

For the permanent betterment of the lands, those interested should, by community action, devise a thorough system of drainage. Such a system might at the beginning be a number of deep ditches, into which the alkali-charged seepage-water could enter from flooded areas; until the far preferable plan of tiling could be profitably introduced.

An illustration in point obtains in the case of the Patterson ranch, at Oxnard, a portion of which became much "salt-stricken," but where, after the construction of a deep drainage canal into which were led laterals, there was, and is, a constant removal of the accumulated salts at a surprisingly rapid rate.

#### VEGETATIVE CHARACTERISTICS OF THE SALTON BASIN.

J. B. Pavy

That the vegetation of any region supplies important information concerning its agricultural adaptations is so well known in practice as not to require discussion. It is especially instructive in its application to alkali lands; and Mr. Snow was therefore instructed to observe and collect for determination specimens of all the plants to be found on the territory explored by him.

"While the adaptation or non-adaptation of particular alkali lands to certain cultures may be determined by sampling the soil and subjecting the leachings to chemical analysis, it is obviously desirable that some other means, if possible available to the farmer himself, should be found to determine the reclaimability and adaptation of such lands for general or special cultures. The natural plant growth seems to afford such means, both as regards the quality and quantity of the saline ingredients. The most superficial observation shows that certain plants indicate extremely strong alkali lands where they occupy the ground alone; others indicate preeminently the presence of common salt; the presence or absence of still others forms definite or probable indications of reclaimability or non-reclaimability. Many such characteristic plants are well known to and readily recognized by the farmers of the alkali districts. 'Alkali weeds' are commonly talked about almost everywhere; but the meaning of this term--i. e., the kind of plant designated thereby--varies materially from place to place, according to climate as well as to the quality of the soil. Yet if these characteristic plants could be definitely observed, described, and named, while also ascertaining the amount and kind of alkali they indicate as existing in the land, lists could be formed for the several districts, which would indicate, in a manner intelligible to the farmer himself, the kind and degree of impregnation with which he would have to deal in the reclamation work, thus enabling him to go to work on the basis of his own judgment, without previous reference to this Station." \*

The season at which the exploration took place (Christmas vacation)

\* Bulletin No. 128, California Experiment Station, p. 35.

was of course unfavorable to the finding of all the kinds of plants that might occur somewhat later. Only twenty-two species in all were collected, and these were submitted for determination to Mr. Joseph Burt Davy, Assistant Botanist to the Station. Mr. Davy's results and comments are given herewith, together with the annotations of Mr. Snow, placed in brackets.

ANNOTATED LIST OF PLANTS FROM THE SALTON BASIN.

(Collected by F. J. SNOW.)

By JOS. BURTT DAVY, Assistant Botanist.

CRUCIFERÆ.

1. *Lepidium lasiocarpum*, Nutt. *Pepper-cress*.

Five miles south of proposed townsite. [Very abundant. near Mexican line.]

Salton River, near Patton's camp. [Abundant in scattering places.]

T. 13, R. 15. [Scarce, except in small patches.]

Mexico: 15 miles from line. [Scarce.]

A common desert annual, probably tolerant of some alkali, as are many other species of the *genus*, but not necessarily indicative. It is sometimes found also in moist alluvial soils, and ranges from Santa Barbara through the Mojave plateau region and, east of the Sierra, northward to Keeler.

ZYGOPHYLLACEÆ.

2. *Larrea tridentata* (DC.) Coville. *Creosote-bush*.

Along Salton River. [Abundant in places along the river. Very abundant toward Mexican line.]

Locality 9, T. 13, R. 15. [A few scattering live bushes.]

Mexico: 15 miles from line. [A few bushes. Becomes very abundant near Mexican line along Salton River.]

One of the most characteristic desert plants, occurring almost throughout the Lower Sonoran zone from the bottom of Death Valley about 300 feet below sea level to an altitude of 5,500 feet in the Panamint Mountains. It is not an alkali plant, and usually grows on well-drained soils well above the alkali line; but at its lower limit a few scattered specimens are often found in the *Atriplex polycarpa* belt, in a mixture of gravel and clay with some visible trace of alkali.

LEGUMINOSÆ.

3. *Astragalus mortoni*, Nutt. *Morton's loco-weed*; "*Loco-weed*"; "*Wild pea*."

Salton River bed; "if cattle eat, will go crazy." [Scattering plants along the river-bed.]

New River bed. [A number of plants near north end of river-bed.]

