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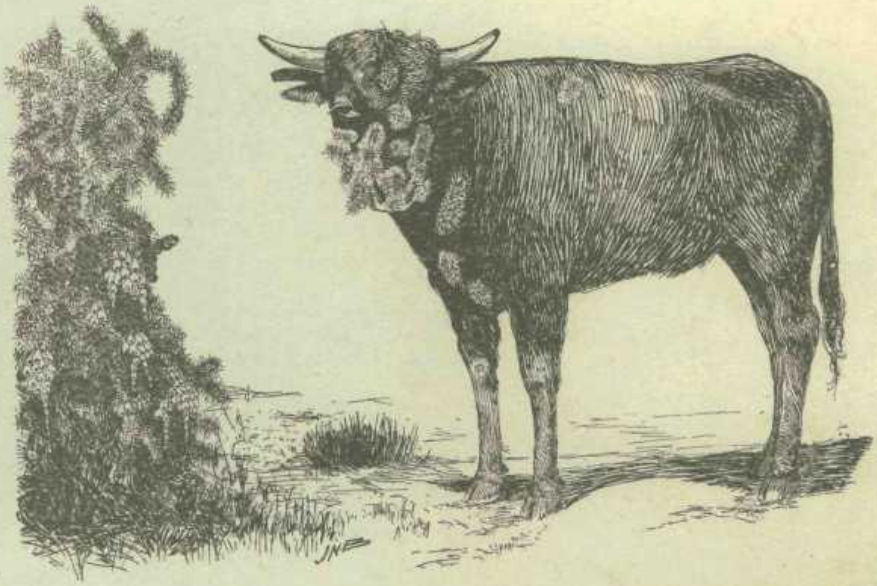

PRICKLY PEAR AND OTHER CACTI

AS FOOD FOR STOCK II.

BY

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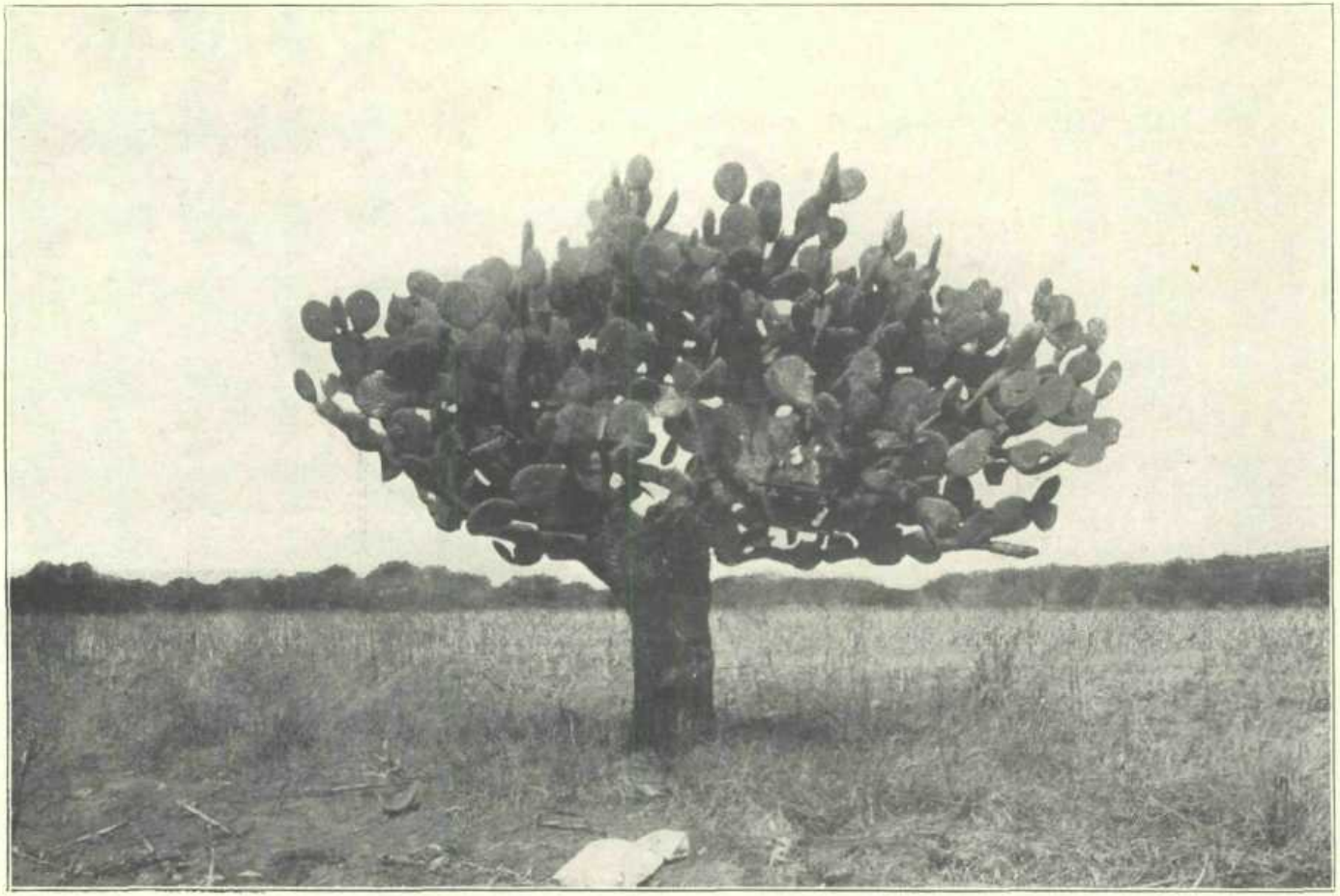


PLATE I. Nopal Cardon. (*Opuntia Streptacantha Lem.*)

PREFACE

In two publications of the United States Department of Agriculture (B. P. I. Bulletin No. 74 and B. A. I. Bulletin No. 91) the value of the cacti as forage plants has been demonstrated. Since these plants are known to possess important economic value, more knowledge concerning them is desirable. As a basis for future investigations, the Bureau of Plant Industry and the New Mexico Experiment Station have collected material from a wide area, from which a large number of chemical analyses have been made. The results are detailed in the following pages. 187 food analyses and 26 complete ash analyses are here reported. The territory from which the material was collected extends from central Texas to California, and southward to the central plateau of Mexico.

Attention is called to the fact that the apparent high content of fats and protein in the fruit of certain species is due to the large amount of these classes of nutrients found in the seed. As these seeds are surrounded by a dense layer of wholly indigestible tissue, the high content of ether extract and protein is misleading. The analyses show that the fodder value of the fruit of cholla (*O. fulgida*) and related species investigated is little more than that of the stems. It will be seen that in chemical composition the different forms of cactus compare favorably with ordinary green fodders and root crops.

There are many points of special interest in connection with the ash analyses, especially the high content of potash, magnesium and calcium. Altho the cane cacti show a relatively higher food value, practical considerations relating to growth and ease of propagation render them of less value than the prickly pear, except in certain limited localities where they are especially abundant.

W. J. SPILLMAN,
Agriculturist.

Farm Management Investigations,
Washington, D. C., October 19, 1906.

PRICKLY PEAR AND OTHER CACTI AS FOOD FOR STOCK II[1]

CONTENTS

1. See Bull. 74: B. P. I., U. S. Dept. Agric.

ILLUSTRATIONS

COVER The appearance of animals which graze on cholla cactus during dry seasons. The terminal joints break off readily and become attached to the animals' heads while they graze upon the pendant bunches of fruits. (Drawn from a photograph taken by the authors in the winter of 1901.)

Plate I. Nopal cardon (*Opuntia streptacantha* Lem.) This is without doubt the most highly prized and the best general utility pear of any of the Mexican species.

II. Nopal cuijo. Fig. 1.—A medium sized plant growing near San Luis Potosi, Mexico. Fig. 2.—A joint of the same plant in bud.

III. Two genera of prickly pear. Fig. 1.—Nopalea. Photograph was taken from specimens in the A. S. White park, Riverside, California. Fig. 2.—*Opuntia occidentalis* Engelm. and Bigel. Photographed near San Diego, Cal.

IV. Nopal durasnillo (*Opuntia leucotricha* P. DC.) Highly prized on account of its succulence and the ease with which the spines are burned off. Fig. 1.—Nopal durasnillo blanco. This plant is about 10 years old and is cultivated by Mrs. A. B. Nickels at Laredo, Texas, from cuttings brought from Mexico. Fig. 2.—Nopal durasnillo colorado. This is a very old and exceptionally large plant growing wild near Aguas Calientes, Mexico.

V. Nopal tapon. Fig. 1.—(*Opuntia robusta Mendl.*) A very robust plant. Compare Bulletin 74 Plate V., Fig. 1.—B. P. I., U. S. Dept. Agric. Soledad, Mexico. Nopal de Castilla. Fig. 2.—(No. 7519). As grazed by cattle. Laredo, Texas.

VI. Cylindropuntia or Cane Cacti. Fig. 1.—*Opuntia spinosior* (Engelm.)Toumey. A rather large specimen from the desert mesas near Tucson, Arizona. Fig. 2.—Cardenche, Goconoxtle (*Opuntia imbricata* (Haw.) DC.) Photographed near Aguas Calientes, Mexico.

VII. Cylindropuntia or Cane Cacti. Fig. 1.—*Opuntia versicolor* Engelm. from upper foothills of Santa Catalina Mountains, Arizona. Fig. 2.—Cholla, *Opuntia fulgida*, from a favorable situation in the desert mesas near Tucson, Arizona. This is probably the most valuable cylindrical jointed species from a stock feed point of view.

INTRODUCTION

When a study of the economic value of the *Cactaceae* was taken up in earnest, three or four years ago, it was recognized that a better knowledge of the chemical composition of the prickly pears was necessary. When this work was undertaken it was decided that the investigation should include promising foreign species as well as native ones and that it could be most profitably taken up in connection with introductions and other investigations then in progress. Considerable chemical work had already been done upon the various forms but an examination of the appended list of literature will show the number of analyses made from the forage standpoint to have been comparatively few and that they were still fewer in number when this work was begun than they are at the time of its publication.

Analyses of some forms are appended here which can never be of any great importance as feed for stock on account of their slowness of growth. This is especially true of those forms outside of the genus *Opuntia*, but the inclusion of analyses of these forms is instructive as a matter of comparison. Some use is made of all of the species. Accounts of the profitable utilization as feed for stock of such unpromising forms as the Viznaga are given in the text and such small forms as the *Echinocacti* described can be made use of in connection with such other forms as they happen to grow with.

The methods of feeding cacti were described in detail in Bulletin No. 74 Bureau of Plant Industry, U. S. D. A. and the use of the prickly pear in the present beef and butter production of Texas has been reported upon in bulletin No. 91 Bureau of Animal Industry of the same Department. The reader is referred to these publications for additional discussions which might be looked for here.

When the work was planned it was thought that 40 chemical analyses would cover the ground fairly well but as the investigations progressed so many forms having more or less value were discovered that the scope of the investigations was very much enlarged. The uncertainty arising from chemical analyses of single samples also had an influence in the extending of the investigations beyond the limits first contemplated.

ACKNOWLEDGMENTS

Due credit should be given Mr. S. R. Mitchell, Assistant Chemist at the New Mexico Experiment Station for valuable assistance rendered in the chemical analyses, as well as in the compilation and tabulation of the results of analyses given in this bulletin. Professor E. O. Wooton has also given valuable assistance in collecting material as well as in its identification, and Professor William Trelease has aided very materially by according us the free use of the Engelmann Herbarium at the Missouri Botanical Garden. All collections, unless otherwise indicated, were made by the authors. The authors are under special obligation to Mr. A. S. White for privileges accorded them in studying as well as in securing specimens from his extensive collections.

The Samples

It has been considered important throughout the investigations to record as minutely as possible the character of the samples which were analyzed. No one appreciates better than the writers the absolute impossibility of securing exact uniformity in any set of samples of plant tissues, more especially ones which vary as do the cacti. Although uniformity cannot be secured, a record has been attempted which will give a clear idea of the nature of the sample. A plan was adopted when the work began which will enable the reader to know very definitely the portion of the plant used. The importance of this is clearly shown in some of the analyses.

In order to condense the descriptions of the samples, a formula is adopted to designate the relative position of the parts of the plants analyzed. This can best be explained from an actual diagram:

2-1-4-3-5.

In this formula the left hand figure represents in all cases the terminal mature joint or, in one or two instances, the last proliferous fruit produced on the plant; the second figure from the left, the second joint, &c. In general, the left hand

figure in the formula indicates the number of one-year old joints in the sample, the second the number of two-year old joints, the third the number of three-year old joints, the fourth the number of four-year old joints, &c. By remembering that the left hand figure in the formula represents the terminal joint, there will be no difficulty in interpreting the sample formulae. When this formula is given within a parenthesis the figure on the outside denotes the number of plants from which the samples were taken.

It is not strictly accurate to say that position in the formula represents the age in years of the joints, because the time it takes for a joint to grow is extremely varied. This depends upon the soil and climatic conditions as well as upon the age and species of the plant. Some years some terminal joints put forth no new growth, while the next may witness the development of two joints. Again, fruiting joints seldom produce new vegetative growth the same year that they do fruit. It has been the common belief that in plants which have reached the fruiting stage one joint per year is produced by the terminal joint of the previous year. While this possibly might be accepted, it is a very rough approximation and overestimates rather than underestimates the actual growth of the plant.

It should be clearly understood that in no case where not expressly stated is any new growth included in the samples. Only mature joints or those which had passed through a winter season have been included. The left hand figure in the formulae of samples collected in 1904, therefore, represents joints which grew in 1903.

Through a misunderstanding a slight error occurs in some of the formulae of the samples collected in 1904. When these were sent to the laboratory joints were set aside for botanical purposes. In every case such joints have been deducted from the total but it was impossible to tell the difference in the dried samples between joints two, three or four years old. The best that could be done was to determine whether or not the joint was a terminal one and make the deduction accordingly,

either from the terminal joint or from some of the others. It will readily be seen that this introduces but a slight error. All of the samples collected in 1905 are exactly as represented in the formulae.

The uncertainty of the chemical analysis of a single sample influenced us to make a special effort to secure two samples of each species or form and this has been very largely accomplished. In the majority of cases the two samples have been collected one year apart from the same plants, the localities having been visited two or, in several cases, three times during the period that these investigations have been in progress.

The transportation of specimens from the field to the laboratory, while satisfactorily arranged finally, was not by any means an easy matter. Inasmuch as it appeared wise to secure as accurate data as possible upon the water content in the green state, the evaporation in transit was difficult to overcome. Fortunately, these plants do not give up their moisture as readily as many do, and the extent of cut surface may be very much minimized in the prickly pears especially, by securing whole joints. But in hot weather the evaporation in transit would be considerable even then. It was finally decided to ship all material to the laboratory in tin cans and to secure those from which there would be the least possible evaporation. It was impracticable to have such vessels made and carried into the field, so it was necessary to buy such as were needed from time to time upon the different convenient markets.

Many kinds of vessels were used. Coffee and baking-powder cans were on the whole the most satisfactory. But tin pails with tight fitting covers and, with small samples, ordinary fruit cans were often employed. The latter, however, were difficult to obtain except upon a few markets. These packages were wrapped and securely tied in several thicknesses of heavy paper and usually inclosed in a cloth sack to be forwarded by either mail or express.

On the whole the method was very satisfactory but it was

impossible to get some of the fruits to the laboratory in good condition. The fruits of both *Echinocereus enneacanthus* and *Cereus geometrizans* spoiled in transit. By wrapping carefully picked fruits in paper, and packing the joint samples free from bruises all other samples came to the laboratory in good condition. Many of the samples were in transit but 24 to 48 hours.

METHODS OF CHEMICAL ANALYSIS

The methods of the Association of Official Agricultural Chemists were used in the fodder analyses included in this bulletin.

In the determination of a number of the elements included in the ash analysis, the A. O. A. C. methods were modified. The analyses were made from the ash, which was prepared by burning the plant in platinum dishes in a muffle furnace at a low temperature, no attempt being made to determine the total inorganic plant constituents.

Preparation for Analysis

Upon receipt of the samples in the laboratory they were at once weighed, and sliced in such a manner as to expose as much as possible of the inner portion for drying. After a number of unsuccessful attempts it was found impracticable to air dry many of the samples, even in the summer sun of New Mexico, because of their tendency to ferment when sliced, or to continue growing if left as whole joints. It became necessary, therefore, to dry many of the samples by means of artificial heat; and for this purpose an old incubator was used, the temperature of which was kept at or below 70° C. until the samples were dried. It has been found that drying such succulent plants as the cacti at this temperature can be effected without causing a change in their chemical composition. By this treatment the samples were dried in good condition.

After drying, the samples were allowed to remain exposed to the air for several days so that they might assume an *air*

dry condition, when they were again weighed and the loss in weight from the weight of the fresh sample gave the amount of water lost in air drying.

