forage but should make a beautiful ornamental.

VERBENACEAE

Lippia wrightii is a common shrub in the foothills of the southwest from western Texas to southern California and south into Mexico. It is a mint with small crenate leaves and a very pleasant odor. The white flowers are in short spikes. These have an even more delicate perfume-like odor than the leaves. The bush is of some value for forage and grows sufficiently abundant in many places on steep slopes to be of value for erosion control. The plant should be used more extensively as a garden shrub because of its flowers and its delightful odor.

VERBENACEAE

*Lippia ligustrina is a shrub somewhat like L. wrightii but one which grows considerably taller. It is not uncommon in western Texas but it does not occur in New Mexico or California. It has been found in a few places in Santa Cruz County in Arizona, close to the Mexican border. This shrub has quite long spikes of small white flowers and even more pleasing odor of leaves and flowers than L. wrightii. In Sonora, Mexico it is highly prized as a forage plant. As it is easily propagated from seeds and cuttings it should be used as an ornamental and may have value in the future as an erosion control and forage plant in our revegetation work in the extreme southwest.

*Lippia canescens, often called L. repens, is an introduction in the southwest. It has been used for many years in lawns in southern California and in southern Arizona. It is a low creeper which roots freely along the prostrate stems and thus constitutes a par-excellence erosion control plant. Its tenderness to frost precludes its use in the northern part of our range. Lippia nodiflora is a plant quite similar to L. canescens but it has a more erect habit. According to reports from California it is an exceptional erosion control plant and should be tried extensively in our range. It is not so suitable for lawns as L. canescens.

Lippia cuneifolia, a native of western Texas and southern New Mexico, is very similar to the last two and may have the advantage of being much hardier. It is being tried at Tucson.

LABIATAE

*Poliomintha incana. This Mint promises to become very important in our revegetation program. It is a low spreading shrub commonly found in deep sand, being very abundant in the White Sands of New Mexico and in the sand hills in the Hopi and Navajo regions. Since it spreads close to the ground it is much more effective in checking drifting sand than plants having single erect stems. This plant is perfectly at home under cultivation, growing luxuriantly at Tucson and Shiprock. If it is kept cut back each season it forms a handsome plant for border planting. The flowers are abundant and showy but not loud. The young shoots are tender and of a pleasant minty flavor. They are used extensively by the Hopis for food. It can be said reasonably that they might well grace the tables of whites in garnishes and salads.

SOLANACEAE

Lycium exsertum, Wolfberry. This species produces fruit in great abundance and it is easy to handle in the nursery. It is

SOLANACEAE

not adaptable to the wide range in which L. pallidum is found and is not particularly good as an erosion control plant. We have beautiful bushes growing on the nursery at Tucson and these supply us with more seed than we require. Perhaps a more careful study should be made of other southwestern species of which we have several in southern New Mexico and Arizona. It is possible too that strains can be developed which will produce fruit of desirable size and flavor.

*Lycium pallidum, Pale Wolfberry. While there are other Lyciums the fruits of which are used to some extent by the Indians and by birds, this is the most outstanding as a soil erosion plant. It forms thickets on mounds and on bottom lands and since it has a vast system of horizontal roots it is a good soil binder. It is browsed by sheep and goats. The association of this with old Aztec ruins has led to the belief that the Aztec either cultivated it or used it extensively and scattered the seeds about their dwellings. The plants are found almost throughout the southwest at altitudes from 3,000 to 6,000 feet. It is much more abundant, however, in the Navajo country and in southern Utah than elsewhere. Up to 1938 it had not been planted in the nursery.

SCROPHULARIACEAE

Antirrhinum antirrhiniflorum and Maurandia wislizeni are herbaceous perennial vines with handsome blue flowers and small triangular arrow-shaped leaves. The normal range is western Texas, southern New Mexico and Mexico. A. antirrhiniflorum extends into southern Arizona also. These plants may have little value for erosion control but both are worthy of use as ornamentals and may become of importance as windbreaks in association with brush. They are extremely drought resistant.

BIGNONIACEAE

*Chilopsis linearis, the Desert Willow, can be compared to the Catalpa as the flowers are very similar and the two belong to the same family. This species is being more generally used for revegetation and erosion control work than most any plant outside of the true willows and cottonwoods. Along our desert washes and draws it forms natural thickets which quite effectively hold soil and boulders. This tree is well worthy of more serious attention. Under cultivation it grows rapidly and should with proper pruning, make a tree of sufficient size for a good post or even two posts. After being cut it sprouts vigorously. The wood takes a satiny finish, has a pleasant odor and is very durable. In nursery practice it is best to use seed, as they germinate readily. Cuttings are also very satisfactory.

