

U.B.C. LIBRARY

CAT. NO. LE3 B7. 1930 A4. M8. S6

ACC. NO. 73784

SOME NATIVE FORAGE PLANTS
AND THEIR USEFULNESS IN
RANGE CONDITIONS

by

John B. Munro

-0-

A Thesis submitted for the Degree of
MASTER OF SCIENCE IN AGRICULTURE
in the Department
of
AGRONOMY

-0-

The University of British Columbia

OCTOBER, 1930.

Plate I

In the foreground are porcupine grasses, sage-brush and perennial herbs of the "Second Weed Stage". In the distance are shown the hills and bench lands which were formerly covered with bunch-grass, but now support weeds and inferior grasses.



<u>Table of Contents</u>	Page
Native Perennial Clover	2
Used as Food by Aborigines	4
Clover Provided Place Names	6
Habitat Affects Type Slightly	8
Other Native Clovers	10
Annual Lance Clover	11
Annual Bird-foot Clover	13
Bird-foot Clover Widely Distributed	14
Lupines Deserve Attention	15
Domesticating Perennial Clover	17
Pathfinders and Farmers	19
Beginnings with Beef	21
Introduction of Horses	22
Extensive Summer Ranges	24
Some Common Forage Plants	25
Humid Area Association	27
Limiting Factor is Moisture	31
Variation in Soil Composition	34
Temperature and Precipitation	36
The Bunch Grass Region	42
Range Mismanagement	43
Bunch Grass Association	49
Conditions Before Grazing Ranges	51
Evidence of Over-Grazing	54
Inferior Grass Associations	56
Grasses of Doubtful Value	58

SOME NATIVE FORAGE PLANTS
AND THEIR USEFULNESS IN RANGE CONDITIONS.

By
John B. Munro

The detailed study of Perennial Clover, *Trifolium fimbriatum*, Lindl., was undertaken for several specific reasons. Early botanists who visited the Pacific Northwest Region recorded the general occurrence of this plant in many coastal areas where soil conditions and moisture supply might well be regarded as inimical to the production of such a legume. Some of those naturalists even suggested that the plant gave promise as a forage and they mentioned the fact that it was relished by the deer, elk, and horses in those fur-trading days. Later writers have for the past fifty years neglected to refer to this crop which had a prominent place in the domestic economy of the Aborigines a century ago and more.

It was for the purpose of definitely ascertaining the distribution of Perennial Clover in British Columbia, as well as its natural habitat, usefulness as a wild forage, and value as a cultivated plant, that the study of this uncommon legume was begun, and as the work

progressed the scope of the investigation was widened to include other indigenous plants of possible value but comparative obscurity. The result of this study has been the assembling of considerable data that was not intended for presentation at this time, but which now appears to rightly belong to the report of the search for information regarding Perennial Clover.

Native Perennial Clover

Botanists are fairly well agreed on the description of Perennial Clover given below, which description has been verified by careful examination of specimens taken from different places where there was wide variation in the soil type and moisture supply, also where conditions of light and shade varied to a marked extent:- *Trifolium fimbriatum*, Lindl. (*Trifolium spinulosum*, Dougl.) commonly called Perennial Clover, is perennial by fleshy, creeping rootstocks; glabrous throughout; branches are prostrate or ascending, depending on habitat, 20 to 50 cms. long; leaflets oblong-obovate to oblanceolate, spinulose denticulate, the lower obtuse or even retuse, the upper acute or acuminate, mostly 1 to 3 cms. long; stipules triangular, acuminate with a few teeth; heads solitary and terminal on a long peduncle, 1 to 2 cms. broad; involucre short laciniately parted; calyx lobes unequal, subulate, somewhat spiny, 2 to 3 times as long as the tube; petals purple with pale or white tips on standard and wings; blooms in July, seed

matures late September or early October.

In his "Botany of the Northern Parts of British America", Sir Wm. J. Hooker in 1840 mentioned that *Trifolium fimbriatum* was "first detected by Mr. Menzies in California; common in Salt Marshes of the Northwest Coast of America from Cape Orford to Puget Sound".

Archibald Menzies who accompanied Captain George Vancouver on the voyage in which he first circumnavigated the Island that bears his name, wrote a detailed account of the trip, recording his observations faithfully. In this interesting Journal by Menzies the following paragraph with reference to *Trifolium fimbriatum* is found, written at Nootka, V.I., under date of September 4, 1792, and it indicates that on Vancouver Island and not in California this clover was first encountered.

"In the evening our curiosity was excited in observing a number of Females busily occupied in digging up a part of the Meadow close to us with Sticks, with as much care & assiduity as if it had been a Potato field, in search of a small creeping Root about the size of a pack-thread. This I found to be the Roots of a new species of *Trifolium* which they always dig up at this time of the year for food. After washing it clean they mix it with a quantity of Oil & eat a portion of it raw with their Fish or Animal Food in the same manner as we do Sallad. Wherever this *Trifolium* abounds the ground is regularly turned over in quest of its

Roots every year, though till this moment we ascribed such digging to their searching after the Sarane or Roots of *Lilium Camschatcensa* which we knew they collect & use as food here & on other parts of the Coast".

Used as Food by Aborigines

Dealing with this same clover and its use in the diet of the Indians, Pliny Earle Goddard, curator of Ethnology, American Museum of Natural History gives still further information both as regards the ownership of the clover patches and the cullinary practises of the Natives. He says, "They made use of fern and bracken roots and the roots of clover The roots were cooked by steaming in underground ovens or were roasted on the coals and eaten with oil

"The clover roots mentioned above are secured from 'clover gardens' situated on low ground where a wild clover grows abundantly. These gardens are family property which cannot be sold or given away, but descend in the family inheritance. The clover roots are dug in the fall after the leaves of the trees fall. Pebbles are removed and roots unsuitable for food are sometimes replanted, but otherwise the growth is unassisted by the owner."

Another reference to this clover in the diet of the Indians is of particular interest by reason of the date of the record which shows that as recently as fifty-

two years ago the Natives had occasion to fall back on this plant as a means of sustenance during a famine. Rev. Chas. Moser, O.S.B., under date of April 13, 1878, mentions in his diary that, "This beautiful weather of the last two weeks, and which will continue fine, puts an end to the destitution of the Indians. There is an abundance of salmon, codfish, halibut, rock cod, etc. The women had, since the beginning of the famine, through bad weather and rain, gone out to their different fern and wild clover patches to dig up fern, clover and other roots for the food of their families."

From the letters and journals of the explorers and traders who visited the Pacific Northwest Coast prior to the settling of the region by white settlers, it is evident that as long as the Aborigines were in control and vegetation was replenished year after year by natural means there was no crop failure as far as Perennial Clover was concerned. On the southern extremity of Vancouver Island this clover was especially abundant. It is reported that when James Douglas of the Hudson's Bay Company landed at the southern end of Vancouver Island for the purpose of selecting a suitable location for the trading post that was established as Fort Victoria in 1843, he found this plant growing luxuriantly. So abundant was it and so rank in growth on the marshy area between Ross Bay and Beacon Hill, the area now designated as Fairfield District, that

the most prominent feature of the coastline at this place was then named Clover Point.

Clover Provided Place Names

The name is all that remains to remind the present generation that Clover Point and the surrounding terrain was once over-grown with the native Perennial Clover. With the clearing, cultivating and underdraining of the Fairfield District the clover disappeared and today not a trace of it remains on this area. This is also true of other parts of Vancouver Island as for example certain portions of the Saanich Peninsula. The late Dr. W.F. Tolmie, an able botanist who arrived at Fort Vancouver in 1833 and two years later was the first white man to draw attention to the fact that coal was to be found on the North Pacific Coast, began in 1859 to develop his eleven hundred acre farm two miles outside of Fort Victoria. He erected the first stone house in British Columbia, which is occupied today by his youngest son, the Hon. Dr. S.F. Tolmie, Premier of this Province. This stone house retains the original name of the farm "Cloverdale" bestowed on it seventy-one years ago because of the wild clover which grew in almost pure stand on many parts of the large farm. This clover has now disappeared from the drained and cultivated parts of what was formerly the Cloverdale farm and is to be found only rarely in the moist, shaded spots where the natural vegetation has not yet been disturbed.

In the "British Columbia Directory" of half a century ago mention is made of wild clover giving the name to a Fraser Valley settlement as follows:- "Surrey Municipality, lying between the corporations of Langley, Fraser River and Delta, extending from Fraser River to the International Boundary Line of 49 degrees North Latitude, containing within its limits the important and growing settlements known as Hall's Prairie, Clover Valley and Mud Bay, consisting of about one hundred and twenty square miles Clover Valley is the most thickly settled section of Surrey Municipality. It takes its name from the great quantity of clover found growing wild throughout this section." The Valley and settlement immediately east of Cloverdale in Surrey Municipality is still referred to as the Clover Valley. Incidentally the prefix "Clover" is found in eight place-names of British Columbia.



Plate II

Specimens of native clover taken from a low part of a permanent meadow on the Saanich Peninsula two miles north of Cloverdale in the fall of 1923 were identified by Professor John Davidson, Department of Botany, University of British Columbia, as *Trifolium fimbriatum*. The area from which these specimens were taken, while abundantly supplied with moisture for nine or ten months of the year, was very dry during July and August and the soil which was a stiff gray clay was baked very hard by the return of the rainy season in the fall. In spite of the somewhat undesirable soil condition and the lack of continued wetness, the clover plants were very sturdy and leafy, though short, and the production of seeds was very much better than in some wet areas where vegetation was more luxuriant. The plants appeared slightly modified by reason of habitat.

Habitat Affects Type Slightly

In this hard soil the root growth was very strong. A mass of fleshy roots penetrated the ground at an average depth of four inches and produced branches at right angles to the main rootstocks at frequent intervals. Ascending stems were sent up more plentifully than was noted in places where moisture and shade better suited the species. In short, this patch of Perennial Clover appeared to have adapted itself to changed conditions of soil and moisture. It was from this stand of clover that seeds were harvested and root cuttings taken for test under field conditions. A

study of the opinions of naturalists of earlier days strengthened the hope that results of practical value might be secured.