Removal of the Spines

After drying and weighing, the spines were next removed from the sample. As one of the most common methods of feeding cactus is to first singe off the spines, it was decided to prepare all of these samples in that manner, so that we might more nearly represent the condition of the plant when fed to animals. Instead, however, of removing the spines from the green material as is done in feeding, they were carefully singed from the *air dry* plant with a small flame of complete combustion. Usually we experienced no difficulty in removing the spines in this manner, as they burned off with a flash without scorching the dried plant. It was the intention at first to remove them by "singeing" the green plant, as is done in feeding, and with a few of the samples collected in 1904 the spines were removed in this manner, but it was soon found that this could not be done without driving some moisture from the sample, thus yielding too high results for percentage of spines, and a slightly low result for water. A similar difficulty was encountered with some of the first few samples in trying to remove the spines from the green material by means of a knife. For this reason, as well as for the reason that it was entirely too tedious a process, this method was abandoned, except for a very few species that had spines entirely too large to be "singed" without danger of overheating the sample. Where samples of the same species, collected in 1905, showed that an apparent error had been introduced by removing the spines from the green material by either of the above processes, the results so obtained have been omitted from the tables of analyses. The percentage of spines was calculated from the difference in weight before and after burning the sample as just described. Where the amount of spines is determined in the air dried plant the results will be slightly low when calculated

to a basis of percentage in green plant, because the spines themselves were found to contain from five to ten per cent. of water.

The amount of spines found on the different species varies widely. Some are spineless, while in a few extreme cases the spines constituted as much as 35 to 40 per cent. of the dry matter of the plant. There is also a great variation in the percentage of spines found on different samples of the same species, depending as a rule upon the size and age of the stems. Very old stems frequently have lost many of their spines and therefore may be almost if not quite spineless. No. 7516 was a sample of this kind, and while the results of the analysis show only a few, there was at one time, no doubt, an appreciable quantity of spines. When a sample is made up of a number of small joints the percentage of spines is much higher than when the joints are all large. No. 3101 was such a sample of the same species as Nos. 3018 and 3100, and while the results indicate over twice as many spines, the probabilities are that they were no more numerous, nor larger than those in the last named samples. In some species the old trunks seem to be normally more spiny than the younger joints. Exceptions to this rule were found in a number of instances, however, and these can only be accounted for by the fact that the spines are naturally more abundant on some stems than they are on others, even when the samples are taken from the same plant, but it is believed that this determination will be of value in giving an approximate idea of the relative percentage of spines in the different species.

Where the percentage of spines amounted to less than 1-10 of one per cent. in the dry material they have been noted in the table as "few." This is the case with nearly all of the fruits, as the spines on these are usually so small that their relative weight is inappreciable.

To determine definitely what, if any, food value was lost in burning the spines from the plant, a sample was collected from No. 3070a and the results reported under No. 3070b

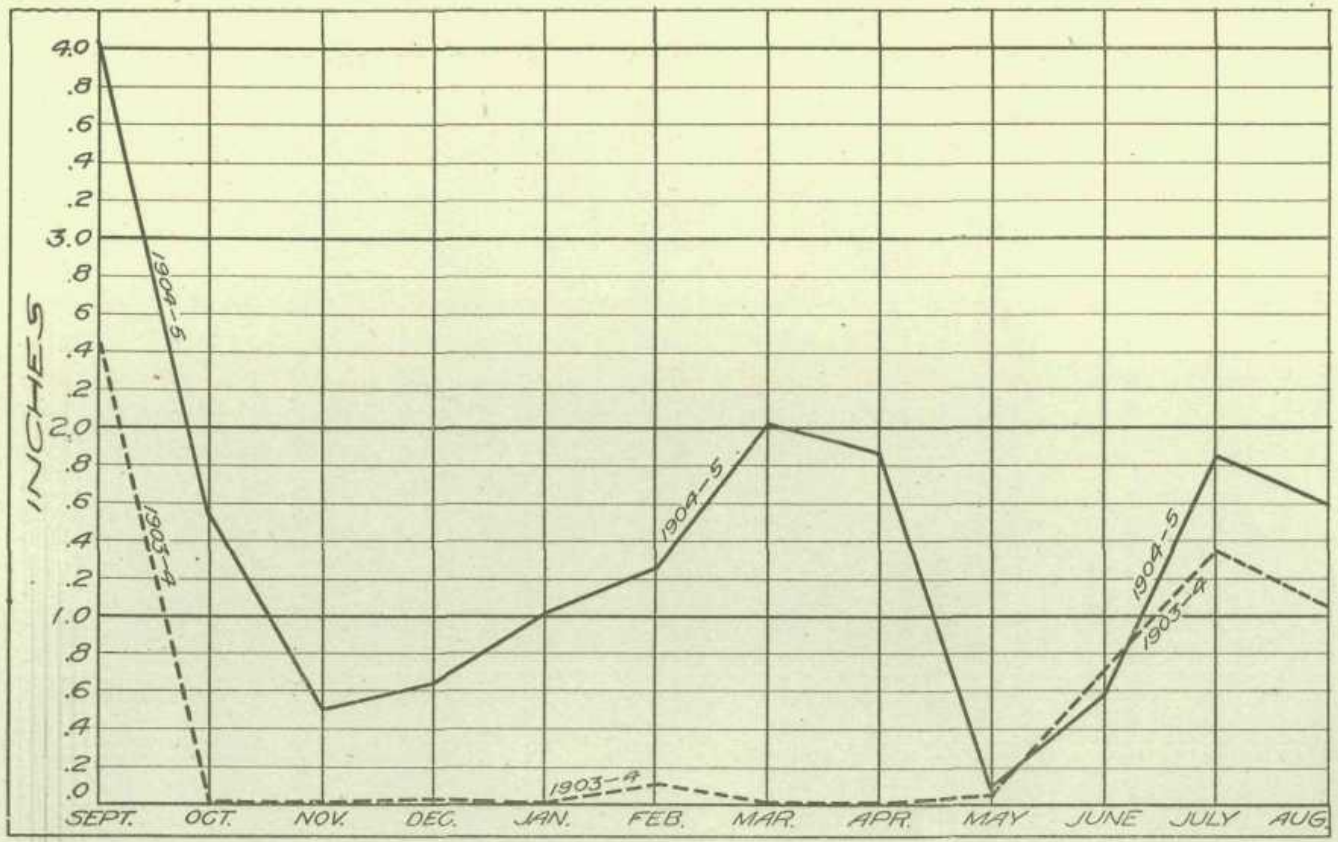
(Table No. 6.) As might be expected they were found to be composed largely of crude fiber, there being 44.17 per cent. in the green spines. It is interesting to note that they contained only 8.73 per cent. water, and 3.73 per cent. ash. While there is considerable nitrogen-free-extract, it is doubtful if any appreciable amount of this would be available to animals. Hence probably very little of value is removed from the plant in "singeing" its spines; on the other hand, much objectionable matter is thus removed and the food is somewhat concentrated by the loss of its spines and some of its water. This fact points more favorably to the method of "singeing" than to that of "chopping" in the preparation of cactus for food, although, of course, this would not be of much consequence except in species that contained a great many spines.

WATER CONTENT

The amount of water in the different samples analyzed varied from 60.99 to 95.5 per cent., omitting No. 6531 because of a probable error in the moisture determination. The miscellaneous group contains more water than do either of the other two, the average amount of water in this group being 87.88 per cent., while the prickly pears averaged 84.26 per cent. and the cane cacti 78.47 per cent.

As a rule the fruits contained more water than did the stems, and the younger growth more than the older. There was more water in those samples collected in 1905 than in those collected in 1904. This fact was no doubt due to the prolonged drouth, quite prevalent over the regions where the samples were collected during the winter of 1903 and the spring of 1904, which was followed by heavy rains during the next winter and spring thus causing the growth in 1905 to be more succulent.

The figures showing the precipitation in inches and tenths for the years 1903-4 and 1904-5 from September 1st of each year are plotted in the diagram below, and a glance at this is sufficient to explain the variation in the water content of the



Map showing precipitation in inches and tenths at the New Mexico Experiment Station from September first to August thirty-first, during the years 1903-04 and 1904-05.

samples for the two years. In one instance the difference in water amounts to 18.86 per cent. These figures were taken at the New Mexico Experiment Station and while such a condition was doubtless prevalent over the area where the samples were collected, they necessarily apply only to southern New Mexico.

Cactus, as a rule, contains more water than other green fodders, in fact, in point of water content, it more nearly approaches roots and tubers.

The above statements apply to the question in general. The effect of rainfall on the water content is more specifically brought out in the following tabular statement correlating the water content of the samples with the rainfall in regions where several of samples were collected.

Table 1.—Showing Relation of Rainfall to Water Content of the Prickly Pear.

No	Name	Locality where collected	Date of collection.	Precipitation during past three months. (Inches)	Percentage of water in plants.
6243	Opuntia engelmanni	Santa Rita	April 30, 1904	.28	79.05
7787	" "	Mts. Arizona	April 19, 1905	9.15	87.36
6240	Opuntia engelmanni	"	April 29, 1904	.28	72.60
7774	" "	"	April 18, 1905	9.15	86.19
6247	Opuntia engelmanni	"	May 2, 1904	.28	81.94
7790	cycloides	"	April 20, 1905	9.15	79.69
6248	" "	"	May 2, 1904	.28	72.65
7791	" "	"	April 21, 1905	9.15	81.90
7009	Opunta phaeacantha	"	Aug. 30, 1904	.28	88.83
7559	" "	"	April 17, 1905	9.15	83.93
6241	Opuntia chlorotica	"	April 30, 1904	.28	77.87
7782	" "	"	April 19, 1905	9.15	79.47
6699	Cereus giganteus	Tucson, Ariz	July 28, 1904	.60	87.31
7805	" "	" "	April 26, 1905	11.56	92.36

In general, the samples collected in 1905 contained more water than those collected in 1904. There are two exceptions in the above tabular statement. If the descriptions of samples No. 6247 and 7790 are compared, it will be found that the

1904 sample contained proportionally much more of the younger growth. It is therefore quite likely that the difference in the samples may account for their apparent deviation from the general rule. Our notes show no explanation for the condition shown in Nos. 7009 and 7559.

Cholla *(Opuntia fulgida)* is especially susceptible to changes during favorable seasons. The younger joints of this species are ordinarily very succulent. During the spring of 1905, after the exceptionally favorable winter season, it was not at all uncommon to find branches and fruits of this species actually ruptured by the excessive pressure due to the absorption of large quantities of water. The phenomenon is sometimes to be seen in the prickly pear forms but never to such an extent as in this species. It is especially common at times in the fruits of certain cultivated Mexican forms. Photographs taken of the plant shown in Plate VI, Figure 2, show over one-half of the fruits upon it to be ruptured.

While the prickly pear is, in the vast majority of cases in this country and elsewhere, an emergency feed, being used when other more nutritious substances fail, it has a limit of drouth endurance. There have been seasons in southern Texas with drouth so prolonged that the pear was fed only with difficulty. It had lost its crisp and succulent nature and become fibrous and tough so that those who fed found it much more advantageous to chop than to scorch because cattle could eat it better when it was cut for them. The effect upon these plants of an unfavorable season is fully as marked as upon the common cultivated crops. The advantage lies in the ability of the pear to withstand a longer period of unfavorable weather without serious or permanent injury.

ASH CONTENT

Plants grown in the arid or semi-arid southwest, where there is an abundance of soluble salts in the soil are found to contain more ash than those grown in regions of frequent rainfall; and the cacti are a group of plants that are certainly no exception to this rule. The average ash in the air dried

TABLE NO. 11—COMPOSITION OF THE ASH

Number	Name	Locality	Date of Collection	Formula 1 and Remarks.	Total Ash in Air Dry Plant	Per cent. Carbon	Per cent. Sand	Per cent. in Pure Ash											
								Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Silicic Acid, Radicle (SiO_2)	Phosphoric Acid, Radicle (PO_4)	Sulphuric Acid, Radicle (SO_4)	Chlorine (Cl)	Carbonic Acid Radicle (CO_3)	Total
6244	Opuntia arbuscula	Santa Rita Mts., Ariz.	April 30, 1904.	Sample from 4 plants.	14.35	.37	1.42	.15	0.00	.22	29.41	5.18	7.98	1.03	.39	2.29	1.17	1.22	47.69	96.73
6251	" versicolor	Santa Catalina Mts., Ariz.	May 4, 1904.	$(4\text{-}4\text{-}4\text{-}4)_6$	20.00	.66	1.29	.26	0.00	.16	29.53	4.76	6.59	1.67	.49	2.49	2.55	2.28	45.37	96.25
6255	" fulgida	Santa Catalina Mts., Ariz.	May 4, 1904.	(6 6)	14.25	.74	1.65	.21	.53	.09	24.31	8.10	11.59	0.00	.63	2.54	2.00	1.33	42.73	94.36
6256	" mammillata	Santa Catalina Mts., Ariz.	April 25, 1904.	$(5\text{-}5\text{-}5\text{-}1)_{\ldots}$	16.75	.35	3.57	.37	.32	.18	23.56	7.62	12.36	.38	1.10	1.72	2.44	1.67	45.53	97.25
6328	" leptocaulis	Eagle Pass, Tex.	May 10, 1904.	Stem, fruit and flowers.	24.80	.21	1.14	.20	.19	.27	33.98	2.28	4.44	.13	1.25	.69	1.35	.57	53.54	98.88
6231	Echinocereus enneacanthus	Eagle Pass, Tex.	May 10, 1904.	Plant	17.78	.26	3.31	.31	.13	.09	22.66	5.07	16.61	.62	.80	1.20	2.35	2.90	42.63	95.37
6517?	Opuntia sp	Bocas, Mex.	March 1904.	Stem	19.70	.11	.88	.15	.17	.22	20.20	5.31	13.33	0.00	1.31	1.86	2.78	4.16	38.19	87.38
6525	" microdasys	Alonzo, Mex.	March 14, 1904.	$(7\text{-}2\text{-}1)_3$	27.35	.28	11.65	1.02	.92	.35	25.00	3.40	11.50	.22	9.60	.98	1.73	1.26	39.53	94.91
6527	" imbricata	Alonzo, Mex.	June 10, 1904.	$(5\text{-}4)_5$	17.53	.26	2.98	.31	.27	.25	25.27	4.86	12.89	.03	1.96	1.73	2.25	4.65	37.84	92.21
6535	" sp	San Luis Potosi, Mex.	June 12, 1904.	$(3\text{-}2\text{-}1)_4$	20.30	.49	8.27	.93	.56	.35	23.19	4.91	13.20	.54	2.30	1.13	2.10	2.30	40.13	91.64
3000	" macrocentra	Garfield, N. M.	July 11, 1901.		16.45	.62	4.37	.53	0.00	.56	24.75	8.25	8.33	1.57	1.56	2.14	1.16	.95	44.80	94.60
3002	" engelmanni cycloides	Hillsboro, N. M.	July 12, 1904.		23.70	.81	.60	.25	.27	.26	26.10	6.08	12.71	.22	.84	1.37	.80	.30	44.74	93.94
6699	Cereus giganteus	Tucson, Ariz.	July 28, 1904.		15.75	.17	.44	.30	.07	.15	31.64	5.78	6.66	0.00	.37	.88	4.12	3.32	41.06	94.55
3016	Opuntia sp.	Fiora Vista, N. M.	Aug. 9, 1901.		22.18	.27	3.67	.21	.79	.21	29.24	6.64	16.27	.30	1.82	2.04	1.95	1.98	43.11	95.56
3018	" polyacantha	Tierra Amarilla, N. M.	Aug. 16, 1901.		15.35	.21	.53	.39	0.00	.32	24.01	5.81	14.15	.12	.52	1.19	2.97	6.18	42.06	97.53
3025	" phaeacantha	Ancho, N. M.	Aug. 28, 1904.		24.56	.28	2.68	.41	0.00	.38	30.94	6.09	3.71	.50	.99	.93	.99	1.36	49.48	95.78
3032	" laevis (?)	Mesilla, N. M.	Sept. 12, 1904.		23.60	1.12	7.00	.55	.46	.19	21.40	9.26	9.44	.44	4.06	2.07	1.24	1.13	43.76	94.00
7476	" cacanapa	Encinal, Texas	Jan. 10, 1905.	Old stems	20.00	.11	1.74	.25	.13	.36	26.03	2.38	13.11	1.16	1.23	.55	1.03	5.20	47.08	98.51
7515	" lindheimeri	Encinal, Texas	Jan. 17, 1905.	$(3\text{-}1\text{-}1)_3$	21.05	.14	.29	.20	0.00	.49	26.71	2.27	14.22	.35	.43	1.11	1.15	2.15	49.12	98.20
7591	" streptacantha	Aguas Calientes, Mex.	March 6, 1905.	$(1\text{-}1\text{-}0\text{-}1)_3$	19.85	.05	.21	.20	.19	.04	30.10	2.70	10.10	.53	1.14	.29	.41	.63	50.25	96.59
7733	" sp. (Nopal chaveño)	Aguas Calientes, Mex.	April 10, 1905.	$(2\text{-}1\text{-}1)_3$	20.34	.19	2.05	.15	.26	.16	27.49	3.30	11.20	.29	1.55	.33	1.45	.53	53.40	100.11
7734	" rufida	La Perla, Mex.	April 10, 1905.	$(1\text{-}1\text{-}1)_2$	19.90	.62	.78	.46	.15	.67	34.79	1.66	3.46	.11	2.54	.72	1.51	.30	54.17	100.54
7774	" engelmanni (?)	Santa Rita Mts., Ariz.	April 18, 1905.	$(1\text{-}1\text{-}0\text{-}1)_3$	19.83	.25	.20	.12	.51	27.59	6.20	8.02	.19	1.41	1.35	1.13	.68	47.96	95.26
7782	" chlorotica	Santa Rita Mts., Ariz.	April 19, 1905.	$(1\text{-}1\text{-}1\text{-}1)_4$	17.10	.39	.67	.10	.27	1.36	33.23	2.78	3.12	.15	.77	1.07	.67	.53	53.68	97.75
7784	" phaeacantha	Santa Rita Mts., Ariz.	April 19, 1905.	$(1\text{-}1\text{-}1\ 0\text{-}1)_2$	15.80	.54	.89	.15	.15	.37	29.00	6.05	6.40	.25	.91	2.64	.82	.55	45.97	93.27
7790	" engelmanni cycloides	Santa Rita Mts., Ariz.	April 20, 1905.	$(1\text{-}1\text{-}1)_3$	20.85	.59	.73	.15	.15	.77	33.90	3.10	4.28	.13	1.25	.61	.97	.43	53.82	99.46
7791	" "	Santa Rita Mts., Ariz.	April 20, 1905.		21.43	.45	.95	.15	.26	.19	32.26	3.43	5.38	.23	1.29	.52	.85	.62	53.86	99.54
	3Composite Sample					.38	3.17	.36	.31	.63	28.90	6.85	10.49	.47	1.90	2.70	1.94	2.20	33.78	90.71
	Average of all Ashes				19.65	.40	2.40	.31	.24	.36	27.38	5.31	9.71	.42	1.58	1.39	1.64	1.84	45.90	95.75