BIGNONIACEAE

Tecoma stans, Wild Trumpet Plant, is confined in our region to western Texas and southern New Mexico and Arizona. It is a very handsome low shrub with pinnate leaves and large brilliant yellow trumpet-shaped flowers. Years ago Mr. M. E. Musgrave of the Soil Conservation Service introduced this plant into the commerce of the southwest. For many decades, probably hundreds of years, it has been used by the inhabitants of Mexico as an ornamental. At present Mr. M. E. Musgrave has plants growing in his yard at Albuquerque, New Mexico. Frequently, even in southern Arizona, this plant freezes to the ground but it readily sprouts from the roots.

ACANTHACEAE

*Anisacanthus thurberi, Desert Honeysuckle, is confined to southern New Mexico, southern Arizona and Mexico. It is a shrub with opposite, rather broad lanceolate leaves and white papery bark. It is browsed extensively when more palatable forage becomes scarce. It is a fair erosion control plant along dry washes. It is ideal for nursery production from cuttings but seed production is small because of a tiny fly which infests the seed pods, destroying the seeds. Cuttings and nursery stock used for range planting is severely injured by jack rabbits. Although nursery stock has been raised at Albuquerque it is not yet known that this species will withstand the climate of the Upper Rio Grande or of the northern portion of New Mexico generally.

There are several other Acanthaceous plants which are interesting as forage or erosion control plants. These have not yet been tried on the nursery or on the range but they are worthy of mention and some of an early trial.

Boloperone californica is a tender shrub confined with us to the warmer portions of southern Arizona and southern California. It has drab, hairy opposite thick leaves and red flowers. It is a good erosion control plant in some of the extremely hot southwestern deserts as it protects the banks of dry washes but it is hardly suitable in any regions on which we are at present conducting control work.

Tetramerium hispidum is a low herbaceous perennial which is abundant in rocky sites at lower altitudes in our southwestern ranges and is found not infrequently in mesquite regions where it is difficult for stock to get. It is highly palatable and will not withstand heavy grazing. Plants are easy to establish in the nursery either from roots collected in the field or from seed. This species, however, is hardly significant as an erosion control agent.

ACANTHACEAE

Elytraria tridentata, another member of the family Acanthaceae, grows in rocky dry sites in the extreme southwest. The plants are low and except for the leaves at the woody base resemble a club moss. The flowers are rather showy and the plant recommends itself for rock gardens and for border. As it has a good root system and is palatable, it may be useful for erosion control work since it grows readily from seeds and can be easily transplanted. It is likely, however, that its use will be insignificant because of the diminutive size of the plant.

Diapedium resupinatum, is considered a rather rare plant probably because it is eaten wherever stock can get at it. It has been grown in the lathhouse for roots and has escaped there, coming up among the pots. It produces an abundance of stems and leaves and should be tried as a crop under irrigation. It is also suitable for use as an ornamental. The natural distribution of Diapodium, the foothills of our southwestern ranges, suggests that it will not withstand much cold. It may be worthwhile, however, to try it further north as an annual.

Carlowrightia linearifolia is a shrub in the foothills of western Texas but the stems are delicate and the plants are commonly found in the protection of other shrubbery. This plant has not been tried in the nurseries but may be found useful as a forage plant as palatability is high. Its erosion control value is doubtless slight.

Carlowrightia arizonica and Siphonoglossa longifolia, are both low shrubs which are highly palatable but which are only suitable for extreme desert, warm sites in the foothills of our southwestern ranges. No experimental work has been conducted with these in the nurseries.

Jacobinia candidans has been reported as occurring along Salt River below the Roosevelt Dam. Up to the present the nurseries have been unable to obtain seed of this shrub. It may prove of value along streams in our warmer regions and as an ornamental. No member of the Acanthaceae should be considered lightly as the group contains valuable forage and erosion control plants.