Until the range of distribution of Perennial Clover had been more definitely established it was believed that it might have value on marshy areas in the interior of the Province. The Perennial Clover mentioned by David Douglas as having been found near Kettle Falls on the Upper Columbia River was thought to have been *Trifolium fimbriatum* until diligent search for the species has failed to show that it grows anywhere but in the humid coast districts, and even there, only in restricted areas where the natural desirable environment has not been greatly altered.

As yet there is no definite information at hand regarding the species to which David Douglas referred as *Trifolium spinulosum*. It does not appear that the question of the identity of this species was cleared up before the great naturalist met his tragic death in 1834. Sir Wm. J. Hooker mentioning *Trifolium spinulosum* in 1840 quotes Douglas as follows:- "Allied to *Trifolium fimbriatum* but sufficiently distinct; the vescellum and alae are shorter and more acute; the flowers smaller, white, the carina and alae tipped with a fine purple and the whole plant more slender. It is abundant in the fertile alluvial soils of the mountain vallies, forming a dense short sward. It might prove, perhaps, very useful as a clover, the herbage being extremely nutritive

and preferred to everything else by deer and horses."

Other Native Clovers

The Journal of 1823-27 kept by David Douglas contains the following interesting references to Perennial Clovers. The first dated July 19, 1825, states, "Trifolium sp.; perennial; flower large; light red; plentiful near the sea", and the next, written August 6, 1828, says, "Trifolium sp.; perennial; leaves very long, minutely serrate; flowers very large, bright red; a strong plant 2 to 3 feet high; this fine plant which I consider a new species will, I have no doubt, be a profitable fodder in cattle-feeding."

In attempting to secure all possible data on the distribution of Perennial Clover on Vancouver Island and on the mainland of British Columbia, the search for specimens has been kept up for seven years. In likely places in the coast regions, especially on Vancouver Island and on the Gulf Islands, this search has been rewarded by the discovery of several clover patches, not only in the wet soils immediately fronting on the sea and subject to periodical inundation at seasons of highest tides, but on meadow lands that have not been overflowed by sea water for many years. However, no specimens have been found where the land is sufficiently well drained to permit of the growing of the best of cultivated legumes. In its ability to thrive in wet land *Trifolium fimbriatum* has a near ally in the European introduction, *Trifolium hybridum*, or Alsike Clover, which is to be found in

association on Prevost Island and Vancouver Island.

The plant association roughly includes *Myosotis* sp., *Mentha* sp., *Polygonum* sp. (*P. hydropiper* for the most part) *Calamagrostis* sp. and *Agrostis* sp. besides a variety of other grasses, herbs and shrubs with water loving tendencies. In this association it was noted that there was a gradual transition from the zone where salt concentration inhibited the development of Alsike Clover to the zone where drainage was such as to prevent the growth of Perennial Clover.

Annual Lance Clover

One species of native clover encountered early in the search on Vancouver Island and later found to be common on burned-over areas on hillsides in the coast area of the mainland is *Trifolium tridentatum*, Lindl., an annual legume commonly called Lance Clover. The flowers of this species bear a resemblance to those of *Trifolium fimbriatum* with which it was confused until carefully examined. This annual legume grows on well drained soil of loamy character. On certain burned-over, logged-off areas in the Comox district this clover is quite plentiful where cattle have not grazed. Being an annual it does not lend itself well to grazing.

All specimens of Lance Clover collected in the Comox district were found to be affected with a leaf-spot disease that gave the leaves a blood splotted appearance; at least the peculiar markings were regarded as the result of

an infection, though no attempt was made to identify the organism responsible. So definite were the markings on the leaves that it was at first thought that the species might be closely related to Calvary Clover. No work on this problem has been undertaken and the leaf spots are still regarded as being due to an unidentified organism.

Trifolium tridentatum was first collected by Douglas on the Columbia River. In his Journal 1823-27 he refers to it under date of May 31, 1825, in the following words:- "Abounds in moist soil where wood has been burned; indeed in every place where stronger herbage has been checked it readily makes its appearance; wild animals, most likely elk, seem to be fond of it, it being only under brushwood that a perfect specimen can be had." It is interesting to note in connection with the growth of this plant on land where wood was burned that Douglas further records the fact that the Indians of the coast regions used wood ashes as a fertilizer on their plantings of tobacco in 1825.

This species of clover, while very plentiful in burned-over areas that have not been grazed, does not appear to merit very much attention because it is only an annual and each plant produces only a limited amount of forage, being of simple upright character of growth. It does not form a tuft nor does it branch out to any appreciable extent. Because it gave so little promise as a forage that would stand grazing, very little study was given to it.

Annual Bird-foot Clover

On the other hand considerable attention has been paid to Bird-foot Clover, *Hosackia denticulata* Drew. (named in honor of Dr. Hosack, famous American Botanist and close friend of David Douglas) and several other species, although the commonest representatives of this genus are also annuals. Despite its annual existence Bird-foot Clover is well able to perpetuate its kind by reason of abundant seed production that extends over a very long season. This plant produces its sessile flower in the axils as the season advances and by the end of July there are mature 2 to 3-seeded pods near the base, flowers in full bloom and blossom-buds developing on the higher parts.

Specimens of Annual Bird-foot Clover have been collected from widely separated parts of the Province and carefully examined. In every case these have been identified as *Hosackia denticulata* although variation in color of flowers, character of growth and habitat gave rise to serious doubts as to the correctness of the identifications. In some localities the flowers are distinctly pink in color; particularly is this true of the species in sections of the Cariboo north of Quesnel and in the Bulkley Valley between Houston and Hazelton. On Vancouver Island there is a creamy yellow tinge to the pale pink flowers. Incidentally it was noted that all specimens of *Hosackia denticulata* collected on Vancouver Island were covered with mildew in July, 1930.

This mildew had not been noticed on plants in any of the interior districts where the species is very common.

The Annual Bird-foot Clover produces an abundance of seeds in pods that usually contain 3 seeds each. Where growing singly without competition the plant usually divides into 4 to 6 main branches immediately above the ground and does its best to occupy a considerable space, but in mass the plants grow erect and produce branches that extend upwards at sharp angles with the main stem. The flowers, 3 to 4 mm. long, pinkish, nearly sessile are produced in the axils, calys teeth entire or minutely denticulate; pods pubescent, 7 to 14 mm. long, 2 to 3 seeded. Two other common species are *Hosackia parviflora* and *H. Americana* known as Spanish Clover, which is quite variable.

Bird-foot Clover Widely Distributed

In some sections such as the plateau east of Princeton at an altitude of 3000 feet above sea level this legume has become a troublesome weed, especially in fields where new seedlings of alfalfa have been completely smothered out by this quick growing, annual legume. Down by the Similkameen River, nearly 1000 feet lower than this plateau, the species grows very sparsely on the sandy soil and gives practically no trouble on irrigated alfalfa land. Neither was it found to give any trouble in Central British Columbia or the Cariboo district. However, on Vancouver Island it produces pure stands that give strong competition to other forage

plants.

Particular attention has been given to the soil enriching propensity of Bird-foot Clover. The strong tap-roots have been examined in every locality where the plant has been detected and in every instance the roots were found to be loaded to capacity with nodules formed by a strain of the beneficial bacteria, *Pseudomonas radicicola*. Apparently the soils of many sections are naturally supplied with desirable organisms which inoculate the seeds or seedling plants abundantly.

The nodules are large in size and adhere closely to the tap-root giving it the appearance of being covered with warty growths. Although cattle eagerly graze on this clover they do not appear to eat it down close, but only nip off the upper parts. This leaves a considerable part to bear seeds and to die down and add humus to the soil. On a carefully measured plot where the growth was in a dense mass, forming a pure stand, the whole of the crop was harvested on the Saanich Peninsula on July 15, 1930. The yield was immediately weighed green and the acre-yield calculated at more than eight tons to the acre.

Lupines Deserve Attention

Many species of the much-maligned Lupine have been found, during the search for *Trifolium fimbriatum*, and some of them seem to warrant the attention of the student of range plants. The usual custom in the past has been to

include lupines among the poisonous plants of the range and undoubtedly there are species whose content of lupinidine in the seeds and stems is high enough to cause poisoning of animals consuming them in quantity, but lupines in general should not be condemned without further proof of their harmful qualities. Both those harmful to cattle and those having definite forage value at certain seasons are deserving of attention for the present wholesale libel against the genus is not in the interest of stock raising.

More than twenty species of the genus *Lupinus* have been encountered in British Columbia. Some are shrubs rather than herbs and are of rather doubtful value if not positively harmful, but all are not poisonous at all seasons. The active principle lupinidine, which causes damage to stock, is contained in all parts above ground, but principally in the seeds. However, there are stockmen in the Chilcotin and Cariboo who speak well of certain of the Lupines. In former times at least one species, *Lupinus littoralis*, Dougl., helped out in the diet of the aborigines when other food was scarce. The roots of this species, called Chinook Licorice, were roasted and eaten by the Indians. This *Lupinus littoralis* is common on the high sandy beaches along the coast and on the Gulf Islands.

Unfortunately some members of the legume family common in British Columbia bear an unsavoury reputation. Among these are Loco weed (*Oxytropis* sp.) and Milk vetch

(Astragalus sp.) certain species of which produce most harmful effects on some classes of live stock frequenting the ranges on which they occur. Numerous cases of illness to cattle and horses as well as to sheep, that came under observation during this investigation of little known native forage plants, showed symptoms that connected the troubles directly with these poisonous plants.

Domesticating Perennial Clover

As has been mentioned already an attempt was made to grow Perennial Clover from both seeds and root cuttings. Seeds secured in the fall of 1923 were distributed to a number of agricultural institutions including experimental farms, agricultural schools and colleges of agriculture. In addition, attempts were made to propagate the species in ordinary garden soil in Victoria by means of seeds and root cuttings. In no case has success been reported. Where given ordinary care in flats under glass and in rows in the garden the seeds germinated and made fair initial growth but none of the plants got beyond the seedling stage of a few pairs of leaves.