1. For explanation of formula see page 7.
2. Tuna blanca, prob ably the same as one of the mission pears of southern California.
3. The composite ash is the ash obtained by burning two grams each from 175 samples of the dried plants.

stems and fruits of the prickly pear group amounted to 18.25 per cent., for the cane cacti 15.50 per cent., and for the miscellaneous group 13.54 per cent. In one sample (No. 6578) ash was 33.08 per cent. of the dry plant. The averages would all be higher if they did not include the fruits, which always contain less ash than do the stems. The average ash in the air dry fruits of the prickly pears, for instance, is 13.21 per cent., which is 5.04 per cent. less than is contained in the average of both stems and fruits of this group.

The greater part of the ash in the fruits is found in the fleshy portion rather than in the seed, in fact the fleshy portion contains about the same amount as is found in the stems. Sample No. 8022a is of the fruit with seed removed, and contained 25.60 per cent. ash, while the seed alone, the analysis of which is given under No. 8022b, contained only 1.77 per cent. ash in the dry material. The low ash content of the seed is undoubtedly what causes the whole fruit to be low in this substance.

The elements of the ash are present perhaps in about the same proportion as in the ash of other plants, except potassium, magnesium, and calcium, which are present in unusually large amounts, due, no doubt, to the fact that salts of these three elements are usually found abundant in most southwestern soils. It is the presence of these salts, in all probability, that causes animals that eat cactus alone to scour so badly. If, for example, a steer should eat 100 pounds of the green plant from sample No. 6578, he would get only 7.96 pounds of organic matter, and in addition to 88.11 pounds of water, he would eat 3.93 pounds of ash, or residue from the ignition of these salts. This would be considered a rather large dose if they were in any way purgative, as some of the magnesium, sodium and potassium salts present undoubtedly are. Manganese is present in unusual amount in a number of the ashes, enough being present in some of the plants to impart a characteristic green color to the ash. It amounted in one instance (No. 7782) to more than one per cent. of the total ash.

The results reported in the table of ash analyses are calculated to the pure ash, and the elements are reported as kathions and anions. It will be noticed that when the results are so reported the sum total of all the constituents amounts to less than 100 per cent. in all but two samples. This is probably accounted for, in part at least, by the presence of small amounts of oxides or hydroxides of calcium or potassium in most of the samples. The presence of these was shown by the alkalinity of the filtrate from the water solution which had been previously precipitated with neutral barium chloride. When the results were calculated to oxides they approximated 100 per cent., but oxygen was lost in converting these results to radicles, because of an excess of basic radicles.

Food Value of Different Parts of the Plant

In the pear region of southern Texas there is a universal belief that the old woody stems are of more value as feed than the younger joints. Indeed it is the practice in some localities to cut off one or two terminal joints, using only the remainder of the stem. Some feeders go so far as to insist that they would feed only the old trunks if they could get enough of them without too much labor. Of course, these opinions and remarks refer only to the southern Texas species, *Opuntia lindheimeri*, which grows only four or five feet high and has a comparatively small trunk. There are many species in Mexico whose trunks are so woody that they would be absolutely worthless as feed for stock. The stems of the Texas species are much more succulent than the larger, ranker forms of Mexico. Our analyses show that the old stems of *Opuntia lindheimeri* contain less water and more crude fiber than the younger growth and are of less food value. On the other hand, a smaller water content is of course a dicided advantage in such exceedingly succulent feed.

Guthrie[1], after comparing his own analysis of the stems of

1. Agric. Gaz. N. S. W. *11*: 671. 1900.

four Australian species with the analysis of fruits made by Wolf, concludes that the latter are of less forage value than the stems because they contain a smaller proportion of nutritious substance and more fiber. Forbes [2], on the other hand, suggests from analysis of cylindrical jointed cacti that the fruits of certain Arizona species are rich in fat and consequently greatly relished by cattle.

Comparative composition of the different parts of the fruit.

Analysis of fruits of the cacti usually shows them to contain more fat and protein than is found in the stems, but when the seeds are separated from the fruits and analyzed they are found to contain most of the food material of the whole fruit, See 8022a and 8022b in the table beyond. However, since the seeds are not masticated by cattle and pass through undigested, probably none of this part of the fruit is available as food hence it would seem that the fruits of many species at least are not so valuable for stock food as the edible portions of the stems. This is especially true of such species as *O. fulgida* and *O. spinosior*. Stock doubtless eat the fruits of these species in preference to the stems because they have fewer spines, not because they are any more nutritious. There are, however, a few fruits especially from those species collected in Mexico, which are very nutritious because of their higher sugar content.

The fruit of Echinocactus (Nos. 8173a and b) and the "miscallaneous" group in general are very different inasmuch as the seeds of these species can be easily masticated. But from the forage standpoint these fruits can all but be ignored. The fiber in the seed of these samples (Nos. 8173a and b) was not more than half of the amount found in No. 8022a, for example, and the seed of the other species of prickly pear resemble No. 8022a in their general properties, and probably in the fiber content also.

It is interesting to note that *O. fulgida* No. 8170a contains very little more food in the whole fruit than is found ln the pulp and rind alone. This is probably due to the fact that the

2. Ariz. Agric. Expr. Sta. Ann. Rep. No. 15, 496. 1904.

seeds in this sample are sterile. No. 7801, which was a normal specimen with fertile seed, is apparently higher in food value but we suspect that this is only apparent and that here again the nutritive material is locked up in the seeds, of which there were a normal number, while No. 8170a was largely sterile.

Table No. III—Showing Composition of the Different Parts of Fruits

Name.	No.	Part of fruit.	Water.	Ash.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Organic matter.
O. phaeacantha.	8022a	Seed	7.26	1.75	6.07	11.41	23.18	50.33	90.99
"	8022b	Pulp	92.50	2.09	.20	.07	4.63	.51	5.41
O. spinosior.....	8162a	Whole fruit.	77.74	2.97	1.74	1.11	11.50	4.94	19.29
"	8162b	Pulp	83.04	3.10	.55	.24	11.74	1.33	13.86
Echinocactus Wislizeni.....	8173a	Seed	8.59	3.09	10.92	15.46	36.59	25.37	88.31
"	8173b	Pulp	94.14	.96	.63	.06	3.05	1.16	4.90
O. falgida.....	8170a	Whole fruit.	82.84	2.70	.63	.51	11.63	1.69	14.46
"	8170b	Pulp	87.17	1.58	.47	.27	9.66	.91	11.25

Relative Food Value of the Three Groups.

Chemical analysis indicates that the cane cacti are the most valuable of the three groups as a food. They contain more protein, fat, and nitrogen-free-extract than do either of the other two groups.

The miscellaneous species which include all the specimens not belonging to the platopuntias and the cylindropuntias. contain more spines and water, and less ash than does either of the other two. They also have more protein, fat, and nitrogen-free-extract in the dry material, but because of the large amount of water, the green plants contain less protein and fat than do the cane cacti and less nitrogen-free-extract than either cane cacti or prickly pears.

But this is only a portion of the story, for while chemical analysis is of great importance in determining the value of any food stuff, there are other problems which must be considered. The cane cacti, are as a rule, drier and contain more

fiber and are consequently less suited to the practical stockman's use. *O. fulgida* is without doubt the most valuable cylindrical jointed species growing within the borders of tho United States, but for various reasons it cannot compare in value with many of the flat jointed forms, because they grow more rapidly, are easier to propagate from cuttings, and are more abundant naturally over a greater extent of territory, are all of which are of vital importance in the economic handling of the crop.

The ash is highest in the prickly pear, but the fruits of the cane cacti contain more ash than the fruits of the other groups.

In table No. IV is given the average analysis of the three groups, and for the purpose of comparing their relative value with other green fodders we have included the analysis of ten very commonly fed green fodders, roots and tubers. Since *Opuntia Lindheimeri* is a very important species, it being the one at present most commonly fed in Texas, we have also included an average of the analysis of seven samples of stems and one of the fruits of this species collected during 1904 and 1905.

It will be seen that this average of analyses of *O. Lindheimeri* shows practically the same amount of constituents as does the average of all the prickly pears. It will also be seen that the cacti resemble other green fodders very much in their composition. Perhaps they average somewhat more water and ash, and less protein and fat.

Table No. IV. Comparative Composition of the Three Groups with Other Green Fodders, Roots and Tubers.[1]

	Spines	Water.	Ash	Protein	Fat	Nitrogen Free Extract	Fiber	Organic Matter
Cane Cacti Cylindropuntias.....	.79	78.47	3.61	1.41	.63	12.30	3.59	17.93
Miscellaneous Cacti	1.03	87.88	1.67	1.05	.41	7.22	1.76	10.45
Prickly Pears Platopuntias.....	.44	84.26	3.06	.73	.34	9.01	2.41	12.53
Opuntia Lindheimeri.....	.....	84.51	3.18	.73	.33	8.59	2.65	12.30
Corn—dent, cut before glazing.....	.....	79.7	1.20	1.70	.50	11.50	5.40	19.10
Pasture grass.....	.....	80.00	2.00	3.50	.80	9.70	4.00	18.00
Sorghum.....	.....	79.40	1.10	1.30	.50	11.60	6.10	19.50
Rye.....	.....	82.00	1.60	2.40	.70	8.50	4.80	16.40
Alfalfa.....	.....	71.80	2.70	4.80	1.00	12.30	7.40	25.50
Red clover.....	.....	70.80	2.10	4.40	1.10	13.50	8.10	27.10
Carrots.....	.....	88.60	1.00	1.10	.40	7.60	1.30	10.40
Potatoes.....	.....	78.90	1.00	2.10	.10	17.30	.60	20.10
Sugar Beets.....	.....	86.50	.90	1.80	.10	9.80	.90	12.60
Turnips.....	.....	90.50	.80	1.10	.20	6.20	1.20	8.70

1. The analysis of green fodders, roots and tubers given in this table were taken from Bull. No. 11, Office of Experiment Stations, U. S. D. A.

In the average analyses of the cane cacti and prickly pears given in the table above it will be seen as before stated that the cane cacti contain the nutrients in larger quantity. An examination of all the samples in each group as shown in table No. VI reveals the fact that a larger proportion of fruits is included in the average of the cane cacti, and at first sight one might conclude that this would at least account for the larger amount of protein and fat in the cane cacti as shown by the averages. If this were the case a fair comparison of the value of the two groups could not be made in this manner since the seed of the fruits hold these nutrients securely

locked from the reach of cattle at least, and a true comparison would have to be made between an average of the stems alone.

Below is given a table showing the average composition of the stems alone of these two groups as well as an average of the stems of *O. fulgida* and *O. lindheimeri*, and for the purpose of comparison the average of the stems and fruit of each group has also been included.

A study of this table will reveal the fact that the high protein and fat content of the cane cacti is not due to the presence of a larger number of fruits analyzed as compared to the number of fruits of the prickly pears. Neither can it be accounted for very often by the fact that the prickly pear contains the more water, since the nutrients are usually present in larger quantity in the air dry cane cactus.

Table No. V—Showing the comparative average composition of the stems, and stems and fruits, of cane cactus and prickly pear, and the average composition, of the stems of the two typical species of each group

		GREEN MATERIAL.							AIR DRY.						
Name.	Part of plant.	Water.	Ash.	Crude protein.	Crude Fat.	Nitrogen-free-extract.	Fiber.	Organic Matter.	Water.	Ash	Crude protein.	Crude Fat	Nitrogen-free-extract.	Fiber.	Organic Matter.
Prickly Pear..	Stems.....	83.31	3.45	.77	.3	9.85	2.38	13.31	5.93	19.56	4.47	1.74	54.83	13.43	74.45
O. linheimeri..	Stems.....	83.41	3.48	.75	.31	9.41	2.64	13.11	5.89	19.03	4.28	1.80	54.48	14.51	75.07
Cane cactus..	Stems.....	75.91	4.32	1.62	.45	13.45	3.90	19.73	6.24	16.50	6.36	1.74	54 19	14.59	77.13
O. fulgida.....	Stems.....	75.63	3.05	1.04	.37	16.99	2.93	21.33	6.46	11.85	4.15	1.43	65.92	10.19	81.70
Cane cactus..	Stems & fruit.	78.47	3.61	1.41	.63	12.30	3.59	17.93	6.15	15.50	6.09	2.77	54.32	15.17	78.35
Prickly Pear..	Stems & fruit.	84.24	3.03	.73	.34	8.95	2.38	12.5a	5.91	18.05	4.65	2.22	54.23	14.61	75.82

A BALANCED RATION OF PEARS

To determine in just what proportion cactus should be fed with other foods to produce a balanced ration it is necessary to know the amount of digestible nutrients contained in the cactus, as well as those of the food or foods with which it is to be fed. This has been determined for most foods, but unfortunately as yet we have no such data for the cacti. We hope to be able soon to obtain the co-efficient of digestion for *O. lindheimeri.* For the present, all that can be done is to assume this digestibility co-efficient to be the same as that of some food as similar in chemical composition and properties to the cacti as possible. It is somewhat difficult to secure a green fodder very similar in character to cactus, but perhaps we will not miss its digestion co-efficient very far by assuming it to be the same as that of immature green corn fodder. By using the co-efficient for this fodder we find the nutrients in *O. lindheimeri* to be protein .47 per cent., fat .26 per cent., and carbohydrates 7.85 per cent. This being the case, cactus would have a nutritive ratio of 1:18, a ratio which, according to the best authorities, would prohibit its use alone for any feeding-standard. The nutritive ratio for a standard ration varies from 1:4 to 1:12, depending upon the age, character, and kind of animal to be fed, as well as the object of the feeding; that is, whether it is desired to produce work, flesh or milk,

If the object of feeding is to produce milk, a cow giving a heavy yield of milk should, according to the best authorities, be fed about 25 to 30 lbs. of organic matter per day, containing from 1.8 to 2 lbs. of digestible protein, from .4 to .7 lbs. of digestible fat, and 11 to 13 lbs. of digestible carbohydrates, making a nutritive ratio of from about 1:5.5 to 1:7. If a cow requiring a ration of this kind should eat cactus alone, it would take 160 lbs. to furnish the fats and carbohydrates, and an additional 240 lbs. to furnish sufficient protein, and since to avoid "scouring" a cow should probably not be fed to exceed 50 or 60 lbs. of cactus a day, it may be readily seen

how impossible it would be for a milk cow to get even a one-sided ration from cactus alone.

A ration of 40 lbs. of cactus with 10 lbs. of wheat bran and 12 lbs. of corn stover would furnish the nutrients in somewhat near the proper proportion. In a ration of this kind the cow would get 21.16 lbs. of organic matter, containing 1.68 lbs. of protein and 11.82 lbs. of carbohydrates and .49 lbs. of fat, which is in a ratio of 1:7.7.

If a ration is desired in which the cactus is fed with dried brewers' grain and cottonseed meal, it could be made by feeding 60 lbs. of cactus with 14 lbs. of brewers' grain and 1 lb. of cottonseed meal. In this case 20.58 lbs. of organic matter is fed, containing 2.85 lbs. of protein, 10.38 lbs. of carbohydrates, and 1 lb. of fat. This ration would contain the nutrients in the ratio of 1:4.5. If this ration is considered too narrow, it could be widened to good advantage by feeding with it a small amount of coarse, dry fodder, rather than by increasing the amount of cactus.