PLANTAGINACEAE

*Plantago fastigiata. This is probably the most important of our Indian Wheats though this is not certain. Several species become very abundant in our deserts in years of sufficient winter rainfall and produce an abundance of food for all kinds of stock. In contrast to many of our annuals these plants remain palatable even after they become dry. There seems to be abundant evidence

PLANTAGINACEAE

that this plant can be overgrazed as areas in the Paradise Valley north of Phoenix, Arizona, which produced solid stands in previous years, produced sparingly this year after a few seasons of heavy grazing by sheep. The Indian Wheat itself is an evidence of over-use of the range.

Mr. H. C. Gambee of the Phoenix Union High School attempted in 1936 to collect and market Indian Wheat as psylla. While the seed proved of high grade judged by the amount of jell produced, he found himself unable to market his product in competition with seed producers in foreign countries. It is possible, however, that selections of good strains and irrigation and cultivation, may produce plants, the seeds of which can be harvested more inexpensively, and cleaner seeds produced. It is doubtful, however, whether the blonde seeds as produced by this and related species, can ever successfully compete with the black psylla.

Results in the nursery with Indian Wheat have been quite discouraging. Indications are that the seed should be planted the same season it is collected and not stored for use one or two seasons after collection.

These plants produce a close ground cover but it lasts but a short time and has very little effect on erosion. As a nurse crop, however, it is probably good.

RUBIACEAE

Bouvardia ternifolia, a very showy shrub at blossoming time, is confined in our range according to Standley, to western Texas, extending from there to Sonora and far south in Mexico. It is highly probable that it occurs in southern New Mexico and Arizona. It has bright red tubular flowers and quite dark green leaves. The plant has been extensively used in Mexico medicinally. As an erosion control plant it has distinct possibilities as it is a good soil binder, often growing quite thicket-like in dry washes in the oak belt. It is doubtless better suited to use as an ornamental. B. glaberrima is quite similar to B. ternifolia. It is confined to southern New Mexico, southern Arizona and Mexico.

Cephalanthus occidentalis or Button Bush, grows across the continent and from Canada to Mexico. In our range it is rare but widely distributed along streams in rocky canyons. It is an excellent stream bank binder but its use for this purpose is very limited. It may be recognized by its large dogwood-like leaves and flowers and seed which occur in round balls.

CAPRIFOLIACEAE

*Sambucus caerulea. A great variety of elderberries have been lumped in literature under this name. There is so much variation between them that it seems there should be some division made. There is a form which is abundant in most of our mountains at rather high altitude. This, often called S. neo-mexicana, is seldom more than a large shrub. It grows along streams and on moist north-facing slopes and in some places appears to be a fairly good erosion control plant. Where it grows erosion control, however, is not commonly a problem. The fruits are edible after a fashion and are sometimes used for making wine and pies. For the latter purpose they serve well for something to be sweetened and on proper flavoring, may serve as a substitute for pie. The berries are delectable food for birds.

A southern form of this is called Sambucus caerulea var. arizonica. It often forms a large tree. Where these trees are numerous frequently much young growth sprouts up. This is browsed often to the point of extermination. The fruits are much the same as those of the mountain form. It appears that the young growth of this plant may be excellent for the control of erosion.

Sambucus mexicana is quite commonly planted in southern New Mexico and southern Arizona. The leaves of this are quite hairy in contrast to those of S. caerulea, which are smooth. These are cultivated for their shade and for the fruits which are similar to those already described.

Symphoricarpos occidentalis, the Coralberry which is so common in swales and valleys in the foothills on the east slopes of the mountains in Colorado, is probably superior to S. oreophilus as an erosion control plant. It has the same habit of growth and is extensive in many places even in the valleys in Kansas and Nebraska. It is reported to be a good sheep browse.

Symphoricarpos oreophilus. This Coralberry Bush is an excellent erosion control plant for swales and deep draws in the mountains of the southwest at altitudes of 4,000 to 8,000 feet. It is not suitable for lower altitudes nor for extremely dry sites. It has a mass of horizontal roots and the stems layer readily. The plant furnishes a fair forage for sheep.

Lonicera albiflora or Honeysuckle, has a wide range in the lower mountains at altitudes from 3,000 to 6,000 feet in southwestern New Mexico and southern Arizona. It doubtless extends also into Old Mexico. It may be necessary to divide what we have been calling by this name into two distinct species. The true L. albiflora should be a vine but in Santa Cruz County, Arizona, for example, it is an erect shrub with just an inclination to be vine-

CAPRIFOLIACEAE

like at the tips of the branches. Perhaps the only value of this plant will be as an ornamental but it has an excellent root system, grows well from cuttings and is quite drought resistant, points which may qualify it for observational work. The plant thrives on the nursery at Tucson.

