agree in several respects, and belong to the same tribe, *Hordeeæ*. In each case, free use can be made of the excellent illustrations, but the careful examination of each species *must not* be omitted.

Another lot of closely related species are sweet vernal, canary-grass and vanilla grass. One genus contains June grass, wire grass, fowl-meadow grass and a few others which are common. Orchard grass is of fair size and well suited to the beginner.

It is an excellent plan, where possible, to take up in connection with each other, especially in reviews, grasses which are nearly related. Any two such species may very profitably be critically compared.

"There is no way for the student to do but to take the thing described in his hand, and patiently compare it with the definition given, until he distinctly sees the application of every part. He must, therefore, take a cornstalk or some other grass, and study its structure until he has made out every statement in the definitions given."—(Gould).

CHAPTER V.

NATIVE GRAZING LANDS.

Effects of Over-Feeding Dry Districts.—The grazing of sheep and cattle often change the character of vegetation for the worse instead of better.

Every farmer knows the value of sheep to exterminate wild raspberries, blackberries and most other bushes, but many times they also introduce troublesome weeds as well.

Dr. A. Gray, in Am. Jour. Science in 1874, notices a contribution by Dr. Shaw to the Linnean Society, in reference to the ill effect of overstocking the dry grazing districts of Southern

Africa with Merino sheep. Troublesome burrs are introduced, which crowd the grasses besides injuring the wool.

When first introduced, the sheep fed mainly on the grass, which in this dry, hot country, began to fail. There were too many sheep for the moderate supply of grasses. Soon the sheep fed on the brush and scrub, and the ground left to them, and to obnoxious and poisonous herbs. As the vegetation became scarce, bitter and nauseous plants of the neighboring region came in and helped to extirpate the indigenous flora, and render it more and more unfit for sheep. As these were forced to eat disagreeable food, it greatly injured the mutton. What is true of Southern Africa is proving true in many parts of the dry, native pastures of the United States. Numerous herds will soon over feed and "stamp out" the native grasses.

Continuous manuring of any kind, continuous mowing or pasturing,—a continuous treatment of any kind will soon produce a change in the plants.

Dr. Samuel Aughey, in Science, 1883, in speaking of the Nebraska flora, says: "A remarkable peculiarity is its changeable character. This is conspicuous among the grasses. In 1865, much of the uplands of Lancaster county was covered with buffalo-grass. By 1871 nearly all of this species had disappeared, and its place was taken by blue-joints (*Andropogon furcatus, A. scoparius*, etc.) interspersed with *Bouteloua, Chrysopogon nutans, Sporobolus*, etc. In 1878 the blue-joints disappeared, and the *Bouteloua* usurped their place. Similar phenomena were observed in almost every county in the State. During the last two years *Chrysopogon* (*Sorghum*) *nutans* has been gaining in Eastern Nebraska over all others. This tendency to change is common in other States. When old Fort Calhoun, above Omaha, was occupied by the military, twenty-five years ago, Kentucky blue-grass was brought in baled hay to that post from the South. It spontaneously took root and spread in every

direction, and now it can be found in prairies thirty miles away. Under favorable conditions the wild, native grasses produce from one to three tons or more of hay per acre."

Professor Shelton, for Central Kansas, says: "Our prairie grasses cannot endure close pasturing or heavy tramping. Notoriously, the most promising wild pastures, after three or four years of even moderately close grazing, become permanently occupied by coarse, rank-smelling, worthless weeds."

"In Nebraska," says Dr. C. E. Bessey, in 1885, "There have been notable migrations of plants within the past twenty or thirty years. The buffalo grasses of various kinds were formerly abundant in the eastern part of the State, now they have retreated a hundred to a hundred and fifty miles, and have been followed up by the blue-stems (*Andropogon* and *Crysopogon*). The blue-stems now grow in great luxuriance all over great parts of the plains of Eastern Nebraska, where twenty years ago the ground was practically bare, being but thinly covered by buffalo grasses. In Dakota it is the same, the tall blue-stems are marching across the plains, and turning what were once but little better than deserts, into grassy prairies."

Native Pastures.—With reference to grazing in Colorado, R. A. Cameron, in the National Live-Stock Journal, 1872, says: "The rainfall is precipitated mainly in the spring as rain, and in the winter entirely as snow. The summer months are dry, with rare rainfalls, and these are short, followed immediately by cloudless skies. The grasses grow rapidly in the spring, but are cut short by the drought, and ripen and dry up in June. It is the absence of moisture in any quantity during the warm weather that not only completely cures the native grasses, but which preserves them unfermented, sweet and nutritious during the summer and winter. They assume a brown color, and give a sombre aspect to the great plains, striking the eye of the farmer from the New England States

very unfavorably. But, short and brown as they are, they are no doubt the richest in the world."