A balanced ration of cotton seed meal and cactus cannot be prepared, for if the meal be fed in just sufficient quantity to furnish the proteids, it would necessitate the feeding of too much cactus to supply the balance of the carbohydrates. From this it must not be inferred that a mixture of these foods would not make a desirable ration, in fact current successful practice has demonstrated that they will. For example, a ration of prickly pear and cotton seed meal were fed to steers for 105 days, in a recent experiment conducted by the Bureau of Plant Industry at Encinal, Texas, with a gain of $1\frac{3}{4}$ lbs. of flesh per day at a cost of only $3\frac{1}{3}$ cents. However, any ration of these two foods that would secure this gain per day would contain an excess of the proteids over an amount necessary for a balanced ration. Fortunately, however, an excess of proteids can be utilized in serving the functions of the carbohydrates in the animal body, and this no doubt is what took place in the above experiment. Usually proteids are the most expensive foods for man and beast, and it is poor economy to substitute them for carbohydrates, yet

such a condition is not uncommon in Texas cattle feeding where cotton seed meal is cheaper than other more starchy foods.

POPULAR NAMES

Some popular names are here used which are rarely, if ever, found in the literature of any language and, therefore, may be strange to the American reader. Special attention has been given to this feature and it is believed that we have been successful in securing these names for which there is a large use. We wish to emphasize that the popular names here given belong to the localities where the particular sample with which they are associated was collected. Some of these plants may have different names in other localities. A complete discussion of this topic, however, requires the employment of a larger list of Mexican species than is here used and we therefore put off further treatment of it for another publicatiou now in course of preparation. These names will assist in the identification of our material and also be of scientific assistance to the student of prickly pears.

SCIENTIFIC NAMES

In a group of plants wherein variations are so extreme, proposed names so numerous, scientific evidence of the bases of authors' conceptions of specific distinctions so rare and fragmentary and characterizations so difficult of expression, it is not surprising that there are forms and species to which we hesitate to apply names. Our intention throughout has been to represent our exact conceptions together with notes upon such data as was at hand. Wherever there is a question in our minds about the determinations the same is clearly indicated. Concerning the Engelman species, which are very largely United States forms, we have no hesitancy in pronouncing our determinations correct, except in a few cases where doubt is expressed.

Inasmuch as many of the forms are poorly described a

rather full set of notes accompanies each of our species. These, which are entirely compiled from field records made beside the plants while the specimens were being collected, elaborated and perfected by subsequent observations, are not presented as full technical descriptions but simply as notes or partial descriptions which will be of assistance in the identification of our material. Nearly every number analyzed is represented in collections by one or more specimens secured at the same time or a year later from the same identical locality. Accompanying these are many photographs of the same plants which, together with our field notes and living specimens in conservatories or one or more of the five plantations maintained by the U. S. Department of Agriculture will render the identification of our material in the future comparatively simple. A special effort has been made somewhere in connection with the discussion of every species to refer to a published illustration where such was available and where the illustration was of such a nature as to leave no doubt regarding its identity with the specimen under discussion. We believe that it is by the liberal use of illustrations that order can be brought out of the chaos which exists in this genus. There is no one who can take isolated herbarium specimens in this group and correctly refer them to their proper species, and it is very doubtful whether any one will ever be able to do so because characters do not preserve perfectly in this genus, and there is a lack of constancy anyway which makes it imperative for one to have in mind a large number of characters of nearly every species. These conceptions often must be assisted by geographical distribution in order to enable one to arrive at conclusions. One of the greatest difficulties in the way of properly correlating literature with the species as they occur is due to the lack of proper designation of origin of specimens described, and this practice has not yet closed. Were the origin of materials known, the correlation of the literature with the plants would not be so entirely hopeless.

CLIMATIC REQUIREMENTS OF PRICKLY PEARS

Prickly pear and other cacti are apparently inseparably connected in the public mind with drouth and heat but this conception of the requirements for their best development is far from perfect. Our driest deserts produce none of these plants in economic quantities and the same is true of our hottest regions. Rather than say they are adapted to conditions of extreme heat and drouth, we would say that they thrive best in a region which has an equitable temperature and aconsiderable rainfall periodically distributed. There is certainly no region in the world where these plants grow naturally in such profusion as they do upon the plateau of Mexico, but this is not a hot country, neither is it excessively dry. It is very dry during a large part of the year. It is a desert as compared with eastern Texas, for instance, but it has a considerable rainfall during an average year. This falls mostly in the summer and then the country looks like anything but a desert. The average rainfall at Zacatecas for the past ten years, we are informed by Mr. Albert L. de Lautreppe, who has made a special study of the weather records of the City in connection with a business venture, is 31½ inches but the average for the seasons January to April and October to December is only ⅝ to 2⅛ inches, while the average for the other months of the year is 3½ to 7⅛ inches a month. June, July and August are the rainy months, which have had an average rainfall of 4¼ to 7⅛ inches each for the past ten years.

While many species appear to be able to withstand high temperatures, they develop naturally in the greatest profusion where the heat is not excessive. The plateau of Mexico is a region with a comparatively equitable climate. Some species thrive under extremes of heat. *O. lindheimeri* is at home in the lower Rio Grande Valley of Texas and Chihuahua and the closely related *O. engelmanni* and *O. engelmanni cycloides* thrive in shouthern Arizona where the mercury often reaches 44° C. On the other hand, there are species which grow

where the winter temperatures go at least to-40° C. but the plants are small and of no economic account in themselves except as they may be used to engraft hardy characters upon more valuable species. The valuable species of the Mexican highlands thrive where the temperature gets down to-10° C. in very rare instances. Usually the freezing point is seldom reached here. During the past winter (1905-6) the mercury dropped at the City of Zacatecas to -10° C. and many of the more delicate spineless forms as well as some of the native species were badly injured. No pear was killed outright but the branches were frozen down for four or more joints. These rotted and dropped off but the old trunks survived. *Opuntia lindheimeri*, the common species of southern Texas, has been injured very severely within the memory of the present generation. It suffered some injury during the winter of 1904-5. In the vicinity of San Antonio many of the plants drooped badly after the coldest weather which registered a temperature of -11° C. The majority of the plants straightened up again but in many the distal joints dropped off as the result of freezing.

THE USE OF PRICKLY PEAR IN MEXICO

In Mexico the use of the prickly pear is much more varied than in this country. There the established plantations are guarded from animal depredations by either rude fences or hedges of some of the tall columnar species of Cereus or the more spiny opuntias are planted thickly in borders around the more nearly spineless ones which stock eat readily.

All of the species are fed to stcok indiscriminately. Whatever is available and can be spared is singed and fed to cattle. So far as we have observed, the Durasnillo is preferred to all others. This is due to some extent to its small fiber content but more especially to its abundant delicate spines which are singed off more readily than those of other species, although they may be fewer in number.

However, the extent of cattle feeding upon this kind of food

is not so great in Mexico as one would suppose from the abundance of the material and the great extent of time during which the practice has been in vogue. The fact is that the average peon cannot afford to feed to stock what he himself can use so profitably in other ways. The prickly pear is to the peon primarily an article of human food and its place cannot be taken by any other plant.

The fruit as well as the young joints are eaten by man in Mexico and the dried stems and joints are used for fuel. Of course, the fuel which it makes is exceedingly poor but it serves the purpose in that land where this commodity is exceedingly scarce. The feeding of cacti to stock, therefore, is a secondary consideration. The limbs which break off and such other portions of the orchad material as can be spared without seriously jeopardizing the tuna crop, together with such wild forms as are available, are fed to cattle. On some of the large haciendas, especially those devoted largely to maguay culture, the feeding of pear to work oxen during the grassless season is a regular practice but then only wild forms are used. Over a large part of the Republic, therefore, although a large use is made of them for forage, their principal use is as an article of human food, which feature will be treated of in a future publication.

THE SPECIES AND THEIR ANALYSIS

Prickly Pears *(Platopuntia.)*

Nos. 6329, 6330, 6542, 7571 and 7572.

PRICKLY PEAR. NOPAL.

Opuntia Lindheimeri Engelm. *Boston Jour. Nat. Hist. 6: 207. 1850.*

An enect or sometimes ascending plant, 3 to 5 feet high, growing in isolated individuals or forming impenetrable thickets; joints mostly obovate but very variable, commonly 5-8 in. x 7-9 in., smooth, yellowish green to glaucous; areoles circular to obovate, ⅛ to ½ in. in greatest diameter but increasing in size with age, about 1 in. apart; wool tawny, black where exposed; spicules yellow to grayish-white, prominent, ½ in. long or sometimes inconspicuous; spines yellow, translucent, faintly anulate, flattened and often a little twisted, erect. divergent or lower often somewhat recurved, 1 to 6 but usually 3 or 4 in number, ¼ to 2¼ in. long but commonly about 1 in.; flowers yellow with greenish style and filaments and bright, deep green, 8-parted stigma, with long cylindrical segments; fruits pyriform, about 1⅝x2½ in., purple throughout, with small, subcircular to triangular areoles about ½ in. apart.

This description applies to the form from which samples were taken and is not intended to cover the many variations of the species as recognized by recent authors.[1] These specimens represent our conception of the typical form of the species. Photographic reproductions will be found in Bull. 74 Pl. 1, f. 2, Pl. 2, f. 1 and Pl. 4, f. 2, Bureau of Plant Industry U. S. D. A.

No. 6329 collected at Eagle Pass, Texas, May 10, 1904, sample consisting of five terminal joints and three partially developed fruits, from 4 plants.

No. 6330 collected at same time and place and from same plants as No. 6329, sample consisting of a small section 3 in. long, cut from old stems near the ground.

No. 6542 collected at Pearsall, Texas, June 15, 1904, sample consisting of fruits from 11 plants. These are the first fruits to mature this season.

1. See Bulletin 91, Bureau of Animal Industry, U. S. D. A.

PLATE II.—NOPAL CUIJO.

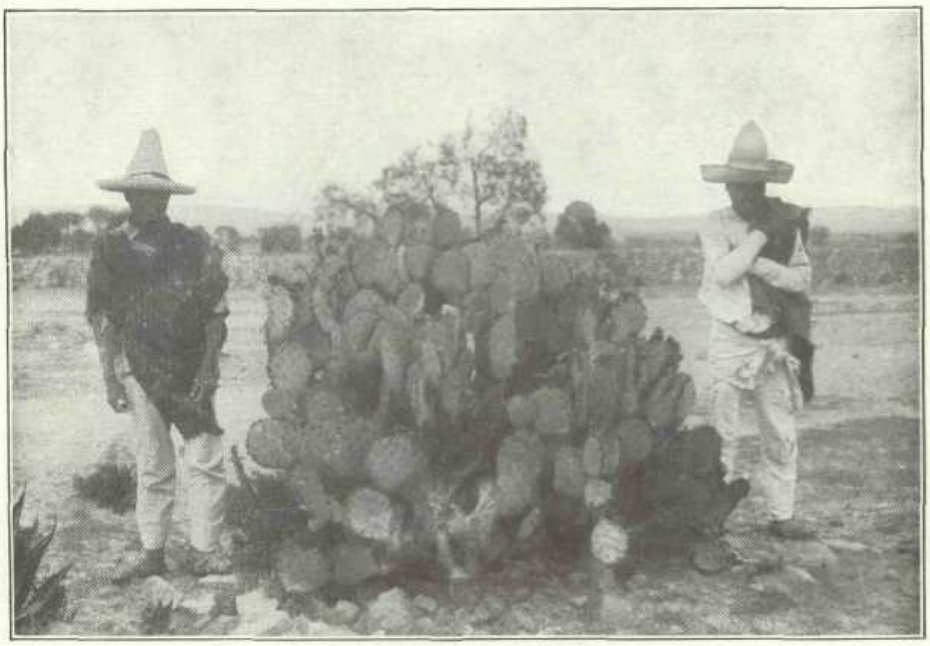


Fig. 1. A medium sized plant growing near San Luis Potosi, Mexico.

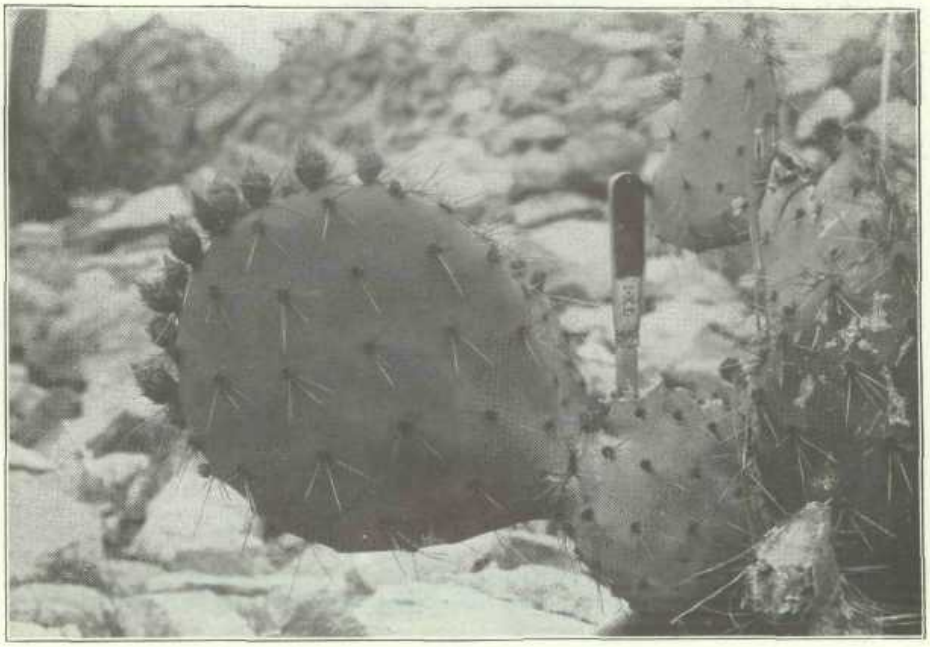


Fig. 2. Joint of the same plant in bud.

PLATE III.—TWO GENERA OF PRICKLY PEAR.

Fig. 1, Nopalea Sp.

Fig. 2. (*Opuntia occidentalis*) Engelm. and Bigel.

PLATE IV.—NOPAL DURASNILLO (*Opuntia leuotricha*) P. D. C.

Fig. 1. Nopal durasnillo blanco.

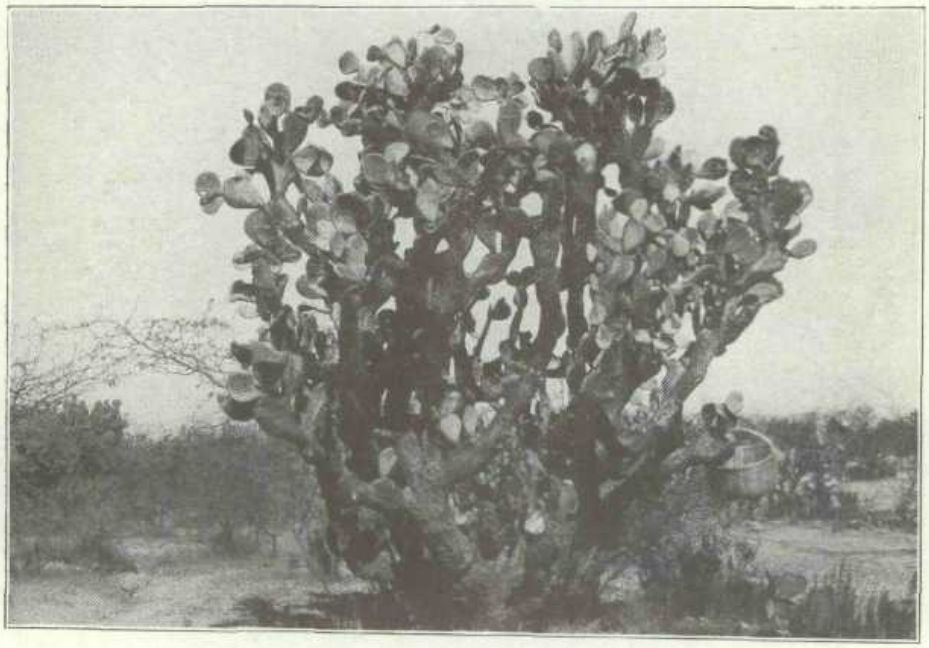


Fig. 2. Nopal durasnillo colorado.

PLATE V.