The use of root cuttings gave more promise than the use of the seeds. Some good sturdy plants were produced which made fair growth as long as the soil was kept very wet, but the least reduction in the moisture supply showed in the condition of the leaves which were extremely sensitive to drought. In spite of careful attention the

plants grown in the garden attained a height of less than 6 inches. They were stunted in the growth of stems but had a plentiful supply of leaves, also there was very little root growth made. Another discouraging thing was the failure of any of the flowers to set seed. These plants were grown from roots of plants that produced seeds abundantly in their natural habitat, but the flowers on the plants so produced died down prematurely and the stems also wilted away with the blossoms.

Where moisture is abundant and continuous throughout the season, especially in areas of submarginal land along the dyked sea-front Perennial Clover deserves the attention of the land owner. The most practical means of propagation is by root cuttings that can be secured in late autumn from clover patches that should be located and marked during the blossoming period in the summer. Perennial Clover stands transplanting well and where moisture and soil conditions are similar to those where the plant grows naturally it is possible to establish the species in a plant association suitable to the reclaimed seaside flats. However, it is doubtful if this clover has practical value as a forage on the higher soils where other clovers will thrive.

As a result of careful observation it is believed that *Trifolium fimbriatum* discharged its duty as an ally of the aborigine and that with his decline and disappearance the natural conditions to which the species was

suited have also passed away. This plant was apparently a companion of the aborigine just as *Polygonum aviculare* is the inseparable follower of the white man and establishes itself wherever he makes his home.

Naturalists have already referred to as well as others who visited the Pacific Northwest region about the time that settlement and colonization was first attempted have left records of value to the student who seeks to reconcile existing conditions with those of a former period. Many of these valuable records, preserved in the Provincial Archives, have been searched for information regarding the kind and quantity of the various forage plants that occupied the wild land in the pre-agricultural times which date back but two or three generations.

Pathfinders And Farmers

Agriculture in British Columbia is in its infancy and in point of years is younger than the same industry in other provinces. We generally concede the first attempt at gardening west of the Canadian Rockies, on the mainland, to the effort of Daniel Williams Harmon, who in 1811 planted a garden at Fort St. James, on Stuart Lake; but Harmon had already succeeded in growing vegetables and cereals at Fort Dunvegan in the Peace River Country. Even four decades before that Peter Pond, the notorious fur-trader and outlaw, had established the first farm in what is now Alberta. It was in 1779 that Pond planted his garden on the

Athabaska River 30 miles from the lake. Consequently British Columbia holds a junior position in agriculture in point of the years engaged in the industry.

Sir Alexander Mackenzie, the great explorer, after whom the Mackenzie River was named, and who on a rock near Bella Coola recorded the successful achievement of the first overland journey across Canada to the Pacific Ocean in these words, "Alexander Mackenzie from Canada by land, the twenty-second of July, 1793", referred in his journal to the exploits of Peter Pond, and the course he followed over the western plains. Pond was the first white man to cross from the drainage basin of the Churchill River to the Arctic watershed, and for a hundred years after his venturing over this canoe route in 1778 it was used by thousands, including such notable men as Sir Alexander Mackenzie, Phillip Turner, the astronomer, Sir George Simpson, David Thompson, Simon Fraser and Daniel W. Harmon--the father of agriculture in British Columbia.

It may not be out of place to mention that Peter Pond did more for western agriculture than to establish a garden at the "Old Establishment" on the Athabaska beyond the great deposits of tar-sands which out-cropped along the river. His stormy disposition and rash acts have already been mentioned, but it is not generally known that the murder of Alexander Ross by Peter Pond, who also killed Etienne Wadin and poisoned an Indian, brought about the union of the X-Y

Company and the Northwesters into the powerful organizations of which Daniel W. Harmon was a representative when he brought the seeds of cultivated plants to New Caledonia and planted his first garden at Fort St. James.

Beginnings With Beef

Naturally the growing of crops preceded the rearing of live stock and it was not until 1829 that the first animals of dairy type were brought up the Fraser River by boat to Fort Langley, the birthplace of mixed farming in this Province. That the venture was a success is evident from the fact that the total dairy population now exceeds 100,000 animals, of which 55,000 are in the Fraser Valley. Beef cattle were not imported until some time later according to Dr. Simon F. Tolmie, who, when representing the Federal Health of Animals and Live Stock Branch in British Columbia in 1915, stated officially:-

"The First record that we have of the introduction of Beef Cattle into British Columbia was in the early forties when consignments were brought to the southern end of Vancouver Island by the Hudson's Bay Company from their farm in what is now Washington State.

"These animals were bred by the Company for a number of years near Victoria, and they supplied animals to many individuals who commenced farming in their neighborhood.

"During the time of the gold excitement on the

Fraser River and in the Cariboo, in the sixties, a number of cattle were driven into British Columbia from Oregon, Washington, and California for supplying beef to the miners. About this time several small herds were established in what are now known as the cattle range districts in the interior of the Province. Under favourable climate conditions and with an abundance of feed, these herds increased rapidly and their surplus animals soon made a reputation for British Columbia bunch-grass beef which for richness of flavour and fine quality cannot be excelled anywhere."

Further on he stated on the same occasion, "The first record we have of pure-bred cattle coming to the Province was in 1867, a pure-bred bull coming from California in that year; more were brought from Oregon in 1873 and a consignment came from Ontario in 1874. As might be expected, all of these were Shorthorns."

Introduction of Horses

Horses were brought into the interior of the Province at a date considerably earlier than either dairy or beef cattle. They were used for transporting the packs of furs from the trading posts to the depot on the Columbia River. As early as 1808 the presence of horses on the upper Fraser River was noted by Simon Fraser who tells in his Journal of the Indians of Soda Creek sending couriers on horseback to warn friends in the south of the approach of the white explorer. Further down the river Simon Fraser four

days later succeeded in purchasing from the Indians four pack horses, one of which on the same day, June 3rd, 1808, stumbled and fell over a precipice in the canyon and was lost, baggage and all.

In addition to the few horses owned by the Indians there were later large bands of these animals raised by the fur company at their establishments at Fort Thompson (Kamloops) and Fort Alexandria, as many as 500 being together at one time a hundred years ago. While forage was abundant and the range lands unoccupied by cattle or sheep the presence of "wild horses" was disregarded, but of late years bands of these unowned animals have helped to deplete the natural pastures; consequently attempts are being made to reduce their numbers and thus conserve the range for other live stock.

These items of history are here interjected for the purpose of emphasizing the fact that cattle have been pasturizing on the range lands of the interior for but a few years. Also it is desirable to focus attention upon the high estimation that was placed on the native bunch-grass. Bunch-grass was popular and deservedly so, and it grew luxuriantly on millions of acres between the International Boundary and the range lands of the Chilcotin and Cariboo, in what is now referred to as the "Dry Belt".

Bunch-grass, upon which the cattle that established the favourable reputation of British Columbia range

beef were raised, will be dealt with further on. In the meantime there are other plants of distinct value as forages to consider in their relation to the production of beef and mutton. These plants still occupy a prominent place in the native vegetation of areas that, as yet, have not been exploited; such areas, in view of the depletion of pasture plants in the former range areas, are deserving of attention in the matter of conservation of vegetation.

Extensive Summer Ranges

There are extensive tracts of land lying to the north of the 53rd Parallel and in the higher levels in the southern interior that hold promise for summer grazing. Cattle men and sheep men are turning their herds and flocks on such ranges as are available, with satisfactory results. However, systematic management of these summer ranges is essential if they are to be of permanent use. They will not tolerate mismanagement any better than the bunch-grass areas withstood the overgrazing a few decades ago.

The abundance of "Peavine", which, in common with par lance, includes several species in addition to *Vicia americana*, has frequently received mention. It is still abundant in districts where settlement is sparse and the land has not been heavily grazed. However, there is now the same tendency to exploit this nourishing vegetation as was responsible for the depletion of the bunch-grass ranges. "Peavine" belongs to the wild, unpastured areas and where too heavily

grazed in the central interior and in the Peace River District it is showing a decline. Like so many other native plants "Peavine" to be retained must be conserved and not over-grazed year after year. Regarding the value of the "Peavine" pasture it is usually considered that although it produces good growth, the flesh of the cattle and sheep grazed on it is inclined to be soft and of inferior quality. Also the drivers of pack trains claimed that their horses quickly lost flesh when put to work after fattening on "Peavine" range.

It has been found impossible to deal with more than a few of the many range plants found in potential grazing areas of the Province. This Province with its wide range of conditions, geographical and climatical, is possible of division into many botanical areas including the dry and wet coast and the dry and wet interior sections, as well as alpine or arctic regions according to their latitude or altitude. On a single trip through the dry area of the southern interior at the end of May more than fifty species of grasses of importance under range conditions were found in bloom in the same week. On other trips through other areas species equally numerous were encountered. Thus it was considered that the problem of range plants was too general for this particular investigation, consequently attention was directed in particular to a few outstanding ones.

Some Common Forage Plants

Of special interest was the Wild Celery,

Legusticum Sp. in the Lakes District of Central British Columbia. This near relative of the cultivated celery, parsnip and carrot is sometimes called wild parsnip, owing to its parsnip aroma, but it must not be confused with the poisonous Water Hemlock which also gets the name of wild parsnip in some localities. The Wild Celery prefers deep, friable, well-drained soils of medium moisture content and occurs on exposed slopes associated with a great variety of native plants that are indicative of excellent agricultural land.

Wild celery is not regenerative by off-shoots from its perennial root system so it does not form complete stands but is scattered here and there among other plants. It will wilt beyond recovery when the water content of the soil gets down to 8 to 9.5%. The viability of its seed is low, perhaps because the fruiting parts of the plant are susceptible to frosts which occur during the critical season of late August when seeds are maturing.