COMPOSITAE

*Artemisia tridentata. The Black Sage is one of our controversial plants. In many portions of the Rocky Mountains it now occupies thousands of sections once grass covered. Its value as a soil erosion plant, particularly in heavily grazed sections, is very slight as stock, particularly sheep, make trails through it which soon become water courses during storms. On the other hand, in some quarters it is unquestionably the climax type, the brush being eight feet high or more and forming a complete ground cover. The brush probably supplies more sheep food than any grass cover the land might support. Eventually, however, the brush is certain to give way to overgrazing and the result is a flood hazard of the worst type. In many places an attempt is being made to eradicate the brush and to permit such grasses as western wheat to come in. As black sage land is commonly fertile it is not usually difficult to establish a grass cover once the brush is removed. All things considered, the black sage is not to be recommended in a revegetation program except on sites where the land is sufficiently level to prevent severe erosion, or where grazing can be properly regulated.

Some other sages are closely related to the Black Sage and it is probable that their use should be governed by the same rules as those of the black sage. Artemisia nova, A. trifida, A. arbuscula and A. bigelovii are all much smaller plants and for this reason can form a closer ground cover and possibly better erosion control cover. A. nova and A. bigelovii are reported to be particularly good forage.

Another sage quite closely related to the black sage is A. cana. This forms probably the best ground cover of any but it grows naturally only at quite high altitudes.

There are still other sages common with us. Some have not been carefully studied. A. filifolia forms pure stands covering large areas on usually quite sandy land. It is doubtful, however, that this and such plants as Parosela scoparia help much in preventing drifting of sand. In fact they may even aggravate it by diverting air currents into small channels. A. filifolia supplies an abundance of forage for all kinds of stock. It is reported, however, as being poisonous at times to horses.

COMPOSITAE

*Artemisia frigida is probably much more important than stockmen and ecologists credit it with being. It is low, has an extensive system of rhizomatous roots which are effective in binding the soil and it is quite palatable to stock, particularly sheep. It withstands grazing remarkably well. The condemnation is that it is an undoubted indication of overgrazing. On well regulated ranges it tends to disappear. Its use is to be recommended as a soil binder and a forerunner of grama grass and western wheat grass where the grass cover has nearly or completely disappeared.

Other sages of very similar nature to A. frigida are A. kansana, which is particularly abundant in the Capitan foothills, and *A. wrightii, in the Mule Creek and Black Range sections of New Mexico. The latter is unquestionably one of the best soil binders occupying sandy stream bottoms and extending far up the slopes. Its rhizomatous roots hold the soil very effectively. It is apparently rather unpalatable and extensive stands indicate an overgrazed condition. Another one to be classed with this group is A. ludoviciana. One place where it is abundant is in Cimarron Canyon in New Mexico.

Artemisia gnaphaloides is much less common with us than the species mentioned above. It has a good rhizomatous root system, is browsed to some extent and has been used, according to Dr. E. F. Castetter of the University of New Mexico, by the Indians for decades to poison insects.

*Baccharis glutinosa, Batamote or Seep Willow. Mr. Hamilton, Regional Agronomist in Region 8, declares that this is one of the best erosion control plants in the Gila water shed. Its use is confined to valleys and bottoms where there is considerable moisture. It occupies the banks of the streams next to land that is likely to be most heavily eroded and even invades the rocky bottoms themselves, thus serving to cause the silt and rocks to become deposited. An advantage in its use is that it is easily propagated by cuttings. Only the stomach of a Jackass, however, can tolerate it as food.

We have other species of Baccharis. Two of these, B. emoryi and B. sarothroides, are tall shrubs interesting only as possible ornamentals. B. thesioides is fair forage but is not very abundant and is hardly to be classed as valuable for erosion control. *B. wrightii has passed out of the picture in many places because of heavy grazing. Stock seem to prefer it to grass or most other browse. It is not of much value for soil erosion control but its high forage value, its extreme drought resistance (it is found in some regions where the rainfall is less than five inches), and the fact that it is readily propagated by cuttings, make it a plant to be considered in the warmer sections of our territory where grazing can be regulated.