Some of the leading grasses which form the native pastures of Texas are: Gama—grass, (*Tripsacum*), *Panicum virgatum*, a kind of Panic grass, Indian grass, *Chrysopogon nutans*, *Andropogon scoparius* and *A. provincialis*. The last two are known as blue-stems, and the latter as broom grass, or broom-sedge. *Tricuspis* (*Triodia*) *sesleroides*, fall red-top, is prominent in places. A vast number of smaller species help make up the pastures, but they are less widely diffused or less prominent than those named above.

In the Report of the Department of Agriculture for 1870, T. R. Dodge states: "The relative value of these species as forage grasses differs very widely, a few of them being entirely worthless. The largest number of the species could be dispensed with without manifest disadvantage to the grazing interests of the country. The relative value of the twelve most important species is exhibited in the following table of per centum estimates, one hundred representing the aggregate value of the twelve:

SPECIES.	Missouri River Region.	Rocky Mountain Region.
	Per Cent.	Per Cent.
Andropogon (furcatus) provincialis	40	16
Andropogon scoparius	20	10
Chrysopogon (Sorghum) nutans	20	12
Sporobolus hetorolepis	12	1
Buchloë dactyloides	5	5
Bouteloua oligostachya	0	10
Spartina cynosuroides	2	2
Festuca ovina	0	20
Festuca macrostachya	0	5
Bromus Kalmii	0	8
Poa serotina	0	8
Stipa viridula	0	5

These estimates can only be approximate for that time. The first three are quite tall, and make the main bulk of hay in the wild regions referred to.

I have taken the following from General Alvord's Bulletin, as quoted in the Agricultural Grasses of the United States, by Dr. G. Vasey:

"In the arid Rocky Mountain plateaus, the grasses, as they stand on the soil, are cured in the sun during the summer, the action of heat retaining and concentrating in the stalks the sugar, gluten and other constituents of which they are composed. It is so cold and so dry in those elevations that there are neither heat nor moisture to rot them. And the snows are so fine (save in some exceptional seasons) in that cold atmosphere, that they are so blown by the winds into drifts, that four-fifths of the soil is never covered by them.

"The difficulties in lower altitudes than those I have described, have been, that after a warm spell and a thaw, the snow freezes to a crust and the grass is matted down by the ice, and kept from the stock.

"In Texas the grazing grounds are mostly at so low a level above the sea that the grasses rot in winter. Hence, in the latter part of winter, the animals there are often poor. The region higher than 3,000 feet above the sea, fit for winter grazing, includes nearly all up to the timber line, of Montana, Idaho, Wyoming, Utah, Nevada, Colorado and New Mexico, and five-sixths of Arizona, one-half of Dakota, one-third of Nebraska, one-fifth of Kansas, one-fourth of Texas, and one-sixth each of California, Oregon and Washington Territory. This embraces about one-fourth of the area of the whole United States."

The Native Grasses of the Pacific Slope.—The following are free extracts from the notes of C. G. Pringle, taken in 1881:

One going into the Southwest from New England, where all

deforested areas are closely sodded with perennial grasses, is struck with the insignificance of permanent grasses there and the almost entire absence of sod.

To speak of Arizona and Southern California: In the bottom of the valleys and along the line of the water-courses, though water may not flow over the surface except during the period of summer or winter rains, and in soil more or less impregnated with alkali, the traveler occasionally meets with natural meadows.

Distichlis maritima, with its creeping roots forming a close network in the soil, and *Sporobolus Wrightii,* growing in great clumps, chiefly form these meadows. The former has wiry stems, and its foliage is tough, but animals accustomed to subduing spring opuntias and thorny shrubs thrive on it. The latter is a rigid, coarse grass, its culms often four to five feet high and as thick as a goose quill. When its stems are but recently grown animals browse away their upper portion, and cull out somewhat from amongst the bristling stumps of the stems of former years, standing dense and stiff, some two feet in height, the long radical leaves of the plant. To arrive after nightfall and a long forced drive to reach grass and water upon such a meadow, and to be compelled to picket our horses on such pasturage, closely gnawed away by the herds of ranches far and near, seems hard, but from May till August the valleys and plains afford nothing better.

Sporobolus cryptandrus var. *strictus* has much the habit and value of *S. Wrightii. Sporobolus asperifolius* occupies patches of wet soil with a fine herbage, and its abundant and leafy sterile culms yield forage more easily appreciated by animals. *Panicum obtusum* growing in low lands, particularly in the partial shade of shrubs, contributes a trifle of forage by its long, wiry, but leafy creeping stems.

In low lands scattered tufts of *Andropogon saccharoides* and *Trichloris fasciculata* contribute a better food to animals, as

acceptable, probably, as any afforded by the perennial grasses. *Panicum lucophæum* and *Andropogon contortus*, in their scattered tufts on the mesas and foot hills, are of similar value.

Hilaria rigida on sandy plains has hard stems and tough leaves, but animals are forced to consume it. *Panicum fuscum*, *P. capillare* var., and *P. colonum* are rather weeds of tilled fields, and as forage plants probably equal *Panicum Crus-galli*, *P. sanguinale*, *Setaria glauca* and *S. viridis*. With them may be classed *Helopus punctatus*, *Eragrostis Purshii* var. *diffusa*, *Chloris alba*, *Leptochloa mucronata*, as they are tender and eaten with avidity.