Sheep are very fond of Wild Celery in the early season and also cattle feed on it during spring and early summer, but as it matures it is not much relished. Often the wild forage cut for winter feed on burned-over slashings in some parts of the Lakes District contains a proportion of this plant which, in mixture, provides roughage that sustains animal life during winter.

Wild Geranium, *Geranium viscosissimum*, is of fairly general distribution in the Interior and occasionally

it constitutes an important part of the pasture on open fertile soil where there is plenty of moisture and good drainage. This perennial plant blooms early and is relished by both sheep and cattle until well on in the season when maturity is approaching. The Geranium appears to flourish in much the same habitat as Indian Paint Brush, *Castilleja* sp., in the Central Interior. However, as there are fifteen or more species of *Castilleja* found in British Columbia this statement concerning association may be considered very indefinite.

Humid Area Association

Many grasses are associated with Wild Celery, Geranium, Paint Brush, Goldenrod, Fireweed and other herbs. They mostly include species of *Calamagrostis*, *Agrostis*, *Poa*, *Deschampsia* and *Festuca*. As long as overgrazing is not permitted these native herbs and grasses along with certain trees and shrubs, which provide good browse and thus add to the forage, can be depended on to produce good gains in cattle and sheep.

In this connection the findings of the range investigators at certain stations in the Western States are of value to us. Of particular interest is the report on the normal growth of range cattle as compiled from data secured on the high summer range areas in Utah, areas which by reason of their altitude bore considerable similarity to the unsettled sections of the Central Interior of British Columbia, in the matter of natural vegetation.

The summary here reproduced shows the annual

gains for nine years made by cattle on summer pasture at the Salina, Utah, Station in the Fishlake National Forest at approximately 8,000 feet altitude. The cattle under observation were average animals secured from local stockmen and placed on the range as early as conditions would permit--about the same time as is found advisable at the lower levels in our own Central Interior. On the following page is the tabulation of data.

Plate III



Natural Forage- Central British Columbia

The association contains Fireweed, Wild Celery, Geranium, Indian Paint Brush and other herbaceous plants, as well as species of Agrostis, Calamagrostis, Poa, Festuca, and other grasses.

ANNUAL GAINS MADE BY CATTLE ON SUMMER RANGE

Year	No Animals Weighed	Initial weights		Final weights		Average increase in weight		Time Observed Days	Average daily gain lbs.
		Date	Average lbs.	Date	Average lbs.	lbs.	%		
1916:	9	June 7:	616	Sept. 23:	887	271	44	108	2.51
1917:	11	" 19:	618	" 28:	873	255	41.3	101	2.52
1918:	6	May 30:	626	" 29:	920.5	294.5	47	122	2.41
1919:	3	June 23:	781	" 26:	1,064	283	36.2	95	2.98
1920:	8	" 10:	582	" "	885	303	52.1	108	2.81
1921:	13	" 11:	618	" 24:	878	260	42.1	105	2.48
1922:	20	" 10:	634	" 23:	878	244	38.5	105	2.32
1923:	22	" 9:	607	" 22:	858	251	41.3	105	2.39
1924:	16	" 14:	640	" 21:	852	212	33.1	99	2.14

TABLE I

The value of Fireweed, *Epilobium angustifolium*, as a forage in early summer is considerable. Almost pure stands of this plant are to be found in most burned-over tracts in humid sections where wind-borne seeds are brought, sometimes from great distances. Fireweed is one of the first species to invade recently burned-over lands and although the viability of the seed is not high it is produced in such quantity as to compensate for any deficiency in germination ability.

The inflorescence of this very common plant is a raceme which begins to bloom at the base in early summer and continues as growth progresses till late autumn, frequently having well matured seed pods at the base and young developing flower-buds at the apex. Although the flowers are usually of a characteristic purple-pink color, there are occasionally pure white flowered plants encountered.

Fireweed grows not only in moist but in comparatively dry situations and when well established is fairly drought resistant. It is undoubtedly the most valuable grazing plant of the Evening Primrose family. Since it begins growth in early spring and is late in reaching maturity it furnishes pasture over a long season. It is relished by cattle and sheep, being quite palatable, and in sections where forest fires and ordinary bush fires are prevalent this plant is of considerable economic importance to the stockmen. Its value to the beekeeper has long been recognized.

One of the most widely distributed and useful herbs found in British Columbia is the common Yarrow, *Achillea lanulosa*. It is not only to be found associated with the moisture-loving herbs and grasses of Vancouver Island, the Lower Mainland and the humid parts of the Interior, but it occurs very generally in the arid sections centering about Kamloops, Vernon and Merritt. It thrives in a wide variety of soils and has been found in all latitudes and altitudes of the Province where cattle or sheep are pastured.

The seed of Yarrow is very fertile and when permitted to mature there is a general distribution of the species by seeding. Being a perennial, well able to stand grazing, it is comparatively permanent when once established. The large amount of forage it provides is selected from among other plants by sheep which keep it closely cropped. In fact, sheep show such a liking for Yarrow that it is not surprising that many shepherds ascribe to it certain tonic properties. The general prevalence of this species on range areas of the Southern Interior, which have rested a year or two after prolonged over-grazing, is regarded as a hopeful omen by cattle men and sheep men.

Limiting Factor is Moisture

Although some of the native plants appear able to exist under very unfavourable conditions of moisture it cannot be denied that moisture supply is one of the most

important factors in pasture production even under range conditions. Where precipitation is abundant or where water is applied by artificial means there is luxuriant growth either of introduced plants or indigenous species, but where moisture is lacking there is dearth of forage no matter how high is the soil content of the essential elements of fertility. Casual examination of irrigated and unirrigated fields provides sufficient evidence to warrant this statement. Further proof has been secured by experiment and laboratory means.

Plate IV



Continual trampling and grazing by herds of cattle on slopes and bench lands has resulted in the wearing down of the surface soil, the destruction of humus and the terracing of the side hills. At the same time the typical

plant associations have gone through a degenerative process until bench lands and slopes once covered with almost pure stands of bunch grass now support only a sparse covering, mostly inferior annual weeds.

Plate V



Four Hereford steers are here seen passing out of sight along the terraced hillside to join the herd on the other side of the hill.

Reference to Plate IV, the photograph showing bench land along the Thompson River near Ashcroft, gives pictorial evidence of the effect of irrigation. This view taken September, 1930, shows alfalfa occupying the levels where once the native bunch-grass flourished. Today there is scarcely a tuft of bunch-grass to be seen here owing to over-grazing in the past, but where water is applied heavy crops

of alfalfa are grown on land that is barren under natural precipitation, or at best occupied with introduced weeds that indicate pasture exploitation. On close inspection it will be seen that *Stipa Comata* and *Artemisia Sp.* are plentiful in the foreground.

Variation in Soil Composition

In the accompanying table it will be noticed that certain soils are recorded from various districts. The arid interior is best represented by the samples from Kamloops. These were taken on land near the confluence of the North and South Thompson Rivers, from areas that without irrigation are now barren though once covered knee deep with native bunch-grass. Other samples from Matsqui showing lower percentages of some of the essential elements are over-grown with grasses of many species. The difference is not in the soil but in the climate, for moisture, in agricultural areas, is dependent naturally on rainfall or snowfall. As far as their chemical constituents are concerned the samples of soil from the Sumas area are not outstanding but due to abundant moisture now that the land is drained and the soil aerated crops especially leguminous grow luxuriantly.

That climatic conditions, which have a direct bearing on the vegetation of any area, are extremely variable in British Columbia is borne out by the meteorological records that have been assembled from the observations of many successive years. The precipitation averages shown in Table III, on