Moist grounds along the eastern base of the Sierra Nevada, in the vicinity of Mono Lake, and northward to the interior of Oregon and Utah. Well known as "a deadly sheep poison." We have no information as to its tolerance of alkali, but other species of the genus are characteristic alkali plants.

4. *Prosopis juliflora* (Swartz) DC. *Mesquit-tree*; *Algaroba*; *Honey mesquit*.

Near Mexican line—a few miles from Blue Lakes. [Abundant.]

Characteristic of desert areas with moist subsoil. It sometimes occurs on the edge of alkali marshes in company with *Atriplex canescens* and *Suaeda suffrutescens*, where a slight alkali efflorescence or thin crust occurs, but above the heavily alkaline soils, though below the *Atriplex polycarpa* belt. I have found it in somewhat alkaline soils near Bakersfield. Though tolerant of some alkali, it is not an alkali indicator. Its altitudinal range varies from 328 feet below sea level, to 5,650 feet above.

FICOIDEÆ.

5. *Sesuvium portulacastrum*, L. *Lowland purslane*.

New River channel. [Found at the north end of New River channel; but few plants to be seen elsewhere.]

A very characteristic plant of moist alkali and saltmarsh soils both in the interior and along the seacoast. It is found in alkali marshes in the Mojave Desert and the Tulare Valley, and in the Great Basin region from northern Nevada to Colorado and New Mexico. It is said that in the interior it often occurs with much broader leaves than is usual when growing along the seashore. We have no analysis showing the tolerance of alkali by this plant, but it has been found growing in soils so heavily impregnated with salts that scarcely any other plants grew there.

COMPOSITÆ.

6. *Bigelovia veneta* (H. B. K.) Gray. *Bigelovia*.

Ten miles south of Blue Lakes. [Abundant.]

Alkali meadow at monument east of Salton River. [Abundant.]

A plant of the Lower Sonoran zone, common in moist alkali soils, but apparently not tolerant of a very large percentage. In the Bakersfield region the salt tolerance of this plant was found to vary from 1,800 pounds of salts per acre to 24,320 pounds. It was not found in soils heavily charged with alkali.

7. *Baccharis* sp. (imperfect material). *Sausal*; *Baccharis*; (also *Arrow-wood*, in part).

Salton River bed. [Found only in river-bed in numerous places.]

Our species of *Baccharis* are swamp plants, usually growing on the borders of rivers and streams or in "washes." As a rule they are found in fresh water, but at least one species (not this one) sometimes occurs in slightly alkaline water. Two other species, *B. emoryi*, Gray, and *B. sergiloides*, Gray (to neither of which does the specimen appear to belong), occur in the Colorado Desert region.

8. *Pluchea sericea* (Nutt.) Coville. *Cachimilla*; *Arrow-wood*.

Salton River bed.

New River.

New River channel. |

T. 13, R. 15. [Scarce.]

[Abundant along portions of the river channels and banks.]

Reported as occurring along sandy borders of streams from Ventura County eastward to Utah and south through Arizona to New Mexico. Both of our species of *Pluchea* frequent moist alkali swamps, and one of them occurs both in the interior in the Suisun marshes and in the saltmarshes of San Francisco Bay. The amount of alkali tolerated is evidently considerable, as *P. sericea* occurs in association with Alkali tussock-grass (*Sporobolus airoides* (Torr.) Thurb.) and Salt-grass (*Distichlis spicata* (L.) Greene) in the Mojave Desert plateau region.

HYDROPHYLLACEÆ.

9. *Nama hispidum*, Benth.

Salton River bed. [Scarce, except in certain portions of the river-bed.]

A desert annual, apparently restricted to the Colorado Desert, and probably not indicative of alkali.

BORAGINACEÆ.

10. *Coldenia palmeri*, Gray.

Sample 10, T. 13, R. 16. [On sandy, high lands. Nut very abundant.]

A dwarf, desert perennial occurring on sand-hills along the Colorado and lower part of the Mojave and adjacent Arizona. (*Bot. Calif.*)

11. *Heliotropium curassavicum*, L. *Wild heliotrope*.

Along Salton.

New River.

New River channel. }

Alkali meadow at monument east of Salton River. [Abundant.]

[Abundant along the river-bed.]

A nearly cosmopolitan weed, common in sands of the seashore, and in moist alkaline soils of the interior. It generally indicates the presence of alkali and moisture, but is sometimes found in soils apparently free from alkali.