Agrostis verticillata, on the margins of water courses, is a tender and nutritious morsel; so also *Eatonia obtusata*, less abundant in Arizona, *Agrostis exarata* by brooks, and *Phalaris intermedia*, more widely scattered along streams and in wet, cultivated soil.

To cattle straying over miles of arid wastes, nibbling at the leaves of thorny trees and shrubs, or pulling here and there a bitter weed, such grasses as *Setaria caudata*, *Tricuspis pulchella* and *mutica*, *Muhlenbergia debilis*, and even *Aristida Americana* and *A. Humboldtiana*, and *Bouteloua aristidoides* and other species, all scattered in thin tufts over hill and mesa, furnish dainty bits seized upon with avidity. When the summer rains fall abundantly these species renew their growth, or spring up from seed, and grow rapidly, so as to cover the soil with a pretty close growth of herbage, which furnishes an abundant pasturage to fatten herds during the autumn months. Only a small part of this is consumed while green; but drying up in the droughts of October and November, and being little weather beaten in that dry climate, it serves to sustain the herds through the winter and early spring months. The more densely covered areas are sometimes mown for hay.

Cottea makes its growth entirely as far as I have observed,

during the summer rains, and this and the two species of *Pappophorum* may be classed in point of economic value with the species of *Aristida* and *Bouteloua*, though apparently less common than these.

Hilaria cenchroides, a perennial, not rare on hills, grows freely, fruits during the dry months, from April to July, and contributes a little to save stock from starvation. So likewise does *Muhlenbergia*, both wiry but nutritious grasses. Under the summer rains they grow more luxuriantly; and the latter growing in bushy clumps, retains in its wiry stems much nutriment, so that it supplies the more common sort of hay in the towns and at the stop stations, being pulled by the Mexicans or Indians, and brought in on the backs of donkeys or on carts, even as late as May, when it is gray with age.

Poa annua var. *stricta* and *Festuca microstachys* furnish a few tender bits of food to cattle following up the mountain streams in spring.

Beside streams of mountain canyons, *Imperata Brasiliensis* var. at any season furnishes tall, leafy clumps, to be eaten down eagerly by the animals fortunate enough to attain to them. On the higher slopes of the mountains, particularly in those turned from the direct rays of the sun, and under the partial shade of pines and oaks, I found in May, *Atropsis* (*Glyceria*) *Californica* and *Muhlenbergia virescens* growing in clumps, standing so close together as to remind one of a northern meadow. The former furnishes the tenderest and sweetest of pasturage, and the latter is a soft and leafy grass. These two species largely compose the "deer parks" of those mountains, but unfortunately for our horses, while we were camping on the mountains they began at such an altitude (6000 feet), that we could seldom get our horses up high enough to take the benefit of them.

In Arizona the coarse grass of the valleys was called by a Spanish name, which sounded as I used to hear it pronounced

by miners and Mexicans "Saccatone," though I suppose it began with a "Z." The name was applied to *Sporobolus Wrightii* and similar species. This and one other are all the names in use among the Mexicans to distinguish the shorter, softer grasses of the mesas.

Beyond the cereals, notably barley most extensively sown for hay, the agricultural grasses are scarcely employed in California agriculture.

Where permanent pasturage and hay is wanted, and where it is possible to secure and maintain this by irrigation, Alfalfa (*Medicago sativa*) is employed almost exclusively. I saw but a very few fields of Timothy, and those were confined to the higher valleys that could be irrigated by mountain springs. In winter and early spring the hills and plains are green with a species of Crane's-bill (*Erodium*), called by the Spaniards "Alfilerilla." Formerly *Avena fatua* covered the hills and valleys of California, but it has been reduced in extent by sheep.

The native grasses contribute but an insignificant portion toward the maintenance of the flocks and herds of California. On the open ranges, cattle scour large areas, browsing upon every green thing that is not too repellant or too repulsive.

Aira (*Deschampsia*) *danthonioides* offers, on damp mesas, etc., patches of fine, soft herbage, which is eaten with avidity by animals.

Deyeuxia Aleutica, growing in dense tufts on the northern coast and adjacent hills, is often sufficiently abundant to be of importance in pasturage; although it is a coarse grass, cattle eat it readily.

Deyeuxia Bolanderi, sparingly scattered through damp forests, with *Hierochloa macrophylla* and *Phalaris amethystina* (these observed at Mendocino) are most tender and palatable, but are of very slight amount.

Deyeuxia rubescens, a hard grass, grows in small, scattered

patches, or thin tufts, on pine barren plains, where there is nothing else to feed deer.

Elymus condensatus grows in thin clumps, or small, scattered patches; its leaves, though tough and hard, are stripped off by hungry animals.