Locality	Nature	Nitro- gen	Potash	Phos. Acid	Lime	Iron & Alum- ina	Insol- uble in Ac- ids
Saanich	:Acid	: 0.30	: 0.05	: Trace	: 0.60	: 9.50	: 75.0
"	:Acid	: 0.10	: 0.13	: 0.25	: 0.80	: 10.50	: 81.5
"	:Acid	: 0.30	: Trace	: Trace	: 0.60	: 8.00	: 79.3
"	:Acid	: 0.18	: 0.07	: 0.20	: 0.40	: 8.80	: 75.3
"	:Acid	: 0.10	: Trace	: 0.01	: 0.50	: 11.90	: 77.7
Shawnigan	:Acid	: 0.21	: Trace	: 0.64	: 0.80	: 14.00	: 71.0
"	:Acid	: 0.10	: Trace	: 0.10	: 0.50	: 10.10	: 80.4
"	:Acid	: 0.12	: Trace	: 0.10	: 0.50	: 10.30	: 76.4
"	:Acid	: 0.28	: 0.14	: 0.90	: 1.00	: 10.30	: 72.3
"	:Acid	: 0.47	: 0.12	: 0.90	: 1.30	: 12.10	: 64.5
Cowichan	:Neutral	: 0.12	: 0.11	: 0.18	: 1.20	: 15.70	: 71.4
"	:Neutral	: 0.17	: 0.12	: 0.90	: 1.30	: 15.90	: 71.0
"	:Neutral	: 0.19	: Trace	: 0.10	: 1.00	: 12.50	: 72.6
"	:Sl. Acid	: 0.16	: 0.05	: Trace	: 1.20	: 13.60	: 76.0
"	:Sl. Acid	: 0.36	: 0.32	: 0.22	: 2.10	: 15.10	: 68.1
Parksville	:Neutral	: 0.01	: Trace	: Trace	: 1.40	: 10.30	: 80.7
"	:S. Acid	: 0.05	: Trace	: Trace	: 1.00	: 10.90	: 84.0
"	:S. Acid	: 0.04	: Trace	: Trace	: 1.50	: 10.20	: 83.0
"	:S. Acid	: 0.03	: Trace	: 0.15	: 1.80	: 13.80	: 79.0
"	:Neutral	: 0.08	: Trace	: 0.14	: 1.60	: 10.70	: 79.6
Comox	:Acid	: 0.25	: 0.12	: 0.09	: 0.88	: 17.50	: 62.3
"	:Acid	: 0.53	: 0.03	: 0.12	: 0.60	: 17.00	: 60.5
"	:Acid	: 0.70	: 0.09	: 0.22	: 0.70	: 14.30	: 62.0
"	:Sl. Acid	: 0.38	: 0.01	: 0.13	: 0.70	: 11.50	: 64.5
"	:Sl. Acid	: 0.62	: 0.05	: 0.13	: 1.10	: 5.50	: 62.7
Mission	:Neutral	: 0.08	: 0.08	: 0.50	: 1.10	: 11.80	: 71.2
"	:Neutral	: 0.12	: 0.15	: 0.25	: 1.30	: 12.30	: 74.3
"	:Neutral	: 0.14	: 0.15	: 0.32	: 1.20	: 12.60	: 73.2
"	:Neutral	: 0.13	: 0.13	: 0.54	: 0.60	: 14.50	: 71.4
Sumas	:Neutral	: 0.04	: 0.19	: 0.25	: 0.90	: 11.70	: 81.2
"	:Neutral	: 0.06	: 0.15	: 0.25	: 1.30	: 11.60	: 82.4
"	:Neutral	: 0.04	: 0.15	: 0.24	: 1.00	: 10.30	: 85.0
"	:Neutral	: 0.07	: 0.12	: 0.23	: 1.10	: 10.50	: 83.3
"	:Neutral	: 0.04	: 0.15	: 0.24	: 1.00	: 10.20	: 85.3
Shuswap Lake	:Neutral	: 0.04	: 0.30	: 0.05	: 0.60	: 6.50	: 86.7
"	:Neutral	: 0.05	: 0.20	: 0.16	: 0.40	: 5.20	: 88.6
"	:Neutral	: 0.04	: 0.10	: 0.22	: 0.40	: 6.20	: 87.5
"	:Neutral	: 0.08	: 0.28	: 0.42	: 0.60	: 9.00	: 82.4
"	:Neutral	: 0.03	: 0.30	: 0.30	: 0.70	: 6.80	: 88.3
Nakusp	:S. Acid	: 0.06	: 0.12	: 0.19	: Trace	: 4.70	: 80.0
"	:S. Acid	: 0.05	: 0.08	: 0.19	: Trace	: 8.20	: 83.0
"	:S. Acid	: 0.08	: 0.08	: 0.38	: Trace	: 3.50	: 89.6
Kamloops	:Alkali	: 0.15	: 0.62	: 0.18	: 0.80	: 7.00	: 78.3
"	:Alkali	: 0.10	: 0.60	: 0.19	: 0.90	: 6.20	: 78.6
"	:Alkali	: 0.15	: 0.62	: 0.25	: 1.10	: 11.00	: 76.5
"	:Alkali	: 0.11	: 0.43	: 0.24	: 1.10	: 10.90	: 78.6
"	:Alkali	: 0.12	: 0.43	: 0.13	: 0.70	: 9.80	: 82.4

TABLE II

Pages 37 and 38, covering considerable periods does far more than simply indicate the amount of moisture available for crop production or the growth of natural vegetation in the different sections of the Province. This great variation in precipitation has doubtless existed since the several ranges of mountains were forced up from the depths to create the series of valleys that stretch from north to south between the ranges from the Pacific Coast to the Rocky Mountains.

Temperature and Precipitation

For ages the precipitation variations have continued to exert their varied influences over somewhat clearly defined regions. Their influences have, in the main, been cumulative and the result is now apparent in the soil classes and types encountered in agricultural pursuits in the several farming or grazing districts. Our humid and arid sections have been so for many years and the soils built up in them present the characteristics of such regions. The vegetation has developed naturally according as the plants were adapted to the soil and climatic conditions of humid or arid acres. Meteorological data are here shown in tabulated form, on Page 41, Table IV.

This table, in addition to giving some idea of the existing type of soils and range of plants that might thrive naturally in the various parts of the Province, also shows the general distribution of the precipitation over the whole year. This distribution of rainfall or snowfall has a

Precipitation Averages at British Columbia Stations

Station.	No. of Years	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
<u>Vancouver Island</u>														
Beaver Lake	35	5.04	3.54	2.67	1.40	1.17	0.84	0.46	0.66	1.56	3.01	5.73	6.30	32.38
Cowichan Bay	15	5.21	4.02	2.75	1.93	1.28	0.94	0.51	0.97	1.68	3.45	4.71	6.77	34.22
Metchosin	14	6.34	3.90	3.53	1.81	1.04	0.64	0.42	0.63	1.66	3.66	4.84	8.12	36.59
Sidney	17	4.09	3.15	2.32	1.56	0.83	0.81	0.51	0.72	1.50	2.87	3.85	5.35	27.56
Victoria	44	4.29	2.99	2.20	1.23	0.97	0.79	0.40	0.68	1.57	2.83	4.41	4.81	27.17
Alberni	35	9.47	8.73	6.01	4.26	2.92	2.21	0.93	1.18	3.37	6.72	10.67	10.92	67.39
Nanaimo	28	5.57	4.07	2.62	1.62	1.43	1.39	0.67	0.97	1.98	3.11	6.32	5.84	35.59
Sandwich	15	6.68	5.81	3.95	2.44	1.64	1.56	0.78	1.28	2.38	5.95	7.20	9.09	48.76
Clayoquot	30	13.88	11.65	10.91	8.14	6.11	3.71	2.18	3.33	6.38	12.82	17.16	16.70	112.97
Quatsino	32	11.55	9.51	8.95	6.57	4.82	3.39	2.21	3.27	6.28	11.79	14.28	15.15	97.77
<u>Mainland Coast</u>														
Britannia Beach..	16	9.76	7.14	6.89	4.68	3.44	2.65	1.59	2.15	5.15	9.19	9.67	11.09	73.40
Powell River	15	4.45	3.45	2.55	2.49	1.79	1.67	1.22	1.76	2.36	4.21	4.34	5.98	36.27
Bella Coola	31	5.03	3.47	3.96	2.32	2.02	1.89	1.81	2.30	4.01	7.17	7.58	7.05	48.61
Ocean Falls	15	17.38	11.83	14.38	9.65	8.21	5.63	5.57	9.20	9.64	19.68	19.68	21.92	152.77
Prince Rupert ...	21	9.45	8.04	9.45	6.98	5.34	3.86	4.78	5.50	8.42	12.85	12.65	11.20	98.52
Pemberton Meadows	17	5.15	3.68	2.61	1.46	1.07	1.07	0.66	1.09	2.50	4.28	4.98	5.52	34.07
Agassiz	40	7.28	5.75	5.31	4.45	4.52	4.03	1.90	2.40	4.52	6.66	8.46	8.01	63.29
Chilliwack	34	8.22	5.87	4.92	3.52	3.54	2.60	1.40	1.87	3.94	6.46	8.70	8.77	59.81
Ladner	33	4.58	3.73	2.85	2.04	1.89	1.40	1.05	1.17	2.40	3.84	5.48	5.20	35.63
New Westminster..	36	7.89	5.56	4.76	3.34	2.82	2.62	1.21	1.63	3.73	5.38	8.48	7.76	55.18
<u>Central Interior</u>														
Babine Lake	18	1.84	1.02	0.94	1.03	1.06	1.90	1.59	1.87	1.61	1.92	1.61	1.79	18.18
New Hazelton	15	1.76	0.99	0.87	0.61	1.00	1.49	2.08	1.65	1.71	1.97	2.20	1.75	18.08
Terrace	16	4.21	3.80	3.24	1.76	1.66	1.74	2.21	1.94	2.74	5.94	7.50	7.11	43.85
Fort St. James ..	36	1.48	1.02	0.86	0.78	1.11	1.47	1.62	1.36	1.31	1.39	1.61	1.62	15.63

TABLE III

Station.	No. of Years	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Prince George ...	17	1.70	1.05	1.38	0.81	1.10	1.83	1.31	2.04	1.69	1.77	1.39	1.51	17.58
Quesnel	34	1.39	0.90	0.62	0.48	1.01	1.86	1.60	1.53	1.47	1.49	1.30	1.20	14.85
Vanderhoof	13	1.69	0.97	1.16	0.45	0.77	1.39	1.23	0.95	1.08	1.48	1.13	1.08	13.38
Alexis Creek	10	1.05	0.44	0.31	0.47	0.44	0.91	0.74	0.94	1.04	0.36	0.51	1.00	8.21
Ashcroft	15	0.82	0.30	0.34	0.27	0.58	0.96	0.65	0.83	0.53	0.40	0.55	0.79	7.02
Lillooet	18	1.44	0.78	0.81	0.43	0.81	1.21	0.86	0.95	0.91	0.98	0.99	1.65	11.82
Southern Interior:														
Kelowna	15	1.21	0.74	0.69	0.74	0.78	1.09	0.58	0.89	1.01	1.01	1.19	1.74	11.67
Keremeos	15	0.80	0.43	0.39	0.71	0.87	0.96	0.56	0.91	0.83	0.83	1.10	1.03	9.42
Penticton	22	0.90	0.68	0.51	0.75	1.14	1.25	0.80	0.96	0.98	0.87	0.81	1.01	10.66
Princeton	33	1.34	0.94	0.62	0.58	1.10	1.18	0.93	0.88	0.94	0.88	1.66	1.60	12.65
Vernon	32	1.42	1.00	0.80	0.81	1.18	1.78	1.14	1.16	1.29	1.06	1.31	1.49	14.44
Merritt	11	1.17	0.69	0.50	0.40	0.68	0.69	0.57	0.76	0.61	0.69	1.16	1.37	9.09
Armstrong	19	2.23	1.05	0.86	0.98	1.21	2.09	1.03	1.32	1.42	1.67	1.70	1.90	17.46
Kamloops	38	0.99	0.68	0.35	0.39	0.96	1.37	1.04	1.08	0.83	0.64	0.91	1.04	10.28
Malakwa	15	4.09	1.76	1.92	1.49	1.85	2.32	1.42	1.76	2.51	2.61	2.42	3.68	27.83
Kootenay & Columbia:														
Grand Forks	20	1.75	1.08	0.90	1.11	1.42	2.07	0.88	1.00	1.19	1.18	1.49	1.75	15.82
Creston	17	2.29	1.43	1.42	0.91	1.59	1.67	1.17	1.01	1.40	1.44	2.06	2.51	18.90
Kaslo	19	3.42	1.78	1.66	1.55	1.51	2.10	0.89	1.72	1.94	2.15	2.96	3.31	24.99
Nelson	28	3.17	2.03	1.83	1.53	2.19	2.57	1.55	1.50	1.90	2.32	2.94	3.31	26.84
Cranbrook	23	1.77	1.06	0.96	0.65	1.24	1.88	1.30	1.07	1.27	0.84	1.42	1.42	14.88
Fernie	15	4.94	3.94	4.51	2.41	2.54	2.82	1.57	1.86	2.58	3.63	4.06	5.83	40.69
Windermere	16	0.86	0.57	0.31	0.52	1.00	1.73	1.04	1.54	1.26	0.79	0.66	1.11	11.39
Miscellaneous														
Atlin	24	1.03	0.83	0.58	0.34	0.45	0.77	0.99	0.98	1.20	1.18	1.23	1.15	10.73
Dawson	28	0.87	0.79	0.52	0.55	0.92	1.16	1.59	1.53	1.44	1.13	1.06	1.05	12.61