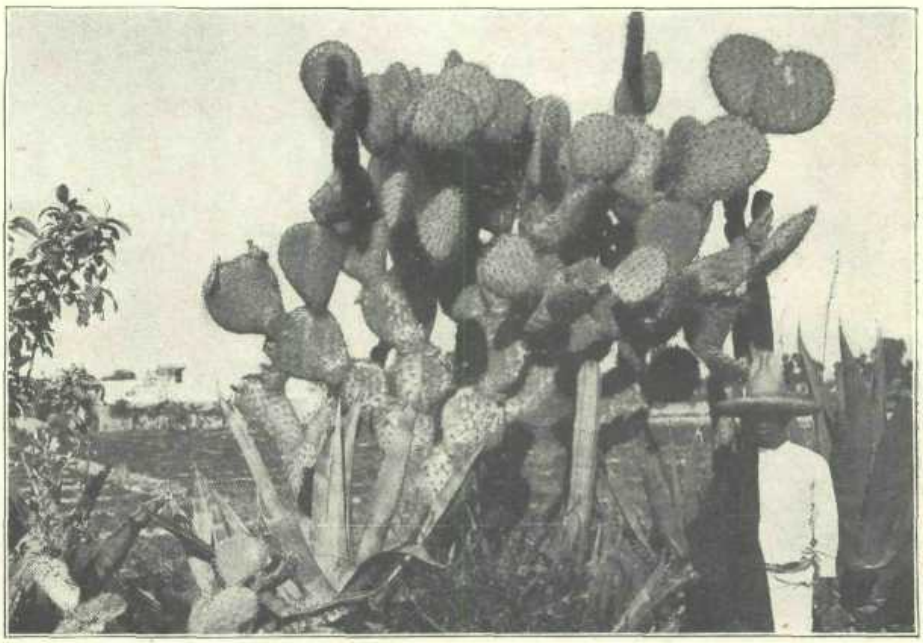


Fig. 1. Nopal Tapon (*Opuntia robusta* Wendl). A very robust plant, compare Bulletin 74, Plate V, Fig. 1, B. P. I., U. S Department of Agriculture. Soledad, Mexico.

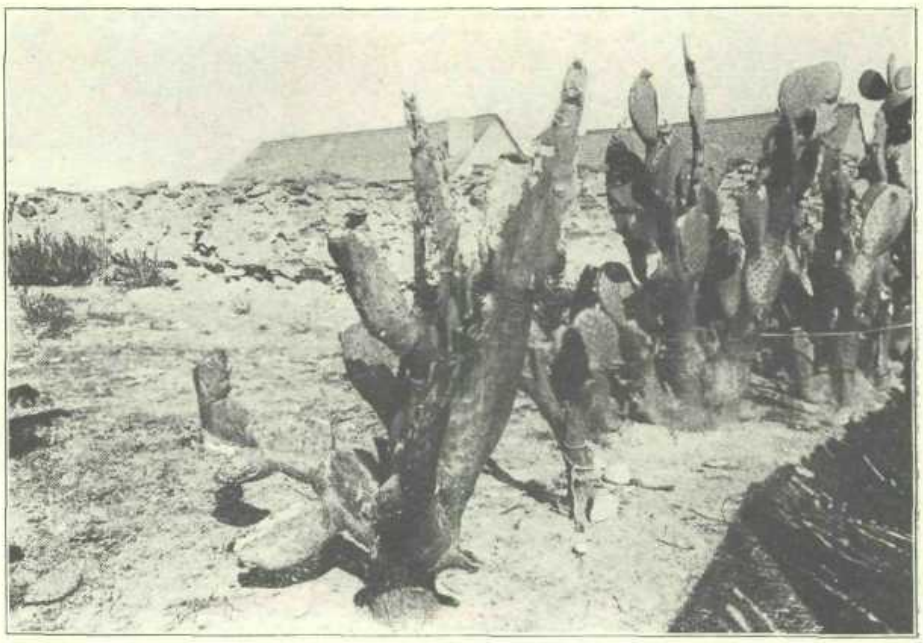


Fig. 2. Nopal de Castilla (No. 7519), as grazed by cattle. Laredo, Tex.

No. 7571 collected at Encinal, Texas, Febuary 26, 1905, sample consisting of 4 terminal joints from 3 plants.

No. 7572 collected at same time and from same plants as No. 7571, sample represented by formula 0-0-0-0-1-1-1.

Chemical Analyses

	Green.					Air Dry.				
Sample No.	63.29	63.30	65.42[1]	75.71	75.72	63.29	63.30	65.42[1]	75.71	75.72
Spines	.76	58	.....	.....	.....	3.73	2.51	.....	.....	.....
Water	80.72	77.95	92.19	88.64	84.49	5.33	5.14	4.85	7.03	6.35
Ash	4.44	5.81	1.09	1.64	2.42	21.78	25.00	13.23	13.40	14.60
Crude Protein	1.38	.92	.65	.55	.36	6.79	3.94	7.88	4.49	2.19
Crude Fat	.42	.41	.49	.29	.27	2.08	1.78	5.95	2.40	1.65
Nitrogen Free Extract	10.87	11.58	2.85	7.72	8.80	53.37	49.81	34.89	63.15	53.18
Crude Fiber	2.17	3.33	2.73	1.16	3.65	10.65	14.33	33.20	9.53	22.03
Organic Matter	14.84	16.24	6.72	9.72	13.08	72.89	69.86	81.92	79.57	79.05

[1] Fruit.

Nos. 7515, 7516 and 7567.

PRICKLY PEAR. NOPAL, NOPAL AZUL, BLUE PEAR

OPUNTIA LINDHEIMERI *Engelm. Boston Jour. Nat. Hist. 6:207. 1850.*

This is a brown-spined form and differs from the typical species in having fewer spines and darker colored orange instead of yellow flowers. The joints are also on an average a somewhat darker glaucous green. Modern botanical practice scarcely admits this into the same species as the previous one, although it has commonly been placed there in the past.

No. 7515 collected at Encinal, Texas, January 17, 1905, sample represented by formula 2-1-1, from three plants.

No. 7516 collected at same time and place and from same plants as No. 7515, sample consisting of 3 pieces from old stems near the ground.

No. 7567 collected at San Antonio, Texas, February 23, 1905, sample represented by formula 1-1-0-1, from 3 plants.

Chemical Analyses

	GREEN			AIR DRY		
Sample No.	7515	7516	7567	7515	7516	7567
Spines	.10		.42	.72		2.60
Water	87.36	79.88	84.82	5.65	5.20	6.55
Ash	2.82	4.98	2.27	21.05	23.45	13.95
Crude Protein	.60	.45	.96	4.49	2.12	5.92
Crude Fat	.26	.20	.30	1.95	.95	1.82
Nitrogen Free Extract	7.54	9.55	9.84	56.26	44.98	60.61
Crude Fiber	1.42	4 94	1.81	10.60	23.30	11.15
Organic Matter	9.82	15.14	12.91	73.30	71.35	79.50

Analyses of the Ash

Sample No.	Carbon, per cent.	Sand, per cent.	PER CENT. IN PURE ASH											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calicum (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicule (SO_4)	Chlorine (Cl)	Carbonic Acid radicule (CO_3)
7515	.14	.29	.43	.20	0.00	.49	26.71	2.27	14.22	.35	1.11	1.15	2.15	49.12

Nos. 6243, 7011 and 7787.

PRICKLY PEAR. NOPAL

OPUNTIA ENGELMANNI *Salm. Bost. Jour. Nat. Hist. 6:207. 1850.*

A suberect plant about 3 feet high, growing in dense thickets or in isolate dindividuals 3 to 5 feet in diameter; joints obovate in proportion of 5 to 8 in., which is a common size, rather light yellow, glossy green but glaucous until after the first winter, usually scurfy brown in age; leaves subulate, mucronate, $\frac{3}{8}$ x 3-32 in., areoles subcircular, prominent, $\frac{1}{8}$ in. in diam., but increasing in size with age; wool gray but dirty brown where exposed; spicules often yellow and brown on

same plant but mostly yellow, $\frac{1}{8}$ in. long on sides of joints but often becoming $\frac{1}{2}$ to 1 in. long on edges and increasing wonderfully with age, in many cases becoming a solid spreading mass filling a $\frac{1}{4}$ in. areole; spines very variable, yellow to white but always with translucent yellowish tips, 1 to 3 or 4, slanting downward or erect spreading, very variable, $\frac{1}{2}$ to $1\frac{1}{4}$ in. in length; flowers yellow with style and filaments greenish-white and stigma bright dark green; fruits obovote, $1\frac{1}{2}$ to $1\frac{3}{4}$ x $2\frac{1}{2}$ to $2\frac{3}{4}$ in., beset with prominent subcircular to triangular areoles about $\frac{1}{2}$ in. apart, bearing formidable yellow spicules, light reddish-purple without but rind and pulp greenish and brittle when mature.

This differs very much in general appearance from the typical form of *Opuntia lindheimeri*, with which it has been commonly placed by recent botanists, but the difference is one of general appearance mostly. This is a smaller and more spiny plant throughout. The most important distinction is in the fruit but *O. lindheimeri* also has fruits with greenish pulp and rind.[1]

No. 6243 collected in Santa Rita Mountains, Arizona, April 30, 1904, sample represented by formula 3-3-2, from 3 plants.

No. 7011 collected from same plants as No. 6243, August 30, 1904, sample consisting of fruits from 10 plants.

No. 7787 collected from the same group of plants as previous numbers April 19, 1905, sample represented by formula 1-2-1, from 3 plants.

1. See Bulletin 91, Bureau of Animal Industry, U. S. D. A.

Chemical Analyses.

	Green.			Air Dry.		
Sample No.	6243	7011[1]	7787	6243	7011[1]	7787
Spines	.....	.....	.26	.....	.....	1.94
Water	79.05	85.70	87.36	5.93	2.35	6.12
Ash	3.56	1.00	1.83	16.00	6.80	13.63
Crude Protein	1.10	.67	.59	4.92	4.60	4.42
Crude Fat	.36	.84	.21	1.60	5.73	1.59
Nitrogen Free Extract	13.81	7.91	8.32	62.05	54.02	61.66
Crude Fiber	2.12	3.88	1.69	9.50	26.50	12.58
Organic Matter	17.39	13.30	10.81	78.07	90.85	80.25

1 Fruit.

Nos. 6240 and 7774.

PRICKLY PEAR. NOPAL

Opuntia Engelmannii Salm. *Boston Jour. Nat. Hist. 6: 208, 1850.*

A large, erect or ascending plant 3 to 5 feet high; joints obovate to subcircular, large in proportion of 6 to 6½ x 10 in., which is a common size, usually more or less glaucous, with a waxy covering; areoles obovate-triangular, prominent, large ¼ x 3-16 in., increasing in size with age and becoming very prominent upon old stems; wool very prominent; brownish on surface but white beneath; spicules brown, prominent, mixed with the wool but more prominent on edges of areole, often ½ in. long on edges of joints; spines yellowish white, with often a tinge of red at base, ¾ to 1 in. long, strong flattened, 1 to 4 or 5, increasing slightly with age, erect, divergent, or often descending; petals yellow, stigma deep dark green, style and filaments greenish white; fruit obovate, 1¾ to 2¾ in., flat or depressed at apex, with light red epidermis and greenish pulp and pericarp.

The rind of this species agrees with previous one in color but differs from it in texture. When fully ripened it is brittle and appears to differ but little in either flavor or texture from the pulp, from which it is easily separable. In this respect it resembles more closely than any other species some of the various forms of what passes for *O. phaeacantha*, but it will be seen from the descriptions that it is very different from that species. It is quite probable that these numbers and the previous ones are the same species but that the differences are simply varietal. These are are from a cañon at the base of the mountains while the previous numbers are from a cañon about five miles below in the lower foothills. These are much more robust plants.

No. 6240 collected in Santa Rita Mountains, Arizona, April 29, 1904, sample represented by formula 1-2-1, from 2 plants.

No. 7774 collected from the same plants April 18, 1905, sample represented by formula 1-1-0-1, from 3 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	6240	7774	6240	7774
Spines	.....	.07	.....	.45
Water	72.60	86.19	4.13	5.43
Ash	6.94	2.90	24.30	19.83
Crude Protein	.84	.63	2.95	4.34
Crude Fat	.41	.19	1.43	1.28
Nitrogen Free Extract	15.37	8.66	53.77	59 33
Crude Fiber	3.84	1.43	13.42	9.79
Organic Matter	20.46	10.91	71.57	74.74

Analyses of the Ash

Sample No.	Per cent. Carbon	Per cent. Sand	Per Cent. Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
7774	.25	.28	1.41	.20	.12	.51	27.39	6.20	8.0	.19	1.35	1.13	.68	47.96

Nos. 6692 and 7890.

PRICKLY PEAR. NOPAL

Opuntia Fngelmannii (?) Salm. *Bost. Jour. Hist. 6: 207. 1850.*

These specimens correspond quite closely with the typical form of *Opuntia engelmannii* and are one of the forms included under *O. lindheimeri Engelm.* by recent monographers (Coulter and Schumann). Small thickets are formed by it here upon gentle slopes comparatively free from rocks. It shows a slight tendency to have areoles which develope like *O, chlorotica,* although to a much less degree.

No. 6692 collected at Hackberry, Arizona, July 25, 1904, sample represented by formula 2-1-1-1, from 4 plants.

No. 7890 collected in same locality May 9, 1905, sample represented by formula ½-2-2-½, from 4 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	66.92	78.90	66.92	78.90
Spines	.35	.15	1.70	.99
Water	81.65	85.75	9.85	6.45
Ash	4.25	3.27	20.90	21.53
Crude Protein	.89	.4b	4.37	2.96
Crude Fat	.32	.39	1.55	2.53
Nitrogen Free Extract	10.84	8.34	53.26	54.73
Crude Fiber	2.05	1.80	10.07	11.80
Organic Matter	14.10	10.98	69.25	72.02

Nos. 6247 and 7790 D. G and 3002, 3073a and 3073b E. O. W.

PRICKLY PEAR. NOPAL

OPUNTIA ENGELMANII CYCLOIDES (?) *Engelm. and Bigel. Pacific. Ry. Rep. 4: 37. Pl. 8, f. l. 1856.*

Plant 3 to 5 feet high, erect, large and stout; joints suborbicular, commonly 10x11 in., glaucous, thick; leaves nearly ½ in. long and ⅛ in. wide, subulate, cuspidate, upon conspicuous tubercles which disappear with growth of joint; areoles 1 to 1¼ in. apart, large and prominent, oval to circular, ¼ to ⅜ in. in longest diam. with a bunch of dirty brown wool projecting 1-16 to ⅛ in. above surface of joint; spicules yellow, inconspicuous, except upon margin of joints, where they are unequal, ⅛ to ⅜ in. long; spines white with a pinkish blush at base and bone-like, translucent tips, stout, erect, divergent, strongly flattened, 1 to 6 in number, commonly 1 in. or less in length; flowers yellow with orange at base of petals and bright green, 8-parted stigma; fruit obovate, about 1¼x2 in. reddish purple throughout, with prominent. circular areoles about ¾ in. apart.

It will be seen that our description of the fruit varies somewhat from that of Dr. Engelmann[1]. The only fruit we have seen from our plants is a few developed in the U. S.

1. Pacific Railway Report 4: 37. Pl. 8, f. l. 1856.

Department of Agriculture greenhouse the first year from cuttings. The habit of the plant is fairly well shown in Bull. 67, *Pl. 6, f. 1*, Bureau of Plant Industry, U. S. D. A.

No. 6247 collected in northern foothills of Santa Rita Mountains, Arizona, May 2, 1904, sample represented by formula 2-2-1, from 3 plants.

No. 7790 collected from same plants April 20, 1905, sample represented by formula 1-1-1.

No. 3002 E. O. W. collected east of Hillsboro, New Mexico, July 12, 1904, sample consisting of joints.

No. 3073a E. O. W. collected in Organ Mountains, New Mexico, January 31, 1905, sample consisting of last year's joints.

No. 3073b E. O. W. collected at same time and from same plants as 3073a, sample consisting of joints and one year older than 3073a.

Chemical Analyses

	Green.					Air Dry.				
Sample No	6247	7790	3002	3073a	3073b	6247	7790	3002	3073a	3073b
Spines	.....	.34	2.17	.55	.27	.....	1.59	.....	1.64	1.27
Water	81.94	79.69	66.67	68.02	79.34	4.15	5.46	3.65	5.63	5.46
Ash	3.82	4.48	8.29	3.67	3.08	20.28	20.85	23.30	10.85	14.10
Crude Protein	.37	.64	1.21	2.41	.98	1.97	2.96	3.39	7.12	4.49
Crude Fat	.22	.33	.69	.26	.27	1.15	1.54	1.95	.76	1.22
Nitrogen Free Extract	7.74	11.93	19.25	22.03	15.46	41.10	55.52	54.08	65.01	61.58
Crude Fiber	5.91	2.93	3.89	3.60	2.87	31.35	13.67	10.93	10.63	13.15
Organic Matter	14.24	15.83	25.04	28.30	17 58	75.57	73.69	70.35	83.52	80.44

Analyses of the Ash

Sample No.	Per Cent. Carbon	Per Cent. Sand	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phorphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
7790	.59	.73	1.25	.15	.15	.77	33.90	3.00	4.28	.13	.61	.97	.43	53.82
3002	.81	.60	.84	.25	.27	.26	26.10	6.08	12.71	.22	1.37	.80	.30	44.74

Nos. 6248 and 7791.