Oryzopsis cuspidata, Sporobolus airoides and *Stipa speciosa* are tufted grasses, scattered over the Mojare desert, and furnish an occasional bite, palatable, though tough to chew, to antelopes, and to strolling cattle and sheep.

Glyceria pauciflora, found on ruins of mountain tarns, is a tender and sweet grass to deer or stock coming to drink.

Melica imperfecta and *Stipa setigera,* tufted species frequenting mesas and hills, are tender and nutritious in April and May.

Throughout the mountains where cattle cannot be herded so successfully, sheep are everywhere led by their herders, swarming like vermin, and creeping up to the very pinnacles of rock or to the snow line, nibbling or tramping in the dust all vegetation. No grass at ever so great an altitude, but must contribute its mite towards the sustenance of these flocks.

Thus *Stipa stricta, Sporobolus depauperatus, S. gracillimus, Agrostis varians, Trisetum canescens, Melica stricta, Poa tenuifolia* and P. Pringlii, on bare mountain tops and around mountain springs and rills, must all yield a dainty mouthful to the miserable dust begrimed sheep, compelled in their ascent to live on the foliage of shrubs and on brittle herbs.

Deyeuxia equivalvis, a tender and sweet grass, grows on the verge of mountain brooks.

Agricultural Grasses of Montana.—The following notes are from a paper read at the fifth meeting of the Society for the Promotion of Agricultural Science, by F. Lamson Scribner:

"Although located so far north, and at no point less than three thousand feet above the level of the sea, horses and cattle thrive upon the 'ranges' throughout the year without care or

shelter. In the valleys the standing grass cures, with all the nutritive properties held within the tissues, affording excellent hay for winter grazing.

The region abounds in a great variety of species, the whole number discovered being one hundred and twelve. Some are rare; many have little value, while one or two can only be treated as troublesome weeds.

Broom-sedge, Broom-grass, or Beard-grass (*Andropogon scoparius*), is widely dispersed from Maine to Texas, and west to the Rocky Mountains. It grows in dry, thin, or sandy soil, and thus serves a good purpose in furnishing fair forage where little else will grow. In some parts of the Missouri river and Rocky Mountain regions this grass is very abundant, and is highly prized, both for hay and for grazing. In the East it is looked upon as comparatively worthless.

Reed Canary-grass (*Phalaris arundinacea*) grows naturally in Montana in wet places, along streams, etc., and adds a little to the grazing.

'Mountain Timothy' (*Alopecurus pratensis, var. alpestris*). This grass is quite common at elevations of from five to seven thousand feet above the sea, growing in rich soil along mountain streams, and frequenting the so-called 'mountain meadows.' In the large, open park, a few miles west of Neihardt, there are many acres covered with this grass, and when I passed through the place, August 14th, it was being harvested for hay. It yields a large bulk of fine, long, bright-colored hay, and is highly valued. It has tall, slender, leafy culms, three feet high, with an oblong head, similar to that of Timothy, whence its local name, but the heads are shorter, thicker, and conspicuously hairy. For the more elevated meadows of the Rocky Mountain region and for northern latitudes, there is no grass which so highly commends itself as this, both for hay and for summer grazing. It is closely allied to the European Meadow Foxtail.

Feather Grass (*Stipa*). Several species of this genus are common to the region, the most prevalent being *Stipa comata* and *Stipa viridula*. They are often found together, and are usually associated with *Poa tenuifolia* and *Kœleria cristata*. The first named (*S. comata*) is the least valuable, but the more hardy of the two, growing on bench lands in soil too gravelly and thin for even *Poa tenuifolia*. It has very narrow and involute radical leaves, a few-flowered panicle, and smooth, twisted and more or less curled, hair-like beards, or awns, five inches long. Both this and the *Stipa viridula* are sometimes called wild-oat grass. The latter is by far the most valuable of the Stipas. *Stipa spartea*, Porcupine Grass, occurs, but happily in no great abundance.

'Bunch Grass" (*Oryzopsis cuspidata*) is very abundant on the sandy bench lands along the Missouri and other rivers. It thrives in soil too dry and sandy for the growth of other valuable species, and is much esteemed for grazing.

Alpine, or "Native" Timothy (*Phleum alpinum*).—This species, which closely resembles our cultivated Timothy, is common in the mountain districts, growing near streams, at elevations of from 6,000 to 8,000 feet. In the mountains back of Fort Logan, I saw this grass associated with *Phleum pratense*, and it was the more luxuriant plant of the two—not so tall, perhaps, but growing to the height of two feet, with stouter and more leafy culms. The common Timothy (*Phleum pratense*) has been introduced, and succeeds well when irrigated. But there are a number of native grasses which would yield equally fine and more abundant crops with less care.

Drop-seed Grass (*Sporobolus*).—There are several species of this genus more or less common, but none of them sufficiently abundant or valuable to have received local names.

Agrostis grandis is a species of bent-grass, common along the rich, moist banks of streams in the mountain districts. This is certainly a valuable grass to introduce into cultivation.