COMPOSITAE

Another *Baccharis* which is quite widely distributed in Arizona at altitudes 4,000 to 7,000 feet, is *B. pterinoides*, Yerba-depasma. It is commonly found in excellent grass land and is never browsed except in times of extreme drought. It is reported to be one of the worst poison plants in the southwest. It is used as a remedy for chills by the Indians and Mexicans.

Solidago spp. There are several species of Goldenrod in the southwest. Some of them extend far to the north while others are confined to the southwest and Mexico. For the most part they are good erosion control plants but valueless for forage. Our chief interest in them at present is for their rubber content. Some species seem to run four or five percent rubber and such plants are comparable to guayule. None of the species are adapted to use in the extremely dry, desert regions but some are suited to the Juniper and Pinon belts.

Parthenium argentatum, the Guayule, sometimes called the Mexican rubber plant, is a low composite shrub with divided, grayish leaves and small whitish, rather inconspicuous flowers. It is a native of western Texas and northern Mexico and has been introduced extensively into California and southern Arizona. The main introduction in southern Arizona was made some years ago by the Continental Rubber Company about twenty miles south of Tucson. This company made elaborate provision for growing the Guayule in quantity under irrigation. It, however, failed to produce adequate rubber when given the added moisture and the project was abandoned. In no place in this section does the Guayule seem to have escaped. Plants are still growing experimentally at Las Cruces, New Mexico and at the Soil Conservation Service nursery at Tucson, as well as on the Continental Rubber Company plantings in southern California. It has been reported that the Guayule is being very successfully grown in portions of Russia and that the Soviet Republic is extracting rubber from it satisfactorily. It seems unlikely that this plant will ever be used extensively for the production of rubber within continental United States unless perchance future wars cut off the supply from tropical regions. Even in this case it seems likely that other plants such as some of our milkweeds, sporges and goldenrods, may prove to be even better for rubber production than the Guayule.

Parthenium incanum, False Guayule, is a low shrub closely resembling the Guayule. It is abundant in western Texas, southern New Mexico, southern Arizona and northern Mexico. It has practically no rubber content but grows sufficiently abundant in places to be a fair ground cover. It should, however, be considered a product of overgrazing and replaced by more valuable plants. It is quite unpalatable.

COMPOSITAE

*Hymenoclea monogyra is a very common shrub along sandy washes, at moderate to low altitudes from western Texas to southern California and southward. It is an erect, rather slender-branched bush with fine, slender leaves. It has a root system which is calculated to hold sand, rocks and soil to perfection. It is one of the best soil binders in the desert regions of the southwest. This tells the whole story for it is good for nothing else. In any program of revegetation it should only be used as an extreme (last) resort. Many of the alluvial flats which it now occupies are suitable to plants of higher forage value.

Hymenoclea salsola resembles H. monogyra only in leaf and fruit character. It is a rather low, small spreading bush with a tap-root and is of no particular significance as an erosion control plant. It is likewise worthless for forage. It is to be found on higher, more desert land than the other species.

Gutierrezia spp., or the Snake weeds, are extremely abundant throughout the west. When in abundance they are definite indicators of overgrazing. In some sections they are considered fair forage during the winter. They are, however, definitely placed on the ledger as poisonous plants and serious results may occur where stock is forced by starvation to eat large quantities of them. These plants are commonly woody at the base and have rather deep roots. They are rather poor competitors of grass where grass is given the opportunity to properly develop. The young snake-weed plants cannot gain a foothold in a grass sod. They are far less serious plants on the range than the Burrowweeds, which upon gaining a foothold on the range are hard to dislodge.

Haplopappus hartwegi and related species, are the Burrowweeds of the overgrazed southwestern ranges. Like the snakeweed, these only become abundant after the range has been abused. Commonly they grow at a somewhat lower altitude than the snakeweeds and as mentioned above, are difficult to eradicate from the range. Extensive experiments have been carried on with these plants on the southwestern range preserve south of Tucson, Arizona. They quite closely resemble the snakeweeds but have divided leaves and commonly more shrubby habit.

Helianthus annuus is the common annual Sunflower which is so abundant throughout the west. It has little value as an erosion control or as a forage plant but the seeds are important wildlife food and the plants have been used for ensilage, in which condition they are reported to be fair stock food. One of the sunflowers, probably a selection from this species, is grown by the Hopi Indians. The seeds of this are used in the preparation of a dye as well as for articles of food.