TABLE III (CON.)

very important bearing on the cropping systems and also affects the range conditions for grazing. In general it may be said that British Columbia, except in particular areas of which some are not suited to agriculture or grazing, is deficient in rainfall during the summer months throughout the southern interior. Even on the lower mainland and on Southern Vancouver Island and the Gulf Islands this condition exists--rainfall in June, July and August is usually scant.

Climatic conditions are, on the average, fairly uniform for the particular stations year after year. Of course, there are certain wide ranges within which precipitation and temperatures may fluctuate; for example, at Henderson Lake, on the West Coast of Vancouver Island, the precipitation for 1928 was reported as 280.5 inches of rain and 9.40 inches of snow, while in 1929 at the same station the totals were 190.03 inches of rain and 29 inches of snow. On the other hand, Tranquille with 3.40 inches of rain and 15.5 inches of snow in 1928, had 4.0 inches of rain and 46.5 inches of snow in 1929. However, in spite of these wide ranges it is safe to assume that Henderson Lake has a good chance of retaining its record for heavy rainfall while Tranquille is just as sure to show up as one of the driest places in the arid zone.

Similarly the temperatures may vary for particular years at all stations, but there is a general or average low and high that properly belongs to each specific locality along with the mean temperature which varies but

little. That temperature variations perform their part in the soil forming processes need scarcely be noted and that these variations influence the kind and quantity of native plants hardly requires mention. These facts are well known so it remains only to present meteorological data containing the temperature records to show at a glance how soils and crops in the several sections of the Province may be affected; affected not alone by the climate of the particular year under study but also by the result of ages of such climatic conditions.

In the following table a list of stations at which data have been secured are shown with the maximum and minimum temperatures for 1929. To further show the possible influence of climatic conditions on the soils and vegetation data regarding precipitation for 1929 are also presented. The comparatively low maximum and high minimum temperatures of the humid sections as well as the high maximum and low minimum temperatures of the more arid interior parts deserve more than passing notice, as will be seen by the table on temperature and precipitation.

It is possible that temperature and precipitation have both undergone modifications within the past sixty years due partly to mismanagement of grazing areas and destruction of forests by fire. This opinion is held by some pioneers. However, data covering a sufficient period of years have not yet been accumulated to prove or disprove this theory.

TABLE IV

Temperature and Precipitation, 1929, at British ColumbiaWeather Stations.

Station.	Temperature.		Precipitation	
	Highest	Lowest	Rainfall	Snowfall
<u>Vancouver Island</u>	Deg. F.	Deg. F.	Inches	Inches
Victoria	86	11	15.26	39.30
Duncan	90	-2	16.95	30.50
Cumberland	82	8	37.15	37.90
Nanaimo	84	12	18.50	34.40
Estevan Point	72	12	71.13	28.20
<u>Mainland Coast</u>				
Powell River	81	12	20.53	21.20
Bella Coola	91	-5	39.97	35.10
Ocean Falls	89	2	163.70	60.00
Prince Rupert	84	8	78.44	39.10
Chilliwack	88	4	33.78	32.50
New Westminster	85	6	32.97	26.00
<u>Central Interior</u>				
New Hazelton	84	-32	13.37	29.00
Terrace	87	-6	44.67	34.90
Barkerville	77	-34	20.27	176.10
Fort St. James	82	-37	11.59	25.30
Prince George	85	-50	15.30	32.80
Quesnel	87	-42	10.84	42.10
Vanderhoof	82	-56	8.33	39.60
<u>Southern Interior</u>				
Big Creek	86	-43	6.75	50.10
Lytton	97	-15	5.68	42.30
Kelowna	96	-13	5.13	45.00
Keremeos	100	-15	3.68	33.50
Merritt	90	-33	4.18	35.00
Oliver	106	-16	3.36	16.50
Penticton	96	-9	4.41	18.70
Vernon	96	-22	8.91	53.80
Armstrong	100	-26	14.57	38.50
Kamloops	96	-22	6.95	29.40
Salmon Arm	98	-18	12.34	40.00
Tranquille	92	-27	4.90	46.50
Nelson	100	-11	13.43	77.00
Cranbrook	97	-34	6.16	29.20
Invermere	91	-40	6.38	59.10
Revelstoke	94	-20	12.39	95.50

The Bunch Grass Region

Climatic conditions in the former bunch-grass region of the Southern Interior have not greatly altered in the past hundred years although there may be a very slight reduction in precipitation in the transitional zones adjoining this region, due to the denudation of the hills by fires. Neither has the composition nor the physical condition of the soil changed materially. The whole responsibility, practically speaking, for the present condition of this range area can be traced to over-grazing or range mismanagement.

When beef cattle were first brought into the bunch-grass country it was thought that the luxuriant pastures would maintain a perpetual supply of grass, summer and winter. Stockmen overlooked the fact that bunch-grass remained erect and retained a large percentage of its seeds from one season to the next, while other grasses were soft and died down not only bringing their seeds into contact with the soil but returning nourishment to the roots.

On some of the range areas, that are now being protected from over-grazing, porcupine-grass associated with useful perennial weeds forms a fair vegetative covering and in spite of its inferior quality it has some pasture value. Its presence following a period during which the land was practically barren of grass indicates that through patient effort and good management the grass covering can be re-established when grazing is prohibited, as shown in Plate VI on the following page.

Plate VIRange Mismanagement

The first introductions of beef herds made but little visible impression on the range but the progeny of those herds not only ate up the natural vegetation but the tread of countless thousands of hoofs during half a century wore deep paths in the sloping hillsides and today the hills of the range country show a terraced effect. The tramping and grazing destroyed the bunch-grass. Rest from grazing and tramping is the best means of restoring it. This is being demonstrated by Experiment Stations in Western Canada and the United States, and is being put into practise by a number of individuals, with good results.

The opening up of range land for agricultural settlement, the construction of roads and the coming of railways into the grazing region have all been blamed for the

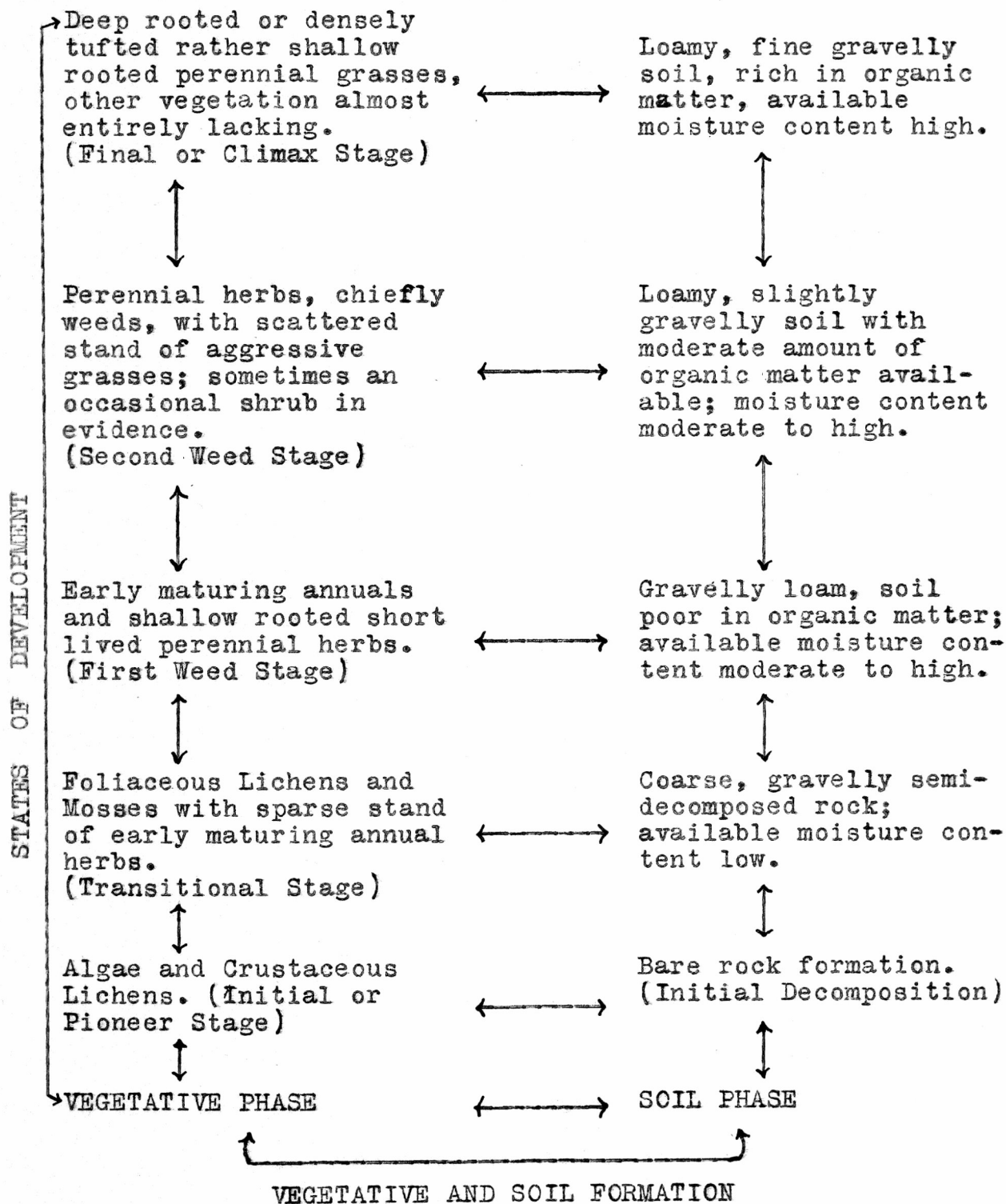
were sufficient but as the herds increased and areas became settled overgrazing became very common.