Reed Bent Grass (*Deyeuxia*).—There are quite a number of species of this genus native to the country, all possessing some value for forage, being readily eaten by stock. Grasses that grow naturally on these dry bench lands without irrigation, and hold the ground in spite of excessive grazing, deserve special attention, for these are the species which will best meet the requirements of the farmer when it becomes necessary for him to cultivate grasses on these same lands.

"Buffalo Grass," Mesquite (*Bouteloua oligostachya*).—The true Buffalo Grass (*Buchloë*) was not seen, but this Bouteloua, which the ranchmen of Montana recognize under that name, is a no less valuable species for grazing. It frequents the bench lands at elevations of from 3,000 to 4,500 feet, and not uncommonly covers wide areas. Its strong, perennial roots and fine curly leaves make a dense turf that yields a large amount of forage, and no other species seems better to withstand the tramping of stock than this.

'June Grass" (*Kœleria cristata*).—This is one of the most common grasses of the bench lands, disputing possession of the soil with *Poa tennifolia*, with which it is almost always associated. On the dry benches it is seldom over a foot high, but on irrigated grounds it grows to the height of two feet or more, and makes excellent hay. "June-grass" is the only local name I heard applied to this species. [It may be needless to say here that this is not the grass called "June-grass" in the east.]

"Bunch-grass," "Meadow-grass," "Spear-grass," etc., (*Poa*).—There are a large number of Poas found throughout the northern portion of our country, and one and all are excellent pasture grasses. Wherever grasses grow at all, from the sea-shore to the mountain-top, from the arctic zone to the antarctic, this genus has its representatives. In Montana, *Poa nemoralis* ascends to the altitude of 9,000 feet. At this elevation it is dwarfed in habit, but lower down the mountain's side it soon becomes taller,

and makes a valuable forage plant. Kentucky Blue-grass (*P. pratensis*) is truly indigenous, and grows quite abundantly along the streams and rivers. *Poa tenuifolia* may well be regarded as *the* grass of the country. No species withstands the long summer drought so well, and it constitutes the chief forage upon the dry bench lands. It has several local names, such as "Bunch-grass," "Red-top," "Red-topped Buffalo-grass," etc. In the drier soils the culms are low, less than a foot, and slender, usually of a reddish color, and the foliage is reduced to the short and dense radical tuft; but the plant responds readily to richer soils and better situations, and when growing along streams or on irrigated land, it makes a luxuriant growth of foliage and attains the height of two or three feet. As fine a field of natural grasses as I saw in the Territory, or, in fact, as I have ever seen anywhere, included *Poa tenuifolia, Kœleria cristata, Stipa viridula, Stipa comata,* as the leading species, the Poa being the most abundant. In this field the Stipas were unusually fine, overtopping the other grasses.

Manna-grass (*Glyceria*)—Three species are common; Reed Meadow-grass (*G. aquatica*), a well-known grass in the eastern and middle States, grows in similar situations here—wet grounds and along the borders of streams—attaining the height of from three to five feet. *Glyceria nervata* is still more abundant.

"Great Bunch-grass," "Buffalo Bunch-grass," (*Festuca scabrella*).—This is one of the characteristic grasses of the country. On the mountain slopes and foot-hills, at elevations of over 6,000 feet, it is the prevailing species, constituting one of the most valuable forage grasses of the winter ranges. It often covers many thousand acres of the "mountain parks," and during August it is cut in large quantities for hay; it makes excellent feed, both for horses and cattle, but is rather too hard and coarse for sheep.

Sheep's Fescue (*Festuca ovina*).—Tne name of "Bunch-grass" is applied also to this species, which, in point of altitude, occu-

pies a belt just below that held by the "Great Bunch-grass." Several varieties are recognized, and all afford excellent grazing for all kinds of stock.

There are several species of *Bromus*, one of which is much like Schrader's grass; in general, however, these brome-grasses are little esteemed.

"Blue-joint," or "Blue-stem" (*Agropyrum glaucum*, var.)—There is no grass in Montana that the settlers more highly value for hay than this "Blue-joint" or "Blue-stem," so named because of the decided bluish tint of its leaves and stalks. In appearance it resembles our common witch or couch-grass (*Agropyrum repens*), and has by some been regarded as a variety or form of that species. Like the couch-grass, this has creeping roots, making it equally objectionable in cultivated lands. It grows naturally on the dry bench lands and river bottoms, and although the yield per acre is not large, the quality of the hay is judged unsurpassed by any other species.

"Fox-tail Grass," Squirrel-tail Grass (*Hardeum jubatum*).—This is a common grass in the low countries, especially where the soil is generally moist. It is considered a great nuisance, for when associated with other grasses it entirely destroys their value for hay. The long and sharp-pointed beards or arms stick fast in the nose and mouth of horses, often penetrating the flesh, and cases are reported where they have caused the death of the animals.

Lyme-grass, Wild-rye, (*Elymus condensatus*), is a large, native grass sometimes cut for hay, but is not very valuable, holding a rank much like the eastern species.