The common sunflower (*Helianthus annuus*)

A common but useful weed

COMPOSITAE

Helianthus ciliaris is a Sunflower which none of us would accuse of being such. It is a low perennial with bluish green leaves and long, perennial root stalks. It is very common in the lower Rio Grande agricultural areas where it is called Blueweed, and loved no better than snakes. Its use has been advocated by erosion-control people because of its excellent soil-binding habits. It should, however, be remembered that it constitutes a very troublesome weed in farm lands and if it is used at all this should be done with extreme caution.

Lygodesmia juncea, Skeleton Plant, is a perennial which is shrubby at the base but has an herbaceous top. As the name "juncea" indicates, the stems are slender and almost leafless. The plant has small, bluish-white flowers and milky juice. Commonly it is not considered of value for forage purposes but observations in the desert leads us to believe that the plant has much more value than is commonly noted. At times it is very heavily browsed and as it is extremely drought resistant it may have a place in revegetation programs. The plant should also be tested for its possible rubber content. It is widely distributed in the west. In some regions it is suspected of being poisonous.

Lygodesmia grandiflora probably is of no significance as a forage plant but why it has not been introduced into flower gardens is hard to comprehend. It blooms through a long season and has very showy, pinkish-white flowers. Its low bushy habit and its ability to withstand drought and to grow in poor soil, make it ideal as an ornamental in many southwestern situations. It does not range as far south as L. juncea, coming only into northern New Mexico and northern Arizona. Otherwise the range is comparable to that of L. juncea.

Chrysethamnus spp. The Rabbit Bushes are extremely abundant at moderate to high altitudes throughout the west. They are low to rather tall shrubs with bright yellow flowers. We have several species in the southwest. While they are effective soil binders in many localities they must be considered weeds as they are not browsed and their growth and abundance are promoted by heavy grazing of the range. Extensive tests have been made on several species of this genus to determine their rubber content. Some are promising from this standpoint.

Senecio filifolius, Groundsel. We have many species of this genus of composites in the west. They range from rare to abundant but none are so wide in distribution and so generally abundant as this species, ranging from Colorado and Utah, south into Mexico.

COMPOSITAE

The light-grayish green shrubs bloom early and late, the yellow blossoms appearing every month in the year in our southern valleys and rocky draws. Frequently it forms almost pure stands over large areas on alluvial fans at the mouths of canyons. It is extremely drought resistant. In very dry years stock browse it severely. It is, however, a starvation ration which is never touched when better plants are available.

Wyethia scabra. This low sunflower-like composite has a wide distribution in the Rocky Mountains from New Mexico to Wyoming and Utah. It is, however, relatively rare, being found only in dry sandy places in the Juniper belt. The plant has long, broad, green shiny leaves coming out from the base of the plant and rather short flower stalks with large flowers resembling those of the sunflower. The plant is very harsh to the touch. It is, however, browsed to some extent and has a good spreading root system making it an excellent erosion control plant.

Tetradymia inornis, Horse Bush, is a low, grayish composite bush with bright yellow flowers, widely distributed in the foothills of the Rocky Mountains and westward but extending south only into northern New Mexico and northern Arizona. It is abundant and constitutes a fair ground cover on many dry sites. It is variously reported as fair to poor sheep browse. Its use as a revegetation plant should be postponed until its palatability has been more carefully studied. The plant may even prove to be poisonous when consumed in large quantities. The following species is definitely known to be poisonous to stock.

Tetradymia axillaris, Horse Bush, is a very weak-stemmed, straggling shrub, always found in the protection of other shrubs. It has bright, yellow flowers, very long spines and clusters of plumose seeds. It is confined to extremely dry mesas in southern Utah and northern Arizona, and is reported to be poisonous to stock. The flowers are among the most fragrant in the desert and suggest the possibility of their use in the manufacture of perfumery. There are several other species of Tetradymias in the west. They are often confused with the rabbit bushes (*Chrysothamnus*). With these they must be considered generally speaking, as undesirable shrubs.

Franseria dumosa, White Bur Sage, is a low desert shrub which forms pure stands over very large areas in the Mohave Desert from California to Utah and Arizona and south into Mexico. It has whitish bark and grayish green leaves which are quite finely divided. It is heavily browsed throughout its range and since it forms pure stands it is unquestionably a valuable erosion control plant. It will not, however, grow in anything but the warmest portion of our range.