AMARANTACEÆ.

12. *Amarantus chlorostachys*, Willd. *Pigweed*.  
Salton River near Patton's camp. [Scattering dead plants, with here and there live plants of rank growth. To the west, about 2 miles, they thrive and attain a very rank growth. It is also found east of Salton River near the Mexican line.]  
A semi-tropical weed, probably naturalized.
13. *Amarantus palmeri*, Wats. (?)  
Sample 11, T. 13, R. 15. [Scattering plants; abundant, toward the Mexican line.]  
A desert species, apparently indigenous to the Colorado Desert and Rio Grande regions. The Amaranths are such omnivorous, weedy plants that they can not be relied upon as alkali indicators.

CHENOPODIACEÆ.

14. *Atriplex lentiformis* (Torr.) Wats. *Lens-fruited saltbush*.  
New River. [Found scattered in New River country; abundant in places and in river-bed.]  
Mexico: 15 miles from line. [Scarce in this locality; but abundant near Mexican line.]  
Alkali meadow at monument east of Salton River. [Abundant.]  
A desert species, ranging from the Tulare Valley to the Colorado Desert and eastward through Arizona. We have no record as to its tolerance of alkali, but the list of localities in which it has been found and the plants with which it is associated, indicate that it is an alkali plant.
15. *Atriplex polycarpa* (Torr.) Wats. *Scrub saltbush; called "Greasewood" in the Mojave Desert, but not the "Greasewood" of the Great Basin region.*  
Mexico: 15 miles from line. [Abundant in certain localities near Mexican line.]  
A characteristic desert species, ranging through the Lower Sonoran zone from the Tulare Valley through the Mojave and Colorado deserts to the Williams River in Arizona. Common in clayey valley bottoms, usually in dry soils. Analyses of scrub saltbush soils near Bakersfield show that its tolerance of salts ranges from 840 pounds to 78,000 pounds per acre.
16. *Atriplex canescens* (Pursh) James. *Shad scale; sometimes called "greasewood."*  
Sample 9, T. 13, R. 15. [Many dead bushes on small hummocks. A few live bushes, which are very large, are found scattered near.]  
Sample 11, T. 13, R. 15. [Many dead bushes are found in this vicinity.]  
T. 13, R. 15. [Many dead bushes on small hummocks; also scattering live bushes.]  
Near Mexican line, a few miles from Blue Lakes. [Abundant near the lake.]  
Mexico: 15 miles from line. [Scarce; but very abundant near the line on Salton River.]  
A common and characteristic species, occurring in dry soils both in the Upper and Lower Sonoran zones in the Mojave and Colorado deserts, and in the Great Basin region from northern Nevada and Colorado to New Mexico. It does not appear to reach the Tulare Valley. It occurs in dry soils, on mountain slopes at altitudes ranging between 2,300 and 4,700 feet, and does not seem to be indicative of the presence of alkali. Like the Mesquit and Creosote-bush, it is sometimes found sparingly in slightly alkaline soils at its lower limit.
17. *Atriplex* sp. (immature).  
Sample 8, T. 11, R. 14. [A few scattering dead bushes.]  
Sample 9, T. 13, R. 15. [Dead bushes are found on small hummocks.]
18. *Suaeda* sp. (immature). *Saltwort; Glasswort.*  
Salton River bed. [Abundant along the river-bed.]  
New River. [Abundant along the river-bed.]  
The saltworts are characteristic alkali indicators, and are not known to occur elsewhere than in moist alkali soils. The total amount of salts tolerated has a wide range of variation, running from 3,700 pounds to 153,000 pounds per acre; but

saltwort has been found in greatest luxuriance where the total amount of salts was 130,000 pounds per acre. The saltworts appreciate more common salt (sodium chloride) than many other characteristic alkali plants, but appear to be somewhat easily affected by *salsoda* (sodium carbonate).

POLYGONACEÆ.

19. *Rumex* sp. (immature). Dock.

Along Salton. [Abundant in places along the river bank.]

Salton River bed. [Abundant in places along the river-bed.]

At monument east of Salton River. [Abundant.]

Two or three species are found in moist places in the Mojave and Colorado deserts.

GRAMINEÆ (TRUE GRASSES).

20. *Leptochloa imbricata*, Thurb. Alkali slender-grass.

Near Salton River bed, 15 miles from line. [Not abundant.]