At Jefferson City, June 28, altitude about 5,000 feet, one would rarely see in any part of the country a finer looking or better sodded field of grass than was observed at this place. The strong and luxuriant growth of the grasses, *all native species*, gave sufficient proof of the resources of the Territory in this

direction. I venture to say she will not find beyond her borders more valuable species either for hay or for pasturage.

Poa tenuifolia, Kœleria cristata, Stipa viridula, and *Poa pratensis* (three feet high) were the prevailing species; then came *Stipa comata, Agropyrum glaucum, A. divergens, Elymus condensatus, Poa Nevadensis, Agrostis scabra,* and *Hordeum jubatum*; along the streams or growing in the water were *Glyceria aquatica, G. nervata, Beckmannia erucæformis, Alopecurus aristulatus,* and *Catabrosa aquatica.*

Some species extend over many degrees north and south, others range within narrow limits. Some of wide range have their limits of greatest abundance confined to a few degrees. So it is in the matter of elevation above the sea. Some species range from sea level to nearly the line of perpetual snow, others are found only at certain elevations, extending but a little above or below a given altitude, while others again may have a considerabe range, but it is only within narrow limits that they are able to conquer in the struggle for life and gain almost complete possession of the soil.

With a little experience one could tell in Montana with a considerable degree of certainty the altitude of his position by the prevailing grasses about him. *Bouteloua olygostachya* and *Oryzopsis cuspidata* were never abundant above 4,000 feet. *Agropyrum glaucum* ranged a little higher, while *Poa tenuifolia, Kœleria cristata,* and *Stipa viridula* prevailed up to about 5,000 feet. *Agropyrum divergens* became the leading species between 5,000 and 5,500, when *Festuca ovina* took the field and usually held its own up to 6,000 feet, when it in turn gave way to *Festuca scabrella,* which has its line of greatest vigor between 6,000 and 7,000 feet.

Native Grasses of the Great Basin.—For Arizona and New Mexico in this basin, Dr. J. T. Rothrock ventures the assertion that for want of water there will always be much waste land so far as raising crops is concerned. For want of water, neither

of these territories have reached anything like the real possibilities of the soil and climate.

Sereno Watson, a very careful observer who has spent much time in the Basin, makes a long report in the United States Geological Exploration of the Fortieth Parallel. He observes that the climate is characterized by a very dry atmosphere, small amount of rain and snow, by a cold winter and a correspondingly hot summer. No portion of this whole district is destitute of some vegetation, even in the driest seasons, excepting only the alkali plats. The vegetation possesses a monotonous sameness of aspect, and is characterized mainly by the absence of trees, by the want of a grassy greensward, the wide distribution of a few low shrubs, and by the universally prevalent gray or dull olive color of the herbage.

The turfing "buffalo" or "grama" grasses, which make the plains east of the Rocky Mountains a vast pasture for the bison, deer, and antelope, are here unknown. The grass grows in sparsely scattered tufts, dying away with the early summer heat. The two or three species that mat into a sward are confined to alkaline meadows and are nearly worthless for pasturage.

Native Grasses of Northern Mexico.—During the summer of 1885, C. G. Pringle collected and studied the flora of this country, mainly in the Mexican State, Chihuahua. By request he has furnished full notes, from which the following are taken:

With respect to the cultivated species, I think I shall surprise you by declaring that though I botanized carefully in the irrigated and tilled valleys as well as on the plains, and on the hills and mountains of every geological formation in that State, and from the beginning to the end of the season, I saw not a single plant of the exotic grasses commonly cultivated in the United States; not a stalk of *Phleum pratense* (Timothy), nor *Poa pratensis* (June grass), nor *Agrostis vulgaris* (red-top), nor any other whose

tender and nutritious herbage so largely maintains the flocks and herds of the American farmer.

The only attention which I have seen the Mexican ranchero bestow upon grass is to inclose, rarely, a limited area of valley sod, formed of hard and tough species like *Sporobolus Wrightii*, *Distichlis maritima* and *Panicum obtusum*, and use the field to restrain a few saddle horses and work oxen. He provides scarcely any store of fodder for his animals, so when the growth of vegetation is arrested by the frosts of winter, they must bite shorter the half dead but still nutritious herbage, and must range widely to do this, and when the growths of the spring months, always feeble, have been entirely checked by the withering droughts which reach their worst in June, they must, if they can, maintain life by browsing shrubs, cactuses, etc.

To supply the wants of the animals kept in the cities gives employment during winter to many of the poorer class, who hawk about the streets, in ox-carts and on the backs of donkeys, bundles of dead grass gathered on far away hillsides or plains. By the beginning of March the neighboring rancheros are selling green wheat and barley in the same way, and they plant maize from early till late to succeed these. Great stacks, freshly cut, may be seen walking into town early in the morning with donkey's legs, scarcely more than the feet visible—a droll sight.

The exotic grasses which accompany cereals as weeds of tillage seem to be very few in northern Mexico. Of the 108 species on my list, I count only three such: *Panicum sanguinale*, L., *P. Crus-galli*, L., *Phalaris canariensis*, L.