PRICKLY PEAR. NOPAL

Opuntia Engelmannii Cycloides *Engelm. and Bigel. Pacif. Ry. Rep. 4: 37. Pl. 8. f. 1. 1856.*

The general aspect of these plants is somewhat different from that of the previous numbers. The main difference is in the spines, which are often 2½ in. long, decidedly red at the base and quite decidedly recurved. The spicules are, as a rule, more abundantly developed and the joints average smaller and are more inclined to be obovate. We consider these numbers to be typical of the variety but the shape of the joints often does not correspond with the published descriptions although in general they do. The majority of our specimens agree perfectly with the type[1] in the Engelmann herbarium.

No. 6248 collected in Santa Rita Mountains, Arizona, May 2, 1904, growing with No. 6247, sample represented by formula 2-1½-1, from 3 plants.

No. 7791 collected from same plants, April 20, 1905, sample represented by formula 1-1-1, from 3 plants.

1. Bigelow of 1853 in Herb. Mo. Bot. Gard.

Chemical Analyses

	Green		Air Dry.	
Sample No	62.48	77.91	62.48	77.91
Spines	.....	.49	.....	2.44
Water	72.65	81.00	5.80	5.78
Ash	5.96	4.32	20.55	21.43
Crude Protein	.79	.62	2.73	3.07
Crude Fat	.41	.36	1.43	1.80
Nitrogen Free Extract	16.79	11.54	57.75	57.21
Crude Fiber	3.40	2.16	11.74	10.71
Organic Matter	21.39	14.68	73.65	72.79

Analyses of the Ash

Sample No.	Per Cent. Carbon	Per Cent. Sand	Per Cent in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric acid radicle (PO_4)	Sulphuric acid radicle (SO_4)	Chlorine (Cl)	Carbonic acid radicle (CO_3)
77.91	.45	.95	1.29	.15	.26	.19	32.76	3.43	5.38	.23	.52	.85	.62	53.86

Nos. 6564 and 7854.

PRICKLY PEAR. NOPAL.

OPUNTIA OCCIDENTALIS *Engelm. and Bigel. Pacif. Ry. Rep 4: 38. Pl. 7, f. 1-2. 1856.*

An erect, open branching species, 4 to 8 feet high, commonly in thickets upon southern exposures, but also growing in scattering individuals; joints ovate, pointed to obovate or subcircular, yellowish-green; areoles subcircular or obovate-triangular, large and prominent, about 1 to 1½ in. apart; spicules yellow, very unequal and formidable, varying in length from ⅛ to 1-16 in. in same areole; spines yellow, translucent, often with reddish-brown bases when young, flattened, twisted, erect-divergent or lower recurved, 3 to 7,

about 1 in. long; flowers orange, red where exposed in bud, with filaments orange, style reddish with deep, bright green, 8-parted stigma; fruit obovate, pyriform, purplish-red throughout.

Of late this species has been referred quite constantly to *O. Lindheimeri* but we consider it wiser to retain the original name as given above until the different forms which have been heretofore placed under *O. Lindheimeri* have been brought together under cultivation so that there may be a basis for comparison, which we now have not. This is certainly distinct from *O. Lindheimeri.*

No. 6564 collected at San Diego, Cal., June 30, 1904, sample represented by formula 1-1-1-1, from 3 plants.

No 7854 collected in same locality May 4, 1905, sample represented by formula $\frac{1}{2}$-2-2-$\frac{1}{2}$, from 4 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No	6564	7854	6564	7854
Spines	.34	.48	3.25	4.11
Water	89.57	89.05	7.38	7.48
Ash	1.96	1.10	18.80	9.35
Crude Protein	.35	.47	3.39	4.01
Crude Fat	.15	.19	1.48	1.60
Nitrogen Free Extract	5.84	7.89	55.97	66.66
Crude Fiber	1.36	1.30	12.98	10.90
Organic Matter	7.70	9.85	73.82	83.17

Nos. 6567 and 7863.

PRICKLY PEAR. NOPAL.

Opuntia Occidentalis *Engelm. and Bigel. Pacific Ry. Rep. 4: 38. Pl. 7, f. 1-2. 1856.*

The previous numbers we consider typical of the plant described by Dr. Engelmann under this name, indeed some of our specimens could easily be sustituted for the type. This one differs very little in any essential particular but it is very peculiar in one respect. Both this and the previous

number are very spiny, as a rule, but often one-half of the joints in this form may be smooth or with only a few of the areoles at apex bearing spines. The areoles on these joints are reduced in size and both spicules and spines may be entirely absent. There is also apparently a stronger tendency for the young spines to be red at the base and to turn chalky earlier than in the other form. The joints also average longer and narrower in these specimens than in the previous numbers. (See *Pl. III. f. 2.*)

No. 6567 collected at San Diego, Cal., July 1, 1904, sample represented by formula 3-2-1-1-1, from 4 plants.

No. 7863 collected in same locality May 4, 1905, sample represented by formula $\frac{1}{2}$-1$\frac{1}{2}$-1$\frac{1}{2}$, from 4 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No	6567	7863	6567	7863
Spines	.62	.35	1.89	2.99
Water	70.19	89.05	8.60	6.63
Ash	5.82	1.45	17.85	12.49
Crude Protein	1.07	.45	3.29	3.83
Crude Fat	.49	.17	1.50	1.45
Nitrogen Free Extract	16.43	6.44	50.36	54.80
Crude Fiber	6.00	2.44	18.40	20.80
Organic Matter	23.99	9.50	73.55	80.88

No. 7429 D. G. and 3032 E. O. W.

Opuntia laevis (?) *Coulter Contr. U. S. Nat. Herb. 3: 419. 1896.*

This is a variety commonly cultivated in the vicinity of Las Cruces, New Mexico, and has been reported to us to have been brought from Chihuahua. In many respects it resembles *Opuntia laevis Coulter.* The locality from which it is reported to have been introduced, the comparatively few spines, the deep purple fruit and the general aspect of the

plant, as we know it from both field and herbarium specimens, suggest Coulter's species very strongly.

No. 7429 D. G. collected from cultivated plants at Las Cruces, New Mexico, October 11, 1904, sample represented by formula 1-2-1, from 2 plants.

No. 3032 E. O. W. collected from cultivated specimens at Mesilla Park, New Mexico, September 12, 1904.

Chemical Analyses

	Green		Air Dry	
Sample No	7429	3032	7429	3032
Spines	.80	.14	7.87	2.10
Water	90.11	93.80	2.80	8.45
Ash	2.66	1.62	26.18	23.60
Crude Protein	.62	.32	6.13	4.71
Crude Fat	.19	.12	1.88	1.85
Nitrogen Free Extract	5.23	3.37	51.26	50.19
Crude Fiber	1.19	.77	11.75	11.20
Organic Matter	7.23	4.58	71.02	67.95

Analysee of the Ash

Sample No.	Per cent. carbon	Per cent. sand	PER CENT. IN PURE ASH											
			Soluble Silicia (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
3032	1.12	7.00	4.06	.55	.46	.19	21.40	9.26	9.44	.44	2.07	1.24	1.13	43.76

Nos. 6534, 6535 and 7596

NOPAL CUIJO

OPUNTIA ENGELMANNI CUIJA *n. var.*

An erect, rather closely branched, compact plant, 4 to 5 feet high; joints obovate, ovate, or quite abruptly contracted

below, yellowish-green, commonly 5½x6½ in. and ¾ to 7-8 in. thick, but often as large as 7x10 in.; areoles subcircular, prominent, ⅛ to ¼ in. in diam. and projecting 1-16 to ⅛ in. above surface of joint, dark brown to black and weathering to gray, 1¼ to 1¾ in. apart; spicules yellow, more or less surrounding the entire areole and often scattered through it, conspicuous, about ⅛ in. long on sides of joints but often 1 in. long on the edges; spines yellow but often red at base, flattened but seldom twisted, very indistinctly annular, 1 to 1¾ in. long, 3 to 8, but mostly 4 to 6, erect-spreading; flowers yellow, with whitish or greenish filaments and style, and a deep bright green, 8 to 10-parted stigma; fruit pyriform, about 1¼ x 1¾ in., deep purple throughout, almost black when fully matured.

In habit this species corresponds very well with *O. lindheimeri* Engelm. but in general appearance, especially in areoles and color of joints, if differs very much from the typical form of the New Braunfels, Texas region. However, it may be possible that this represents the southern extension of this typically Rio Grande valley species. (See Pl. IV). Number 7636, San Luie Potosi, Mexico, is the botanical type of this species.

No. 6534 collected at San Luis Potosi, Mexico, June 12, 1904, sample consisting of many mature fruits from 9 plants.

No. 6535 collected at same time and place, sample represented by formula 3-2-1, from 4 plants.

No. 7596 collected at San Luis Potosi, Mexico, March 13, 1905, sample represented by formula 1-1-1-2, from 3 plants.

Chemical Analyses

	Green			Air Dry.		
Sample No.	6534[1]	6535	7596	6534[1]	6535	7596
Spines	.....	.82	.38	.....	4.40	2.94
Water	86.00	82.67	97.76	3.28	7.40	5.08
Ash	1.20	3.80	1.94	8.28	20.30	15.00
Crude Protein	1.12	1.31	.45	7.77	7.01	3.50
Crude Fat	1.29	.40	.23	8.90	2.13	1.75
Nitrogen Free Extract	5.73	8.65	8.48	39.59	46.21	65.82
Crude Fiber	4.66	3.17	1.14	32.18	16.95	8.85
Organic Matter	12.80	13.53	10.30	88.44	72.30	79.92

1. Fruit.

Analyses of the Ash

Sample No.	Per Cent. Carbon	Per Cent. Sand	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
65.35	.49	8.27	2.30	.93	.56	.35	23.19	4.91	13.20	.54	1.13	2.10	2.30	40.13

Nos. 6573 and 7876.

OPUNTIA

Plant ascending, erect, divaricately branched, 2 to 4 feet high, and forming thickets upon steep hillsides; joints obovate, 4 x 6 in. to 5 x 7 in., either bright or glaucous green; leaves about 1-16 x $\frac{3}{8}$ in., subulate, pointed; areoles $\frac{3}{4}$ to 1 in. apart, ovate, obovate or subcircular, increasing in size with age; spicules yelow, $\frac{1}{8}$ in. long, increasing with age to fill entire areole; spines reddish-brown at base and yellow toward tip, turning chalky to dirty black, often chalky throughout, with scarcely a tinge of red, 1 to 5 or 6, usua y 3 or 4, erect-divergent, the longest $\frac{3}{4}$ to 1 in. long, flattened; flowers a light magenta, resembling very closely the well known color of *O. bascilaris* with style and filaments pink and 8 to 9-parted, yellowish-green stigma; mature fruit not seen.

It will be seen from the description that this differs in several particulars from the coastal forms of California, with which it has commonly been associated. It differs from No. 6567 (*Opuntia occidentalis* Engelm. and Bigel.) in spine, habit and joint characters but more especially in color of flowers. It differs from *O. litteralis* of the coast, which we consider distinct from *O. occidentalis*, in being erect and having smaller joints as well as in having magenta instead of yellow flowers. Associated with this (No. 6573 and 7876), however, is a yellow flowered form which differs but very li.tle from it in any other character. As a general rule the yellow flowered form has longer, whiter spines but this does not always hold true.

We have had no opportunity of comparing the fruits of this and its yellow flowered associate.

No. 6573 collected at Redlands, Cal., July 6, 1904, sample represented by formula 2-3-2-1, from 4 plants.

No. 7876 collected in same locality May 6, 1905, sample represented by formula 1-2-1, from 4 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	65.73	78.76	65.73	78.76
Spines	.66	.21	2.14	1.47
Water	71.54	86.26	7.93	5.05
Ash	5.70	1.88	18.45	13.01
Crude Protein	.61	.35	1.97	2.41
Crude Fat	.32	.23	1.03	1.60
Nitrogen Free Extract	18.26	9 48	59.07	65.48
Crude Fiber	3.57	1.80	11.55	12.45
Orgonic Matter	22.76	11.86	73.62	81.94

Nos. 7475 and 7476.

CACANAPA

OPUNTIA CACANAPA *n. sp.*

An erect, open branching shrub 4 to 6 feet high, with a scaly black trunk 4 to 6 in. in diameter; joints subcircular to obovate, 5 to 7 or 8 in. in greatest diameter, thin, light to glaucous green, brown and scurfy in age; areoles ¾ to 1½ in. apart, subcircular to ovate, about ⅛ 3-16 in. in longest diameter, but increasing with age to ¼ in. or more; spicules yellow, not conspicuous on sides of joint but often ¼ in. or more long on edges; spines yellow, sometimes but not usually red at base, flattened, annular, usually not twisted, single, erect, 1 to 2 in. in length; flowers yellow to orange with seldom a tinge of red at base of petals and with white or slightly pinkish style and filaments and white or yellowish green stigma; fruits red throughout, small, obovate to subglobose, about 1 in. in diameter, with comparatively thick rind.

This species has heretofore been confused with *Opuntia lindheimeri*, to which it is related and with which it is always

associated. It is easily distinquished from the latter, however, by its more open branching habit, more woody texture and thinner, more nearly circular joints, single erect spines, smaller, more nearly globular fruit and later maturity. Cacanapa produces flowers and fruits a month to six weeks later than *Opuntia lindheimeri* growing beside it. (See Bull. 91 Bureau Animal Industry, U. S. D. A. for further notes upon this species.) The botanical type of this species is No. 8383 D. G. collected at Encinal, Texas, August 12, 1906.

No. 7475 collected at Encinal, Texas, January 10, 1905 sample represented by formula 3-1-1 from 3 plants.

No. 7476 collected from two of the above plants at same time and place, sample consisting of two sections from the old woody stem six inches above the ground.

Chemical Analyses

	Green		Air Dry	
Sample No.	7475	7476	7475	7476
Spines	.25		1.41	
Water	83.05	80.98	3.92	6.78
Ash	4.66	4.08	26.40	20.00
Crude Protein	.88	.71	4.99	3.46
Crude Fat	.35	.37	2.00	1.83
Nitrogen Free Extract	9.16	9.49	51.91	46.53
Crude Fiber	1.90	4.37	10.75	21.40
Organic Matter	12.29	14.94	69.68	73.22

Analsses of the Ash

Sample No.	Per Cent. Carbon	Per Cent. Sand	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
7476	.11	1.74	1.23	.26	.13	.36	26.03	2.3	13.11	1.16	.55	1.03	5.20	47.08

Nos. 6578, 6579, 7809 and 7812

OPUNTIA INERMIS *P. DC. Plant. Grass. t. 138. 1799.*

An erect ascending, loosely branched plant 2 to 4 feet high; joints narrowly obovate, in proportion of 3x9 in. which is a common size, deep blue green; leaves about $^1/_{16}$x$\frac{1}{8}$ in., subulate, cuspidate; areoles very variable, elongated to oval, about $\frac{1}{8}$x$\frac{1}{4}$ in.; wool dull tawny; spicules yellow, inconspicuous and entirely harmless upon young joints but becoming $\frac{1}{4}$ in. long on older ones; spines almost absent, only an occasional yellow or brown one on edges of joints, not increasing on old trunks, $\frac{1}{2}$ to 1 in. long, terete, flowers yellow or greenish-yellow with green style, filaments and stigma; fruit obovate to long pyriform, deep purple throughout, with prominent, yellow spicules 1-16 in. or more long.

Although a very prolific fruit bearer, this species is not a rapid grower in this climate. It is one of the common spineless forms of the cultivated plantations of this country and Europe.

The fruit and floral characters, as illustrated by DeCandole's figures[1], correspond very well with our plant but the joints do not correspond so well. But the synonomy of this species seeems reasonably straight, Weber[2], Schumann[3], Regel[4] and others referring undoubtedly to the same species. A typical figure may be found in Gartenflora *31:* 132. 1882.

No. 6578 secured from The Albert S. White Park, Riverside, Cal., July 7, 1904, sample represented by formula 2-2-2, from one plant.

No. 6579 collected at the same time and place as No. 6578, sample consisting of 30 fruits from one plant.

No. 7809 collected from same plant as No. 6578 April 29, 1905, sample represented by formula 2-2-1.

No. 7812 collected at same time and place as No. 7809, sample consisting of 32 fruits from 2 plants.

1. Plant. Grass No. 138. 1799.
2. Bois Dict. d'Hort. 894. 1893-1899.
3. Gesamtbeschreibung d. Kakt. 718. 1848.
4. Gartenflora *31:* 132. 1882.

Chemical Analyses.

	Green.				Air Dry.			
Sample No.	65.78	65.791	78.09	78.121	65.78	65.791	78.09	78.121
Spines	.....	.....	.....	.....	.....	.....	.....	.....
Water	88.11	91.56	86.54	87.11	9.32	7.35	6.29	5.57
Ash	4.34	1.58	2.94	1.49	33.08	17.30	20.45	10.90
Crude Protein	.55	.57	.58	.50	4.16	6.24	4.05	3.68
Crude Fat	.12	.35	.16	.32	.93	3.88	1.10	2.34
Nitaogen Free Extract	5.37	4.32	8.77	8.31	41.01	47.43	61.06	60.90
Crude Fiber	1.50	1.62	1.01	2.27	11.50	17.80	10.25	16.61
Organic Matter	7.55	6.86	10.52	11.40	57.60	75.35	73.26	83.53

Nos. 6242, 7784, 8052a and 8022b D. G., and 3025 and 3067 E. O. W.