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There are several other species of *Franseria* in the southwest, most of which are considered weeds. They are for the most part unpalatable and some have burs resembling cockleburs. One of the most outstanding of these rank weeds is *F. ambrosioides*, which is a common sight along the sandy draws from Tucson, Arizona westward. It has rather long, coarse leaves with serrate-dentate margins and slender petioles. As it grows along the edges of washes it has some value as an erosion control plant. It is not, however, recommended for planting.

Encelia farinosa, White Brittlebush, is a common shrub in the hot, dry regions of southern Arizona as well as northern Mexico. It has grayish leaves and bright yellow flowers. It constitutes an almost complete ground cover in places and may be significant as a soil binder. It, however, does not have a good root system or a low-spreading habit so characteristic of excellent erosion control plants. It is browsed slightly. As a hay fever inducer this rates high.

Brickellia squamulosa, Brickellbush. In the draws and bottoms about Hillsboro, New Mexico, is a perennial plant with a woody base and with abundant straight stems. It somewhat resembles rabbit brush. The bases of the plants are thick and well rooted and constitute excellent soil binders. Whole bottoms in this vicinity are held in place by this plant. Its soil binding properties seem to be all to recommend it, as it is useless as forage or nearly so. There are several other *Brickellias* which occur in the southwest, some of which are reported to be fair forage. Further work is required to determine their value as erosion control plants.

Oxytonia acerosa is a perennial composite which resembles slightly a sage. It is shrubby at the base and has a strong rhizomatous root system. It occurs in dry alkali flats in southwestern Colorado and adjacent Utah and Arizona where it forms pure stands. It is incomparable for erosion control in these areas and is browsed to some extent, probably only as a starvation diet. Selenium tests have been run on this plant and not more than a trace has been found. It, however, has been definitely proved to be a serious stock poison and must not be considered in any erosion control program.

Malampodium leucanthum is a low perennial composite with handsome white rays. Its only possible value is as an ornamental but for this purpose it should have a distinct place in the southwestern flower garden. It is abundant on many dry plains and rocky foothills.

Flourensia cernus, Tar Bush, is a glutinous composite shrub

COMPOSITAE

often called Black Bush. It ranges over wide areas in western Texas, southern New Mexico and Arizona and adjacent Mexico. The shrub is encouraged by overgrazing and now occupies extensive areas which doubtless were formerly in grass. It is worthless as forage and its more or less erect habit does not recommend it for erosion control. This has been used extensively in the past medicinally for every disease practically, to which the human body is subject. It is likely that its use is based on the superstition that the nastiest thing is the best medicine.

*Euryops multifidus. Euryops is one of our more promising exotics as far as its ability to withstand drought and to seed itself are concerned. It is reported to have some value as a sheep browse but our work has thus far not permitted any feeding experiments. It has a habit very similar to many of our rabbit bushes (Chrysothamnus spp.). The habit of the plant and its root system do not make it outstanding for soil conservation work. If, however, it proves to be worthwhile as a forage plant it may prove to have a distinct value in the warmer sections of our region. It blooms profusely and attracts bees in great numbers. We do not have information on the grade of honey produced.

Tripteris pachypteris. This is another of our exotics from South Africa. It is very similar in general habit and root growth to Euryops. What applies to Euryops applies equally well to Tripteris. It is reported to be fair sheep forage but we need to conduct feeding experiments to establish its real value. It is blooming almost constantly and is a favorite with bees. Here again we do not know the quality of the honey produced.

*Pentzia incana. Our most outstanding exotic from South Africa of the sheep browse type is Pentzia. It is lower and more spreading than either Euryops or Tripteris. In fact it forms a dense tangled rooted mass on the ground. As intimated, it is recommended as a good sheep browse. It was treated at some length in a back number of Soil Conservation by Dr. Franklin J. Crider. Where it becomes established in our warmer regions individual plants survive well. Mr. Prichard of the Forest Service Nursery at Superior, Arizona, says that it reproduces itself on the desert so sparingly as to make the plant practically valueless. At Shiprock, New Mexico it freezes out where it does not receive the protection of snow or buildings. It is a plant of such outstanding characteristics that it should be given a trial in many places throughout the southwest, including California and Nevada. In any region where it will survive the winters and reproduce itself readily it should prove very valuable. We plan to use it on all the observational plantings we establish in Arizona.

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