Nearly all the grasses range northward from Chihuahua to a greater or less extent into the United States. All my species of *Aristida* and *Stipa*, and some species of *Muhlenbergia*, are as yet undetermined.

Paspalum Hallii, V. & S., is confined to moist situations, as the vicinity of streams and the banks of irrigating ditches. Its

herbage is tender, its growth strong, and it might be cultivated to advantage in fields capable of profuse irrigation.

Panicum reticulatum, Torr., is a soft and tender annual, growing in low, scattered tufts on rich plains, and contributes not a little to the sustenance of the herds which range over them.

Panicum cæspitosum, Swartz. On rich, moist soil this forms a low, dense mat of tender and leafy herbage, relished by animals. Although only an annual, it might well be employed in irrigated fields for grazing.

Eriochloa polystachya, H. B. K., like *Panicum sanguinale,* L., is a weed in cultivated fields, and often yields large crops of a quality which would be considered good in the southwest.

Hilaria cenchroides, H. B. K. Here this is a plant of much importance to the stock grower. It forms a close perennial sod in patches of greater or less extent on the plains and mesas. As its culms are few and small and its leaves short, its yield is light, but it is a pasture grass of good character and quality.

Hilaria mutica, Benth, called in Arizona "Black Gramma," is considered one of the most valuable grasses in that region. It grows in dense perennial clumps about a foot broad, and these growing close together, to the exclusion of other species, occupy areas of considerable extent, usually in depressions of plains or mesas, sometimes even on hillsides. Except during the rainy season, about August, the plants show few living leaves, but at all times of the year the numerous branching stems contain nutriment. The clumps are detached from the soil by a blow with a mattock directed at their base, and this gives rise to the saying that hay is cut in Arizona with a hoe. As the dead leaves and their sheaths adhere for a long time on the slow growing perennial branches, a patch of this grass presents a dark grey appearance, which gives it the name of Black Gramma. Its stems are very hard, so that I was at first surprised that animals could eat it at all. My horses soon got tired of it, preferring softer grasses.

Heteropogon contortus, R. & S. This is probably the most abundant grass of dry hills of igneous rock thinly covered with soil. It grows in tall, narrow clumps, and is a perennial with numerous leafy branches. Stock show a preference for other grasses if such are to be found. The hay on sale in Chihuahua last spring seemed to be mainly composed of this plant, usually dead when gathered, and blanched by winter weather. During autumn I found its seeds a nuisance. Their long bearded and twisted awns sent the slender and rough seeds into my clothing, and often into my flesh. Sheep, goats, and even donkeys must find these seeds a terrible annoyance.

Andropogon hirtiflorus, Kth., is a fine, soft, leafy plant, growing in dense clumps, but apparently confined to hedges, etc.

Andropogon saccharoides, Sw., grows in clumps three or four feet tall. In valleys, and the moister depressions of the plains, this is a grass of some importance.

Some ten species or more of *Aristida* are mostly bunch grasses of hills and mountains, of average frequency in such situations, and of full average quality, contributing largely toward the upland pastures.

There are two new species of *Stipa* also, tall and tender plants, excellent for forage but not abundant.

There are many species of *Muhlenbergia* of more or less value. *M. Texana*, Thurber, is the mesquite grass of our southwest, and one of the most valuable species of those regions, common over mesas and hills. It is such a favorite with animals that it is exterminated except when growing under the protection of thorny shrubs, usually mesquite bushes (species of *Prosopis* and *Acacia*). Its leaves are short and scanty, but its branching, perennial, wiry stems are nutritious, and at all seasons furnish forage which is greatly relished by all kinds of stock. In Arizona the Indians bring it during winter and spring long distances into the towns to sell, the men tying the bundles behind and

beside them on their ponies, and the women carry them on their backs or heads, trundling painfully behind the ponies. How many times I have contended with the horrid mesquite bushes to gather an armful of this grass to carry joyfully to my hungry and jaded horses.

Muhlenbergia gracilis, Trin., thrives on cool, grassy summits of mountains, perhaps the most important element in the pasturage of such ranges. It grows in small clumps about two feet high, and is rather wiry and tough.

Sporobolus Wrightii, Munro, grows along water courses, forming great clumps, nearly contiguous, four to six feet high. These are browsed down by stock within a foot or two of the ground. The culms are stout and stiff and the leaves long and conspicuous. They appear to be acceptable to animals. It is to this species notably that the Mexicans apply the name *Zacaton* or *Zacate grass*, meaning great grass. The same name is given to other species.

Bouteloua hirsuta is a common grass on rocky, dry soil of the hills and plains, with rather wiry culms. The quality is equal to the most of the species enumerated, and furnishes an important proportion of the forage of the region.

Bouteloua oligostachya, Torr., var. *pallida*, Scrib., is the most abundant species of the plains, especially abundant, and forms a close sod in the less arid portions. In amount of yield and in quality it is surpassed by no common grass of the plains, and is the one native species adapted to permanent mowing. I believe it would bear the effects of close grazing in enclosed areas.