OPUNTIA PHAEACANTHA *Engelm. Mem. Am. Acad. (Plant. Fend.) 4: 52. 1849.*

Plants ascending to prostrate, 1½ to 3 feet high; joints obovate or in older, lower, prostrate ones semi-obovate, 3½ to 5x5 to 7 in., yellow to glaucous green; leaves about 3-32 in. x ¼ in., subulate cuspidate; areoles circular to ovate-obovate, ¾ to 1¼ in. apart; wool dark tawny; spicules abundant, reddish brown, commonly ⅛ in. long on sides of joint but often ½ in. on edges; spines from light to dark red and becoming bleached to chalky with age but their bases nearly always darker than tips, 1 to 2 in. long, flattened and often slightly twisted 1 to 4 in number and always more numerous above, erect, divergent, or often somewhat recurved, very variable; flowers yellow with stigma yellowish to very light green and style and fllaments greenish; fruit obovate. 1½ x 2 in., depressed at apex, with prominent areoles, about ½ in. apart, reddish-purple outwardly with pulp and rind greenish-yellow.

This species is exceedingly variable and it is very doubtful whether our knowledge of it is at all adequate. *O. phaeacantha brunnea* is represented in the foregoing list by by Nos. 8022a and 8022b and possibly by 3025. This variety has the habit of changing its aspects with growth very decidedly. In summer the season's growth is glaucous and

spines black but with age the color of the joints become yellowish-green and the spines reddish-brown, the contrast being most striking.

Of several specimens of our own collection before us only those from the exact locality of the two first numbers above have pulp or rind at all red and even here there is but little pulp, the fruit being not at all juicy. Joint characters agree very well with the type. But they also agree nearly as well with *O. camanchica* but the fruit of the latter is said to be red throughout, palatable and juicy. It is quite probable that the two numbers referred to above with red pulp are not normal. Insects do much damage to the fruits of all species in this locality and it may be that the dryness of the fruits is due here, as in other species which we have observed, to insect influences.

The type of *O. camanchica* does not differ from some of the forms of *phaeacantha* in the Engelmann Herbarium so far as the characters which are evident now are concerned. It is possible that they grade into each other. The description of the fruit, however, leads us to keep them separate for the present. *O. phaeacantha* has fruit with a greenish interior while *O. camanchica* is said to have fruit red throughout with pulp sweet and edible. It is possible that the two forms should be united but we cannot be certain about the matter until we have studied the species in the type locality of *O. camanchica*.

No. 6242 collected in Santa Rita Mountains, Arizona, April 30, 1904, sample represented by formula 2-2-3, from 3 plants.

No. 7784 collected in same locality April 19, 1905, and represented by formula 1-1-1-0 1, from 2 plants.

No. 8022a collected at El Paso, Texas, July 30, 1905, sample consisting of seed.

No. 8022b, same fruit as 8022a minus seed.

No. 3025 E. O. W. collected at Ancho, New Mexico, August 1904, sample consisting of joints Plants growing in cedar zone.

No. 3067 E. O. W. collected upon mesas near Agriculture College, New Mexico, December 22, 1904, sample consisting of joints.

Chemical Analyses

	Green.						Air Dry.					
Sample No....	6242	7784	3025	3067	8022a	8022b	6242	7784	3025	3067	8022a	8022b
Spines	1.96	.44	2.18	1.33	.....	.....	7.66	2.44	12.15	16.85	.....	.....
Water,.....	75.83	83.33	83.56	75.29	7.26	92.50	5.40	6.50	8.48	3.83	6.32	8.12
Ash	3.82	2.82	4.48	4.90	1.75	2.09	14.95	15.80	24.96	19.10	1.77	25.60
Crude Protein	.54	.51	.55	1.72	6.07	.20	2.52	2.85	3.07	6.72	6.13	2.39
Crude Fat.....	.37	.26	.19	.47	11.41	.07	1.43	1.48	1.08	1.85	11.53	.88
Nitro Free Extract	16.56	10.84	9.12	15.07	23.18	4.63	64.82	60.81	50.78	58.55	23.41	56.76
Crude Fiber..	2.78	2.24	2.09	2.55	50.33	.51	10.88	12.56	11.63	9.95	50.84	6.25
Organic Matter.....	20.35	13.85	11.95	19.81	90.99	5.41	79.65	77.70	66.56	77.07	91.91	66.28

Analyses of the Ash

Sample No.	Per cent. carbon	Per cent. sand	Per Cent. in Pure Ash											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric acid radicle (PO_4)	Sulphuric acid radicle (SO_3)	Chlorine (Cl)	Carbonic acid radicle (CO_3)
7784	54.	.89	.91	.15	.15	.37	29.00	6.06	6.40	.25	2.64	.82	.55	45.97
3025	.28	2.68	.99	.41	0.00	.38	30.94	6.09	3.71	.50	.93	.99	1.36	49.48

Nos. 7009, 7010 and 7759

OPUNTIA PHAEACANTHA *Engelm. Mem. Am. Acad. (Plant. Fend.) 4: 52. 1849.*

Plant low, prostrate to ascending, seldom over 18 inches high; joints obovate or, in case they are prostrate, roughly subcircular to cuneiform, bright, smooth, yellowish-green,

5 to 6 in. by 6 to 8 in.; areoles ¾ to 1¼ in. apart, circular to obovate, 3-16 in. longest diameter; spicules yellow, prominent, 3-16 in. long on last year's joints but increasing with age to ½ in.; spines red at base with opalescent brown tips but weathering to a chalky white, 2 to 4, mostly 3, 1 to 1½ in. long; flowers with inner petals yellow above, orange about middle and reddish at base on inner side, outer ones with greenish ribs, style and filaments white or greenish and stigma yellowish-green; fruits obovate, purple outside and greenish within.

These numbers are treated seperately from the previous group on account of the constantly smaller joints. The plant grows upon the gentle slopes of the open grassy areas in upper foothills.

No. 7009 collected in the Santa Rita Mountains, Arizona, August 30, 1904, sample represented by formula 2-2-0-1 from 5 plants.

No. 7010 collected at same time and place as No. 7009, sample consisting of fruits from 8 plants.

No. 7759 collected in same locality April 17, 1905, sample represented by formula 1-1-1, from 3 plants.

Chemical Analyses

	Green.			Air Dry.		
Sample No.	7009	7010[1]	7750	7709	7010[1]	7759
Spines	.29	.....	.34	2.50	.. ..	1.99
Water	88.83	84.37	83.93	4.54	5.20	6.24
Ash	2.33	1.23	2.02	19.90	7.43	11.78
Crude Protein	.69	.76	.73	5.91	4.60	4.25
Crude Fat	.20	.96	.38	1.70	5.80	2.20
Nitrogen Free Extract	6.45	8.40	10.98	55.10	51.02	64.12
Crude Fiber	1.50	4.28	1.96	12.85	25.95	11.41
Organic Matter	8.84	14.40	14.05	75.56	87.37	81.98

1 Fruit.

No. 3069 E. O. W.

OPUNTIA PHAEACANTHA *Engelm. Mem. Am. Acad Plant. Fend. 4: 52. 1849.*

A prostrate to ascending, spreading species, which dies at

base and strikes root distally, giving a central dead area and a vigorous marginal; one joints obovate, rather light green, in proportion of 4 x 6 in., which is a common size; leaves subulate cuspidate, pointed, about 3-16 in. long; spicules yellow, prominent, in an unequal ⅛ in. long bunch from upper part of areole or occupying nearly the entire area of the lower ones, commonly ⅛ to 3-16 in. long; spines reddish-brown, weathering to a chalky white rather irregularly, some plants scarcely showing any brown while others retain it indefinitely, angularly flattened, largest ones 1 to 2 in. long and 1 to 4 or 5 in number with 1 to 3 additional shorter ones on lateral lower margins of areole, always sloping downward but often tightly recurved; flowers yellow with petals tipped with red externally and always appearing red when closed; fruits obovate to pyriform, very variable, about 1 x 2 in., purple externally.

This differs from the other forms by its more slender, lighter colored spines and its smaller size throughout. It agrees in some respects with *O. setispina* Engelm. We believe it to be specifically distinct from the previous numbers recorded under *O. phaeacantha.*

Collected at Agricultural College, New Mexico, December 22, 1904, sample consisting of joints.

Chemical Analyses.

	Green.	Air Dry.
Sample No.	30.69	30.69
Spines	4.08	11.63
Water	67.40	6.50
Ash	6.02	17.16
Crude Protein	1.08	3.07
Crude Fat	.64	1.83
Nitrogen Free Extract	21.60	62.24
Crude Fiber	3.26	9.30
Organic Matter	26.58	76.34

Nos. 3018, 3100 and 3101 E. O. W.

OPUNTIA POLYCANTHA ? *Haw.*

A low, prostrate to ascending plant seldom 12 in. high; joints obovate in proportion of 2¾ x 3½ in., which is a common

size, bright green when young but becoming dark with age, more or less wrinkled; leaves small, subulate cuspidate, about ¼ in. long; spicules yellow, short, with often a few long, rather stout, brownish ones on upper edge which almost appear to be between spines and spicules; spines white upon mature plants but somewhat brownish when young, soon fading to white but the tips often decidedly brown for some time, finally fading to a dark translucent bony consistence. On sides of joints there is usually one to two or three large central spines 1¼ to 1½ in. long sloping downward slightly or erect-spreading, flattened, slightly or not at all twisted and marginal 2 to 6 short, tightly recurved more delicate ones, on the margins both forms more numerous; flowers yellow with usually greenish-red in all exposed portions of bud, filaments either green or red and stigma bright deep green; fruits oval to obovate, about ¾ x 1¼ in., dry.

Good specimens in the herbaria of both New Mexico Agricultural Colege and U. S. Department of Agriculture will serve to identify further the form which we have analyzed of this very variable species, the extremes of whose forms appear to be worthy of specific rank but whose intergrading forms make it a difficult to separate it into distinct species.

No. 3018 E. O. W. collected south of Tierra Amarilla, New Mexico, August 16, 1904, sample consisting of joints.

No. 3100 E. O. W. collected at Lakewood, New Mexico, August 3, 1905, sample consisting of joints including a few green fruits,

No. 3101 E. O. W. collected at same time and place but from smaller jointed plants.

Chemical Analyses

	Green.			Air Dry.		
Sample No.	30.18	31.00	31.01	30.18	31.00	31.01
Spines	.88	1.09	2.24	7.61	8.89	17 .
Water	89.54	88.24	88.32	9.73	4.65	6.68
Ash	1.78	3.75	2.90	15.35	30.39	23.23
Crude Protein	.60	.43	.49	5.15	3.50	3.94
Crude Fat	.21	.21	.15	1.78	1.70	1.16
Nitrogen Free Extract	6.56	5.94	6.77	56.66	48.14	53.04
Crude Fiber	1.31	1.43	1.37	11.33	11.62	10.95
Organic Matter	8.68	8.01	8.78	74.92	64.96	70.09

Analyses of the Ash

Sample No	Per cent. carbon	Per cent. sand	Per Cent. in Pure Ash											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
3018	.21	.63	.52	.20	0.00	.32	24.01	5.81	14.15	.12	1.19	2.97	6.18	42.06

No. 3016 E. O. W.

OPUNTIA *sp.*

This sample may represent an undescribed species. At all events we are unable to refer it to any species already described. We therefore prefer to leave it unnamed until we are able to secure more critical field notes upon it. It is fairly common at an altitude of 6000 to 7000 feet in the mountains of southwestern Colorado.

Collected at Flora Vista, New Mexico, August 9, 1904, sample consisting of joints.

Chemical Analyses

	Green	Air Dry
Sample No	3016	3016
Spines	1.16	8.43
Water	87.37	8.10
Ash	3.05	22.18
Crude Protein	1.37	9.96
Crude Fat	.24	1.75
Nitrogen Free Extract	6.27	45.61
Crude Fiber	1.70	12.40
Organic Matter	9.58	69.72

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric acid radicle (PO_4)	Sulphuric acid radicle (SO_4)	Chlorine (Cl)	Carbonic acid radicle (CO_3)
30.16	.27	3.67	1.82	.21	.79	.21	20.24	6.64	16.27	.30	2.04	1.95	1.98	43.11

Nos. 3000 and 3066 E. O. W.

OPUNTIA MACROCENTRA *Engelm. and Bigel. Proc. Am. Acad. Arts and Sci. 8: 292. 1856.*

A suberect or spreading-ascending plant with commonly a purplish tinge or often distinctly purple throughout; joints subcircular but often ovate or obovate, about 6 or 7 in. in longest diameter; spicules reddish-brown but often yellow, prominent, unequal in a conical or lenticular bunch, $\frac{1}{8}$ in. in length in upper portion of areole; spines long, prominent, erect, brown to black, fading distally to light brown or even chalky white with translucent, bonelike tip, usually single on sides of joints but two or three on edges above and entirely absent on lower portion of the joint, often 3 in. long, flattened and often slightly twisted; flowers yellow with some red in midribs and at bases of inner petals, consequently more or less red when old or closed, style purplish, filaments and stigma greenish-white; fruit obovate to pyriform, about $1\frac{1}{4}$ x $2\frac{1}{2}$ in., generally pitted at apex, purple without with greenish pulp and rind.

This is quite a characteristic and distinct species of western Texas and adjacent New and Old Mexico and extends as far west as the Santa Cruz Valley of Arizona. Its long, straight, mostly, dark brown to black spines and subcircular joints are its chief characteristics.

No. 3000 E. O. W. collected near Garfield, New Mexico, July 11, 1904, sample consisting of joints.

No. 3066 E. O. W. collected 3 miles east of Agricultural

College, New Mexico, December 22, 1904, sample consisting of joints.

Chemical Analyses

	Green.		Air Dry.	
Sample No	3000	3066	3000	3066
Spines	.....	1.46	.....	6.16
Water	62.93	77.41	7.18	4.75
Ash	6.57	4.86	16.45	20.50
Crude Protein	1.88	1.30	4.71	5.52
Crude Fat	.80	.48	2 00	2.06
Nitrogen Free Extract	22.05	13.33	55.21	56.12
Crude Fiber	5.77	2.62	14.45	11.05
Organic Matter	30.50	17.73	76.37	74.75

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
3000	.62	4.27	1.56	.53	0.00	.56	24.75	8.25	8.33	1.57	2.14	1.16	.95	44.80

Nos. 6543, 6544 and 7568.

OPUNTIA MACRORHIZA *Engelm. Boston Jour. Nat. Hist. 5: 206. 1845.*

A small, prostrate or ascending, usually tuberous rooted species of little economic promise; joints dark green, always more or less wrinkled, tuberculate, obovate, subcircular or even pointed at both ends, commonly 3½ x 5 in.; areoles obovate, about ¾ in. apart; spicules very unequal, reddish-brown, in semicircle or often surrounding the entire areole or sometimes occupying it entirely, ⅛ in. or more long; spines red-

dish-brown, erect-spreading, 2 to 5, 1 to 1½ in. long, slightly flattened; flowers orange but petals red below on inner surface and commonly streaked with red above; fruit long, pyriform, depressed at apex or often flat when well developed, purple without and greenish or mottled within.

This is too small to be of much promise as stock food. Around San Antonio it is often difficult to find the tuberous roots where hogs run loose. In pastures where the animals run, the ground about the plants is invariably rooted up and the roots of the plants eaten off. Of course the joints strike root and grow again but usually no tubers are found upon them for several years. Our plant is without doubt Engelmann's species. A good illustration will bo found in U. S. & Mex. Bound. Sur. *2: Pl. 69.* 1859.

No. 6543 collected south of Hebronville, Texas, June 15, 1904, sample consisting of fruits from 6 plants.

No. 6544 collected at the same time and place as No. 6543, sample represented by formula 3-2-1-1, from 6 plants.

No. 7568 collected at San Antonio, Texas, February 23, 1905, sample represented by formula 1-2-3, from 5 plants.

Chemical Analyses.

	Green			Air Dry		
Sample No	65431	6544	7568	65431	6544	7568
Spines		.47	.69		2.16	3.41
Water	91.26	79.37	86.96	6.10	5.60	5.82
Ash	1.23	6.21	4.11	13.25	28.40	20 31
Crude Protein	.62	1.29	1.20	6.68	5.91	5.92
Crude Fat	.50	.38	.35	5.40	1.75	1.73
Nitrogen Free Extract	4.37	9.43	11.51	46.89	43.16	56.99
Crude Fiber	2.02	3.32	1.87	21.68	15.18	9.23
Organic Matter	7.51	14.42	14.93	80.65	66.00	73.87

1 Fruit.

No. 7639

NOPAL LASARON (?)