Common in moist places and alkali plains from the Tulare Valley through the Colorado Desert to Lower California, and eastward into Mexico and Texas. A somewhat stout perennial, 1 to 3 feet high, "abundant in fields and gardens, thrifty on alkali plains and near soft [salt?] water; abundant in August and September, when alfalfa is dried up; a good forage plant, cut and fed to animals." (Dr. Ed. Palmer.)

GNETACEÆ.

21. *Ephedra* sp. (immature).

Ten miles from Blue Lakes. [Abundant near the lake and along New River near the Mexican line.]

Characteristic desert shrubs, said to be sometimes found in alkali soils.

UNCLASSIFIED.

22. Dwarf annual (immature and not recognized),

Sample 8, T. 11, R. 14. [Only a few plants to be found.]

Sample 9, T. 13, R. 15. [Only a few plants to be found.]

The list of plants here given is notable for the absence of most of the species considered elsewhere as prominent alkali indicators. We miss at once the salt- or alkali-grass (*Distichlis*), the "greasewood" of Nevada (*Sarcobatus*) and that of the San Joaquin Valley (*Allenrolfea*), the samphire (*Salicornia*), and the tussock-grass (*Sporobolus airoides*). Of the saltbushes proper (*Atriplex*), two (*A. polycarpa* and *lentiformis*) appear elsewhere as species indicating the probable presence of considerable alkali, while the other two species observed are not known as alkali plants. The two plants that may be considered as indicators of strong alkali, especially of common salt, are the saltwort (*Suaeda*) and the lowland purslane (*Sesuvium*); their indication is strengthened by their occurrence in the river channels, at whose level the profiles (pp. 20 and 21) show an abundance of salt. But as a whole, the collection made does not speak of "irreclaimable" alkali land, so far as we know their habits. The heliotrope will grow luxuriantly in non-saline lands, but also where common salt can be seen by the seaside. The creosote bush (*Larrea*), the pepper-cress (*Lepidium*), the pigweeds (*Amarantus*), the Bigelovia (yellow-flowered, sometimes called green sage) are not plants addicted to alkali lands. Taken as a whole, the native vegetation does not altogether confirm the unfavorable impression derived from the leach-

ing of the soil samples. It is hoped that a more detailed examination of the flora at a more favorable season, soon to be undertaken, will throw more light on these questions.

### CLIMATE OF THE SALTON BASIN.

The high summer temperature and dryness of the air in the Salton region are well known, being in this respect similar to the rest of the Colorado Desert. While the thermometer during summer usually rises to and above 100° Fahr. (124° having been recorded twice at Salton during 1901), the heat is not oppressive, on account of the dryness of the air, which evaporates the perspiration as soon as formed. The nights are usually decidedly cool to the sensation. The winter temperatures are in strong contrast to the summer heat, as will be seen from the small table, given below, of observations made by Mr. Snow during December, 1900, and January, 1901. It will be noted that a minimum temperature of 13° occurred on January 2d, so that ice two inches thick formed near camp. Such a temperature would at once prohibit the culture of citrus fruits, but may occur only locally, on low ground. Still, the run of December temperatures, from observations all over the region, indicates clearly that "semi-tropic" growths will incur considerable risks, unless protected in winter.

**Morning Temperatures Observed in Salton Basin at 8 o'clock.**

1900.	1900.	1901.
Dec. 22..... 23°	Dec. 27..... 21°	Jan. 1..... 38°
23..... *21	28..... 25	2..... 13
23..... †70	28..... ††73	3§..... 23
24..... †24	29..... 28	4..... 30
25..... 23	30..... 26	5..... 40
26..... 20	31..... 24	6..... 30

\* Dec. 23. Ice in washpan and on pond two inches thick.

† Dec. 24, 25, 26, and 27. Ice in ponds.

‡ Jan. 3. Surveyors' Camp 17.

† Dec. 23. For the day.

†† Dec. 28. For the day.

### CROPS FOR THE SALTON BASIN.

As to crops for the silt soils of this region, it must be said that the showing here made is not at all encouraging for extensive fruit-growing at the present time. While there may be localities in the region which could grow the fruits more tolerant of alkali and dry heat, yet we deem it unwise at present to encourage the planting of fruit, except the date-palm, to any considerable extent. The date-palm would doubtless be one of the fruits which could be most successfully grown, taking into consideration both the climate and the alkali soils. To this might be added olives, figs, table, sherry, and port grapes; and on the sandier lands, almonds,