Unfortunately the symptoms of overgrazing are not immediately apparent because the bunch-grass association may persist even after the plants have been weakened by overgrazing and destruction of soil texture. However, the depletion of the humus, the spoiling of the surface soil by trampling and the prevention of re-seeding through overgrazing during the season when seeds should be maturing ultimately resulted in the ruination of the bunch-grass pasture.

According to ecologists who have made a close study of the development of soil and plant phases and the successive improvement of range lands through natural agencies a process such as is indicated in Table V on the following page, reproduced from "Plant Succession & Range Management", takes place.

Apparently the bunch-grass ranges of the interior resulted from the successive vegetative associations which began with algae and lichens and passed through the transitional stage, the first and second weed stage and reached the final stage as far as natural pasture was concerned. On their arrival in the interior with their herds the cattlemen found this superior plant association and it was only through exploitation of the pasture areas that this group of grasses disappeared and was replaced in turn by the succession next lower down the scale, which was the porcupine-grass and weed association.

TABLE V



Plant succession or the development of vegetation where grass constitutes the climax or subclimax type.

This association is to be seen where the bunch-grass is not common but where, by fencing, cattle have been prevented from grazing the area too closely for a year or two. The porcupine-grass very quickly reappears with associated weeds on areas that are protected. However, where protection is not afforded the area passes into the first weed stage where such inferior annuals as burr-weed, tumbling mustard, stink-weed and annual brome grasses make up the bulk of the sparse plant covering.

Whether these range lands can again be brought back to their former stage, in which they supported luxuriant coverings of bunch-grass, within a generation, is open to question. It has taken time for soil conditions, especially the humus content, to become suitable for the support of the finest grasses and it will again take years of patient effort to bring back the desired conditions. However, within a very few years it is possible to re-establish the second weed stage, in which many perennial herbs and some grasses provide fairly good grazing for cattle and quite satisfactory pasture for sheep. The abundance of yarrow and other weeds of almost equal value as far as sheep are concerned are hopeful indicators that by bringing back the second weed stage a satisfactory native plant covering may be secured within a reasonable time.

Of course, such introduced weeds as Russian Thistle, *Salsola kali* variety *tenuifolia*, and several species of *Chenopodium* and *Amaranthus* are commonly found in cultivated

fields and constitute a nuisance, but these are not altogether useless as forage and they do not occupy the over-grazed lands as do those mentioned in the former paragraph. These weeds as well as the Saltbush *Atriplex*, of which there are several species common in the arid district, in addition to the *Atriplex* which was introduced some years ago, are in a distinct class separate from the objectionable species of the exploited range areas.

Plate VII



In the foreground of the above, Plate VII, are Russian thistle, lambsquarter and wild barley, very common weeds on roadsides in the interior range country. Beyond the fence the over-grazed range is sparsely covered with burrweed, tumbling mustard and other annuals indicative of mismanagement of the range. The soil of the area shown in this photograph is highly alkaline.

Usually the bunch-grass ranges are treeless and even free from any considerable growth of shrubs or underbrush. The most conspicuous plants found along with the grasses include lupines which are very abundant; sunflowers of various species; yarrow which has already been referred to; occasional rose bushes and in the hollows or "draws" there are aspens, willows, blueberry and other shrubs. The several species of *Artemisia* are very common on the areas where cattle have pastured.

Bunch-Grass Association

The term "bunch-grass" covers a fairly large number of varieties and species and is often applied to different genera. However, in dealing with the range lands of the Southern Interior of British Columbia it generally refers to several varieties of *Agropyron spicatum* and *Agropyron tenerum* but also takes in other *Agropyrons* of which several important species are to be found in this Province.

One of the earliest references to *Agropyron spicatum* was made by Captain Meriwether Lewis, who accompanied Captain William Clark on the first overland journey through the United States to the Pacific Ocean twelve years after Alexander Mackenzie reached the coast by a Canadian route. When returning from the Pacific in June, 1806, Captain Lewis recorded the existence of the species on the range lands of Idaho. Since that early record was penned many other writers have made mention of it and other species that form the

"wheat-grass" or "bunch-grass" group.

The bunch-grass in the range country between Lytton on the west and the Okanagan on the east and between the 49th Parallel on the south and Quesnel on the north, does not occupy the important place it held a few decades ago. In the Blue Book for 1860, part 4, page 54, Governor Douglas, speaking of the country of which Kamloops is the centre, states, "The district comprehended within those limits is exceedingly beautiful and picturesque, being composed of a succession of hills and valleys, lakes and rivers, exhibiting to the traveller accustomed to the endless forests of the coast districts the unusual and grateful spectacle of miles of green hills crowning slopes and level meadows, almost without a bush or tree to obstruct the view and even to the very hill-tops producing an abundant growth of grass. It is of great value as a grazing district,--a circumstance which appears to be thoroughly understood and appreciated by the country packers, who are in the habit of leaving their mules and horses here when the regular work of packing goods to the mines is suspended for the winter. The animals even at that season are considered to improve in condition though left to seek their own fodder and to roam at large over the country; a fact which speaks volumes in favour of the climate and of the natural pastures. It has certainly never been my good fortune to visit a country more pleasing to the eye or possessing a more healthy and agreeable climate or a greater extent of fine pasture land."

Conditions Before Grazing Ranges

Referring to the same section of the Interior, which he traversed in 1859, Commander R.C. Mayne in his book entitled "Four Years in British Columbia and Vancouver Island" published in 1862, says: "There is much good grazing along the Bonaparte; the whole being clothed with long grass of which horses seemed very fond. We carried no fodder with us on this expedition, turning the horses loose at night to graze". Then referring to a wider territory he goes on to say, "These flats, or benches as they are called in this country, are found generally at the base of the river and are raised some 50 to 60 feet above it. They occur much more frequently on the Thompson and Nicola Rivers and higher up the Fraser than here. They are all covered with the long, sweet grass of which cattle and horses are so fond and which has so wonderful an effect in fattening them."

Dealing with his overland journey from the Fraser River to the confluence of the North and South Thompson, Mayne says further, "From this time all the way to Kamloops the aspect of the country had completely changed from that of the Fraser below Lytton; and we passed through a section of valleys sufficiently cleared of timber to make settling easy, yet with enough for building purposes, well watered and covered with long, sweet grass The view from hence (3600 feet altitude) was very extensive and beautiful, ranging as far as the Similkameen Valley and the Shuswap Lake and dis-

closing a fine tract of grass land which will some day become a notable grazing country. Ascending the mountainside we crossed a section of low, grassy hills, coming in time to the Thompson River Both the plain and mountains were covered with grass and in early spring, wild flowers."

The Rev. Matthew Macfie in 1865 wrote in his book "Vancouver Island and British Columbia" regarding the pastures of the Interior, "Bunch-grass, which is highly nutritious for cattle, is also abundant. On this fodder the Cayoosh nags or native horses so thrive that they surpass in power of endurance many an English hack fed on grain. One of those hardy animals can accomplish without injury a journey of 40 miles in a day. Mules that in the upper-country have to carry 300 or 400 pounds over long daily stages have bunch-grass for their only provender on the journey."

Rev. Geo. M. Grant, who recorded the events of Sanford Fleming's expedition of 1872 in his book "Ocean to Ocean" and was accompanied for at least part of the way across the continent by the late Professor John Macoun, speaks of the vegetation encountered in September as the party neared Kamloops by way of the North Thompson:- "The country today resembled that of yesterday; but even where it opened out the steady drizzle and the heavy mists on the hills hid everything. Cedars had entirely disappeared and the spruce and pines were comparatively small. The aralea gave place to a smaller-leaved trailer with a red berry like the raspberry; and a dark green

prickly leaved bush like English holly, called the Oregon grape, and several grasses and plants new to us covered the ground.

"Six miles from camp we came to Mad River, a violent, mountain affluent of the Thompson, crossed by a good bridge; and ten miles further on to Pea Vine Prairie, where as the rain ceased we saw for the first time the celebrated bunch-grass which has no superior as feed for horses or cattle, especially for the latter as the beef that has been fed on it is peculiarly juicy and tender. The name explains its character as a grass. It consists of small, narrow blades--10 to 50 of them growing in a bunch from 6 to 18 inches high and the bunches so close together in places that at a distance they appear to form a sward. The blades are green in spring and summer, but at this season they are russet grey, apparently withered and tasteless, but with the avidity with which the horses cropped them, turning aside from green and succulent marsh grass and even vetches, showed that the virtue of the bunch-grass had not been lost."