Bouteloua Harvardi, Vasey, I find to be the most valuable pasture grass of the hills and mesas around the city of Chihuahua. It is perennial and forms a sod more or less interrupted. It is tender and nutritious, and is kept closely cropped during most of the year.

Six or eight other species and varieties of *Bouteloua* furnish more or less pasture.

Diplachne dubia, Benth, sends up here and there, over hills from perennial shoots, a few late, succulent stems, especially relished by animals. It seems probable that this grass would succeed under good cultivation without irrigation, and, if so, no species native to Mexico would be likely to yield crops of greater amount or of superior quality.

Diplachne imbricata, Scrib., is similar to the last in habit and quality, and would probably succeed as well, but only on rich soil with copious irrigation.

Arundo donax, L., grows on the banks of streams, and is stripped of its broad leaves by cattle, which crowd upon the tall canes, straddling them to bring the leaves within reach.

Eragrostis erosa, Scrib., is a tall, soft, leafy bunch grass of the mountains, than which none can be more acceptable to stock. *Eragrostis lugens*, Nees, is a closely related species, of similar habit and quality.

In these notes I have said little about the possibility of the species mentioned for cultivation, because it does not to me seem possible that Mexican agriculture can in this generation, or in several generations, attain to the cultivation of grasses. I cannot say in what way their methods are in advance of those of the ancient Egyptians and Syrians; certainly one is astonished to find numerous parallels between their customs and practices and those of the ancients.

In regard to other forage plants which interest stock growers, I have seen a little lucern or alfalfa grown there, but only a little. The place it occupies in the American southwest is there filled by barley, wheat, and corn.

The clovers, native or introduced, are almost entirely wanting in the southwest. Of course there are a large number of plants of many natural orders which help to sustain animal life, and I

can attest from observation that there are few plants so repulsive to taste or so spicy that they are not occasionally appropriated by animals, according to the extremity of their hunger. I used to think that nothing but starvation could induce cattle to nibble at horrid opuntias, as I have seen them doing during drought.

The mesquite tree, *Prosopis juliflora*, of the southwest is worthy of especial mention. It is a godsend to those regions. Its abundant and nutritious pods, resembling those of our field bean, begin to fall in August before the grass has made much advance under the midsummer rains, and afford much relief to the half famished stock. I have gathered sacks full of them for my horses as I have journeyed through those arid districts.

Seeds are Distributed in a great variety of ways—through the agency of wind, water, snow, animals, including man himself, who purposely or unintentionally accomplishes more than any of the other agents.

The small size of the seeds of most grasses is a great help in their distribution. Many of them remain attached to the glumes and palea, or even to some of the branches, and others are provided with beards, hooks, or awns, all of which make it easy for them to be carried about by the wind, water, snow, or animals.

"It would seem that nature has appointed every animal as a special disseminator of the plants which furnish it with food. We have seen the activity of the rodent in scattering the fruits of the Nuciferæ, and of birds in sowing broadcast the seeds of fruit-bearing plants, and the ruminants seem no less active in performing a similar work for their favorite grasses. The great efficiency of animals as disseminators of seeds appears more marked when we regard them in masses. The herds of reindeer and elk on the plains of northern Europe and Asia, the bison on the prairies of North America, or the herds of naturalized horses and cattle on South American pampas, migrating from place to place in immense masses, cannot fail to sow as they pass along a

host of seeds which adhere to their coats, or which they have swallowed and drop uninjured upon the soil."—(Prof. A. N. Prentiss, in Prize Essay.)

A few examples may be given to illustrate the distribution of grass seeds. The panicles of *Panicum capillare*, when ripe, easily separate from the culm and are freely tossed about and carried by the wind, scattering seeds as they go for long distances, even leaping over fences and bushes.

When snow arrives its surface becomes slightly packed, and seeds, with their chaff or branches still left on the dead culms, are occasionally torn away and drifted for long distances before the wind.

Small seeds in the mud adhere to the feet of many kinds of animals, and are thence transported from one place to another.

The elongating and spreading root-stalks of some grasses and clovers enable them to spread and occupy different ground or more ground.

The chapter on the geographical distribution of grasses will be given in the second volume.

CHAPTER VI.

GRASSES FOR CULTIVATION.

PHLEUM, L. TIMOTHY.

Spikelets in spike-like panicles, 1-flowered, rachilla very short and jointed above the empty glumes, extending beyond the floret, rarely bearing a rudimentary flower. Flower perfect. The empty glumes persistent, nearly equal, membranous, much compressed laterally, keeled, awned, or mucronate. Floral glume much shorter, broader, hyaline, truncate or toothed, 3-5-nerved. Palea narrow, hyaline. Lodicules 2, hyaline, toothed on the outer margins. Stamens 3. Styles distinct, long, slender, hairy. Caryopsis ovoid, enclosed in the floral glume, and palea, free.