As the expedition neared Kamloops, the nature of the vegetation drew forth further remarks and the following appears under date of Sept. 28, 1872, "For the first half of the way the river scenery was very similar to that of yesterday, except that the flats along the banks were broader and more fertile, and the hills covered more abundantly with bunch-grass As we drew nearer Kamloops characteristics

of a different climate could be noted with increasing distinctness, a milder atmosphere, softer skies, easy rolling hills, but the total absence of under-brush and the dry grey grass everywhere covering the ground, were the most striking differences to us, accustomed so long to the broad-leafed under-brush and dark green foliage of the humid upper-countryThe natural timber in the district is a knotty red pine and as the trees grow widely apart and the bunch-grass underneath is clean, unmixed with weeds and shrubs, and uniform in color, the country has a well kept, park-like appearance, though there is too little of fresh green and too many signs of aridity for beauty."

Evidence of Over-Grazing

Evidently the pasture in the vicinity of Ashcroft had been more closely grazed than the sections seen further east along the Thompson, for on Oct. 1st, 1872, Grant wrote, "The country about Ashcroft is sparsely peopled, and men accustomed to the rich, grassy plains on the other side of the mountains, might wonder at first sight that it is peopled at all. In appearance it is little better than a vast sand and gravel pit, bounded by broken hills, bald and arid except on a few summits that support a scanty growth of scrub pines. The cattle had eaten off all the bunch-grass within three or four miles of the road and a poor substitute for it, chiefly in the shape of a bluish weed or shrub, called sage-grass or sage-bush, has taken its place. The cattle eat

this readily and fare well on it in winter; but it grows thinly, dotting rather than covering the sandy soil, and giving a "pepper and salt" look to the near hillsides. This poor looking land, however, is no more a desert than are the rich valleys of California. Like them, it will grow anything, if irrigated."

The type of country mentioned by Grant is well portrayed in the leading illustration which shows the tufts of sage-brush on the distant hillsides where water has not been applied. The level tracts of bench land of which he speaks are shown as alfalfa fields which, under irrigation, yield abundance of this legume. The soil has not lost its ability to produce heavy crops when water is applied. In the immediate foreground the sage brush is clearly shown along with a representative growth of *Stipa comata* and the occasional pine tree which here and there dots the landscape in the dry Southern Interior. On closely examining the photograph it will be seen that *Bromus tectorum* and Cactus, most likely *Opuntia polyacantha*, are to be seen in the foreground. The jointed flat segments of the Cactus or Prickly Pear are well provided with sharp spines which are exceedingly troublesome, being able not only to injure live stock but to penetrate heavy shoe leather as well.

The several species or varieties of *Agropyron* are worthy of investigation because they present improvement possibilities even under natural selection. While the general

type of the particular species is fixed there are found variations that deserve close attention and an effort towards reproducing the desirable plants. Some work on this project has been undertaken but as yet it has not been as seriously taken up as its value warrants. The fencing off of range lands and the prevention of over-grazing will, it has been demonstrated, restore the bunch-grass, but this grass is not alone deserving of restoration--it is worth improving by selection and breeding.

Inferior Grass Associations

On the same lands as have just been considered another group of grasses known as needle-grass or Porcupine grass are fairly common and when given a chance they re-establish themselves quickly. One of the species of usual occurrence is *Stipa comata*, which may be considered as representing the whole genus. This *Stipa comata* or Needle and Thread grass, while palatable in spring and fairly nourishing in late fall is decidedly injurious, especially to sheep when the heads are developed, and before the seeds have fallen. However, with proper range management even the Porcupine grasses may be regarded as valuable.

In spite of the diminutiveness of its size, there is no question as to the value of Sheep fescue, *Festuca ovina*, found throughout all the dry open areas at medium elevations and a persistent associate of the Sage-brush. Sheep fescue is native to the Southern Interior and is a highly drought

resistent species that thrives in the glaring sunlight which is depressing to so many grasses.

This species is a densely tufted perennial, well supplied with basal leaves, which grows from half a foot to a foot and a half high, depending on soil and moisture conditions. It matures its seed very early in some of the very hot, dry exposures but extending its flowering season over a long period, where conditions are different. Sheep fescue is palatable to all classes of stock, but especially to sheep which crop the fine, basal leaves until late in the fall. Undoubtedly this species is one of the most important though least showy of the grasses on the arid range.

A related species, Red fescue, *Festuca rubra*, is another very valuable grass and, owing to its extreme variableness in nature, it should be a species that will lend itself to considerable improvement. Unlike Sheep fescue the Red fescue is a loosely tufted perennial with creeping root-stocks. Otherwise it closely resembles the former and is just as palatable. This species is able to thrive on a wide variety of soils, including very dry exposures. The fescues are an extremely important group and at least a score of species are to be found in this Province.

Shining Spike-grass, *Koeleria cristata*, is very generally distributed at altitudes of 1500 to 2500 feet in the Southern Interior, notably in the Boundary district and Similkameen Valley, but it does not in any area form a large

percentage of the forage. It is a tufted perennial species with very numerous basal leaves. In spite of the fact that it inhabits very dry situations it wilts very readily when the moisture content of the soil falls below 10%. Its ability to grow in dry regions is no doubt due to its very early maturity. The flower stalks bearing the seeds are not as much eaten as are the succulent basal leaves, consequently there is fair production of seed, but its viability is quite low. This grass is by no means as important in the area under consideration as are those mentioned above. It is more in the class with Mountain Rice, *Oryzopsis asperifolia*; Indian Millet, *Oryzopsis hymenoides*; and other showy grasses.

Grasses of Doubtful Value

The Lyme-grasses of several species are common in the dry areas of the Interior and some of them make excellent growth on soil of very alkaline nature. *Elymus glaucus*, usually referred to as a Rye grass, is of wide distribution, as are also *Elymus canadensis* and *E. condensatus*, which are also rank growing tufted perennials. In fact, the latter, called Giant Rye grass, which grows well in the coast districts, sometimes attains a height of 10 feet or more. However, it is *Elymus glaucus* that is of most importance to the live stock industry in the range sections of the Southern Interior.

Plate VIII

As shown in the above illustration, certain species of *Elymus*, mainly *Elymus glaucus*, form a considerable part of the vegetation covering an old Indian settlement. The keekwillee holes over which the Indians built their store-houses and shelters many years ago are clearly seen in the foreground, while the Lyme-grass in almost pure stand appears in the background.

This species, in common with several others, is in the early part of the summer a nutritious and palatable grass, especially for cattle and horses. Later on it becomes so coarse and woody as to be of very little value. Many of these Lyme-grasses are usually affected with Ergot and are consequently not safe for grazing late in the season when the seeds are maturing and the Ergot grains are well formed. For this reason and also because of the coarser late growth Lyme-

grass is limited in usefulness to the early summer.

There have, however, been cases where, when other grasses were scarce, Lyme-grass has served as a forage for winter and in certain limited areas it is abundant enough to provide considerable roughage. Its habitat includes rich, dry situations in the sage-brush association and also wet situations where there is a high saline concentration in the soil moisture. Doubtless the ability of this grass to withstand drought as well as high saline concentrations is partly due to the ability of the genus to roll its leaves cylindrically and thus reduce transpiration.

In the Sedge family there are many species of definite forage value and a number of these grow in sufficient abundance to be of importance. Many of the Sedges are found in swamps and the margins of lakes and ponds but several are very common in dry ground and saline or alkaline areas of the arid sections. Among these are *Carex Douglasii*, *Carex Sartwellii* variety *occidentalis* and *Carex canporum*, all of which occur in the dry range country. There are upwards of a hundred species which are found in wet soils and average moist places in the Province but these are not very highly regarded because more valuable grasses and herbs are usually abundant where such sedges will thrive. It is when such vegetation grows well on soils that will not support better pasture plants that they are worthy of attention.

Plate IX



In the re-establishing of a useful vegetative covering on the somewhat arid range lands of the interior they should remain unused for a sufficient number of years to enable suitable plant associations to gain a foothold, and when vegetation has been re-established proper rotation of the grazing areas must be adopted. A well made fence of economic but dependable construction is an absolute necessity where range lands are being brought back into production again. Grazing in the immediate foreground has been so severe that rocks and small stones are exposed on the bare earth, while just beyond the fence the protection afforded has enabled grasses of various species as well as useful herbs and shrubs to establish a satisfactory vegetative covering.

Literature Cited

- Rev. Charles Moser, O.S.B. "Reminiscences of the North West Coast"
- David Douglas "Journal 1823-27"
- Earl P. Goddard "Handbook American Museum Natural History"
- Sir Wm. J. Hooker "Botany of Southern Parts of British Columbia"
- Rev. Matthew Macfie, F.R.G.S. "Vancouver Island and British Columbia"
- Commander R.C. Mayne, R.N. "British Columbia and V.I."
- Piper and Beattie "Flora of the North West Coast"
- J.K. Henry "Flora of Southern British Columbia"
- C.V. Piper "Flora of Washington"
- Archibald Menzies "Journal of Vancouver's Voyage, 1792"
- Sir Alexander Mackenzie "Mackenzie's Journal"
- Simon Fraser "Fraser's Journal"
- Rev. George M. Grant "Ocean to Ocean"
- Alexander Begg "History of the North West"
- Sir James Douglas "Blue Book for 1860"
- Daniel Williams Harmon "Harmon's Journal"
- A.W. Sampson, U.S.D.A. "Important Range Plants"
- " " " "Plant Succession in Relation to Range Management"
- A.B. Clawson, U.S.D.A. "Normal Growth of Range Cattle"
- V.V. Parr, U.S.D.A. "Beef Cattle Production in the Range Area"
- Bureau of American Ethnology, 18th Annual Report
- Annual Reports, Division of Forage Plants, Ottawa
- Annual Reports, Division of Field Husbandry, Ottawa
- Annual Reports, Department of Agriculture, British Columbia
- Ottawa, "Beef Raising in Canada"
- British Columbia, "Climate of British Columbia", Annual Reports
- Principal Poisonous Plants of Canada