OPUNTIA STENOPETALA *Engelm. U. S. & Mex. Bound. Sur. 2: Cactaceae 46. Pl. 66. 1859.*

A prostrate, spreading, small plant, seldom over 18 inches high; joints subcircular, 4 to 6 in. in diameter, dark green, glaucous, with a tinge of purple around areoles and edges of joints; leaves scarlet, 1-16 in. wide by ¼ in. long, subulate, with prominent white wool at base; areoles circular below and oval above, about 3-16 in. in greatest diameter, and 1 to 1½ in. apart; wool tawny but black where exposed; spicules red but soon becoming black where exposed, about ⅛ in. long; spines at first red but becoming decidedly chalky and finally black, with translucent tips, 1 to 4, usually 3 or 4, annular, recurved or simply spreading, very variable in length but commonly 1 to 2 in.; flowers said to be dioecious, orange-red with white filaments and yellow, 8 to 9 parted stigma; fruit subglobose, with truncate to depressed apex, and conspicuous areoles, wine red exteriorly with streaked rind and greenish pulp slightly mottled with red, very acid.

Weber[1], whom Schumann[2] follows, considered *O. stenopetala* a synonym of *O. glaucescens* Salm. but Berger[3] has recently shown that this, as well as *O. grandis* Pfeiff., is a different thing entirely. Both the specific name and the descriptions would indicate that this is true. Our plants match Engelmann's type perfectly. This is too small to be of value as stock food but it is one of the most valuable ornamentals and is hardy in southern California, although it does not appear to fruit well. The common name used above was applied to this plant by a peon at Ypiña, San Luis Potosi, Mexico.

Collected at Alonzo, Mexico, March 14, 1905, sample represented by formula 1-1-1, from 2 plants.

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1. Bois, Dict. d'Hort. 893. 1893-1899. 2. Gesamtbeschreib. d. Kakt. 742. 1899. Engler's Bot. Jahrbuchern 36: 447. 1905.

Chemical Analyses

No. 7639.

	Green.	Air Dry
Spines	.02	.14
Water	86.76	6.40
Ash	2.93	20.75
Crude Protein	1.17	8.28
Crude Fat	.23	1.65
Nitrogen Free Extract	7.70	54.39
Crude Fiber	1.21	8.53
Organic Matter	10.31	72.85

Nos. 6580 and 7813.

OPUNTIA MONACANTHA[1] *Haw. Suppl. Plant. Suc. 81. 1819.*

An ascending or erect, sparingly branched and very prolific fruited species; joints obovate, commonly contracted below into a long, stipitate base, in proportion of 4 x 8 and 5 x 10 in., which are common sizes, bright green, smooth, somewhat tuberculate; areoles oval, obovate, about 3-16 x $\frac{1}{8}$ in. but very variable and becoming very much elongated with protruding, tawny wool on old joints; spicules yellow, inconspicuous, and not increasing upon old stems; spines normally one and erect, gray, with conspicuous horn-like tip but increasing irregularly to as high as 10 upon old stems, $\frac{1}{2}$ to 1 in. long but upon old stems often 3 in. long; flowers yellow with tips of outer segments red, style and filaments white or greenish and stigma yellowish-white; fruit proliferous, green, with a blush of red on outside, about $1\frac{3}{4}$ x 3 in. when fully grown, remaining upon trees for 4 or 5 years and developing continually.

This is one of the few flat-jointed prickly pears with proliferous fruits. These remain attached to the plant for 4 or 5 years, putting forth new ones from year to year until there is a string of them sometimes 6 or 8 inches long, containing 8 or 10 individual fruits. Not only do the fruits remain on

1. The variegated variety is commonly advertised in catalogues under the name. *Opuntia monacantha variegata.* It differs in no way from the species except in the unequal distribution of the green coloring matter in the joints.

the shrub but they continue to grow as long as they are so attached, the proximal always being larger than the distal ones. Our plant is evidently the same as that figured by Maiden in Agric. Gaz. New South Wales *9:* opp. p. 1001. 1898. The The species does not appear to grow so large in this country as here figured and the fruit with us is more prolific than this figure shows them to be. It is also figured by DeCandole Pl. Grass. *Pl. 138.* 1799. Professor Maiden reports it to be a bad weed in portions of Australia.

No. 6580 secured from The Albert S. White Park, Riverside, California, July 7, 1904, sample consisting of 20 fruits from one plant, represented by formula 12-5-2-1.

No. 7813 secured from the same plant April 29, 1905, sample consisting of 24 fruits 1 to 3 years old, the older ones predominating.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	65801	78131	65801	78131
Spines.	.....	.....	.....	.....
Water	91.03	90.03	6.45	5.41
Ash	1.41	1.29	14.70	12.27
Crude Protein	.31	.35	3.18	3.39
Crude Fat	.16	.32	1.65	3.00
Nitrogen Free Extract	5.95	6.98	62.14	66.10
Crude Fiber	1.14	1.03	11.88	9.83
Organic Matter	7.56	8.68	78.85	82.32

1. Fruit.

Nos. 6691 and 7889.

PRICKLY PEAR. NOPAL.

OPUNTIA CHLOROTICA *Engelm. and Bigel. Pacif. Ry Rep. 4: 38. Pl. 6, f. 1-3. 1856.*

A tall, erect, woody, formidably protected prickly pear 4 to 6 or 7 feet high, with a well marked trunk; joints normally subcircular, 5 x 5½ in. to 6 x 7 in., glaucous to yellowish-green; areoles obovate to subcircular, prominent and numerous, ½

to ¾ in. apart on sides of joints but often occupying entire margin, its tissues continuing to develop indefinitely upon old trunks, giving rise to a conical or cylindrical structure often ½ in. long covering, in many cases, the entire trunk, from the annual growth of which wool and spicules continue to develop abundantly but only rarely new spines; spicules yellow, very unequal, often ¾ in. long, surrounding upper portion of areoles in young joints but scattered through it in older ones; spines yellow, 1 to 5, with 1 to 6 smaller, more delicate ones below, increasing but slightly on old joints but becoming more tightly recurved; flowers yellow with filaments and style white and 7-parted stigma greenish-white; fruit subglobose to obovate or even pyriform, purple without and greenish yellow within.

This is a very distinct and, in some respects, peculiar species. Its perfectly erect habit with well developed trunk, densely papillate stems and old joints are very characteristic. The proliferation of the tissues of the areole into conical or calumnar structures is not at all common but is very noticeable and characteristic in a few species of *Opuntia*, more especially in this and *Opuntia rufida*.

No. 6691 collected at Hackberry, Arizona, July 25, 1904, sample represented by formula 1-1-1-1, from 4 plants.

No. 7889 collected in same locality May 9, 1905, sample represented by formula 1-1-½, from 3 plants.

Chemical Analyses

	Green		Air Dry	
Sample No.	6691	7889	6691	7889
Spines	.80	1.75	3.01	7.77
Water	74.99	78.50	6.03	5.45
Ash	5.00	4.90	18 80	21.58
Crude Protein	.95	.95	3.56	4.16
Crude Fat	.49	.44	1.85	1.95
Nitrogen Free Extract	13.10	12.46	49.21	54.76
Crude Fiber	5.47	2.75	20.55	12.10
Organic Matter	20.01	16.60	75.17	72.97

Nos. 6241 and 7782.

OPUNTIA CHLOROTICA SANTA RITA *n. var.*

An erect, open branching prickly pear of woody texture, with a distinct trunk, 4 to 6 in. in diameter; joints mostly subcircular but sometimes ovate and pointed (No. 7783 D. G.) or obovate (No. 8156 D. G.), 5 to 7 in. in diameter, glaucous or in spring purplish around areoles and edges of joints especially; leaves about 1-16x⅜ in., subulate, early deciduous from the young purplish joints; areoles ¾ to ⅞ in. apart, obovate to subcircular, ⅛ in. or more in longest diameter on one and two-year-old joints but increasing in size and prominence with age giving rise to columnar structures ¼ to ½ in. long upon old trunks; wool tawny but brown outwardly, giving a brown appearance to areole; spicules varying from light yellow to brown and always dirty brown with age; spines nearly absent in these numbers, sometimes 1 to 3 on edges of joints only, ¾ to 1½ in. long, yellow to reddish-brown; flowers yellow with white filaments and style and white or yellowish, 7 parted stigma; fruit oval, depressed at apex, with very rough flower scar formidably protected with prominent spicules, purplish outwardly and greenish within, pleasantly acid.

We have not seen this form of the species in the northern highlands of the Territory where the typical form grows abundantly but in the southern mountains of Arizona this is the most common form. All gradations of spine characters may be found between this and the typical, very spiny *Opuntia chlorotica*. One very conspicuous character is the proliferation of tissue in the areoles upon old stems of this and the other form, giving a prominent papillum or small columnar projection ¼ to ½ in. long covered with wool and formidablespicules. When the fruit ripens it falls to the ground and remains in good condition for a long time, not being molested by birds or animals. The pulp is comparatively small in amount and the rind thin, approaching the dry fruited forms to some extent in this respect. The botanical type of this variety is No. 8157 D. G. collected in Celero mountains, Arizona, October 8, 1905.

No. 6241 collected upon steep, rocky canyon sides in Santa

Rita Mountains, Arizona, April 30, 1904, sample represented by formula 2-3-2, from one plant.

No. 7782 collected from same locality April 19, 1905, sample represented by formula 1-1-1-1, from 4 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No	6241	7782	6241	7782
Spines	.....	.....	.....	.....
Water	77.87	79.47	5.63	5.77
Ash	5.89	3.73	25.10	17.10
Crude Protein	.95	.85	4.05	3.89
Crude Fat	.49	.43	2.08	1.98
Nitrogen Free Extract	11.55	12.15	49.27	55.80
Crude Fiber	3.25	3.37	13.87	15.46
Organic Matter	16.24	16.80	69.27	77.13

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric acid radicle (PO_4)	Sulphoric acid radicle (PO_4)	Chlorine (Cl)	Carbonic acid radicle (CO_3)
77.82	.39	.67	.79	.10	.27	1.36	33.23	2.78	3.12	.15	1.07	.67	.53	53.68

No. 7591.

NOPAL CARDON

OPUNTIA STREPTACANTHA *Cactarum Gen. Nov. 62. (Paris) 1839.*

A tall, stout, widely branching tree 10 to 15 or more feet high, with a black, scaly trunk 10 to 18 in. in diameter; joints ovate to obovate, in proportion of 10 to 12 in., which is a common size for last year's growth, 1 to 1½ in. thick, dark dull

green, flaking off the third or fourth year and finally changing into a black scaly trunk; areoles oval, $\frac{1}{8}$ to $\frac{1}{4}$ in. in longest diameter, black; spicules bright reddish-brown, seldom protruding to surface of joint; spines recurved in all directions, often tightly against the surface of the joint, upper ones more erect than the lower, 3 to 7, with often an additional 2 or 3 very delicate ones below, increasing in number to 9 or 10 from upper part of areole, at first opalescent, changing to white, which soon becomes mottled and finally dirty gray, flattened, twisted and usually groved below; flowers yellow, varying to orange with fips of outer sepals red, outer filaments greenish yellow and inner tinged with red, style tinged with red near apex and stigma, 8 to 12 parted, light glossy green; fruit oval to subglobose, deep dull red with pulp darker than rind and easily separable from it.

This is one of the most distinct and characteristic of the Mexican pears. The dull. dark green, thick joints with mottled gray, recurved spines enable one to recognize it easily. The only other form with which it can be confused is nopal arton, which is a larger plant with larger, darker fruits and spines on the whole more erect. The variety which is here described is red fruited but there occurs a form with a yellowish-white fruits, known as nopal cardon blanco. The latter is rather rare in nature but is common in orchards. The common name cardon is uniformly referred to this plant throughout the region where it grows. It is one of the species whose popular name appears to be stable.

Collected at Aguas Calientes, Mexico, March 6, 1905, sample represented by formula 1-1-0-1, from 3 plants.

Chemical Analyses

No. 7591.

	Green.	Air Dry.
Spines	.49	2.90
Water	83.90	3.75
Ash	3.32	19.85
Crude Protein	.51	3.07
Crude Fat	.32	1.90
Nitrogen Free Extract	8.91	53.23
Crude Fiber	3.04	18.20
Organic Matter	12.78	76.40

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
7591	.05	.21	1.14	.20	.19	.04	30.10	2.70	10.10	.53	.29	.41	.63	50.25

No. 7635.

NOPAL JARILLO

OPUNTIA *ap.*

Plant tall, erect, open branching, with a distinct black, scally trunk 10 to 12 in. in diameter; joints obovate in proportion of 7 x 12 in., which is a common size, dark green, slightly tuberculate for one or two years; areoles subcircular to obovate, about ¾ in. apart; spicules seldom visible on upper part of joint, but there is usally a prominent, small reddish-brown bunch of unequal, ⅛ in. long ones in the lower, less spiny areoles; spines translucent, soon turning to white, with translucent tips and changing the second or third year to a grayish-brown, horn-like appearance, persisting to a remarkable degree upon all trunks 10 in. or more in diameter and continuing to increase in number and enlarge the areole to often ½ in. in diameter, the central and longest one erect, and the others spreading around it, the longest one often 1¾ in. long the others varying as low as ½ in. with usually 2 or 3 delicate, easily separable ones besides, 4 to 8 on sides of joints with often 10 on edges, and increasing on old trunks to as high as 30, angular, flattened, twisted; flowers not seen; fruits obovate, somewhat tubercular, red, with pulp turning red before the rind and epipermis.

This is one of the most formidably protected of all of the prickly pears. The spines are very stout and brittle. The common name does not appear to be very well established.

Collected at San Luis Potosi, Mexico, March 13, 1905, sample represented by formula 1-1-1, from 3 plants.

Chemical Analyses

No. 7635.

	Green.	Air Dry.
Spines	.51	6.25
Water	92.35	5.60
Ash	1.79	22.05
Crude Protein	.82	10.07
Crude Fat	.16	2.15
Nitrogen Free Extract	3.95	48.69
Crude Fiber	.93	11.44
Organic Matter	5.86	72.35

No. 7715.

OPUNTIA *sp.*

A tall, open branching tree, with a black, scaly trunk 10 to 15 in. diameter, 15 feet or more high, and very woody; joints subcircular to obovate, 6 x 8 or 9 in., thin, slightly tuberculate, dark green, smooth and shiny, turning dark but very variable; areoles oval, 3-16 in. or more in greatest diameter, 1¼ to 1⅝ in. apart; wool tawny; spicules yellow, very variable, often rather brown, unequal in length but commonly about ⅜ in. long; spines brown, turning to white at tips, leaving the bases brownish translucent but in second or third year they become dirty black, suberect, spreading with the lower recurved and central largest flattened and often twisted, 3 to 8 in number and increasing in both number and length for 2 or 3 years; flowers yellow, often streaked with red and always red without, 1½ in. across and about 1 in. long with filament light chocolate, and 6 to 9-parted light green stigma; fruits obovate or pyriform, covered with circular areoles well armed with long yellow spicules, rind thin and very deep red pulp.

The species is easily recognized by its dark, glossy green joints which turn very dark after maturity, its peculiar streaked flowers and its chocolate colored stamens.

Collected at Guadalajara, Mexico, April 6, 1905, sample represented by formula 1-1-1, from 3 plants.

Chemical Analyses
No. 7715

	Green	Air Dry
Spines	.27	2.11
Water	88.01	5.40
Ash	1.91	15.10
Crude Protein	.57	4.47
Crude Fat	.52	4.08
Nitrogen Free Extract	6.22	49.07
Crude Fiber	2.77	21.88
Organic Matter	10.08	79.50

Nos. 6529, 6530, 6531 and 7590

NOPAL TAPON

OPUNTIA ROBUSTA *Wendl. Cat. Herrenh. (1835)*[1]

Plant body very variable in size and habit, commonly erect 5 to 7 feet high but sometimes ascending and often erect and arborescent, 12 or 15 feet high when planted in favorable situations such as irrigating ditch banks; joints subcircular, very large and fleshy, often 18 to 24 in. in diameter and 1½ to 2 in. thick, glaucous, with abundant bloom when young but becoming scaly with age and producing a black, scaly trunk; areoles very large and conspicuous, subcircular 3-16 to 3-8 in in diameter and 1¼ to 3 in. apart on sides of joints, dark brown to black; spicules yellow, forming a crescentric bunch on upper side of areole but often forming a complete ring surrounding it, commonly 1-16 to ⅛ in. long but often ½ or even 1 in. long on edges of joints; spines 2 to 6 in young joints, usually 3 to 5, but increasing to 7 or 8 on two-year-old joints, deep yellow to almost orange at base and fading outward to translucent bone-like tips and soon weathering white, stout, flattened, not annulate, slightly twisted; flowers large, 2 in. wide in full bloom, yellow with blush of red in portions exposed in the bud, with filaments and style white or greenish and stigma deep bright green, 8 to 9 parted; fruit subglobose, deep blood red throughout, usually more or less tuberculate, which largely disappears toward maturity.

This is a very characteristic and easily recognized species,

[1] Citation taken from Schumann's Gesamtbeschreib. d. Kakt. 741. 1898.

the common name of which is constant throughout the plateau region where it grows. It is always easily recognized by its very large, nearly circular, thick, glaucous joints.

No. 6529 collected at Alonzo, Mexico, June 10, 1904, sample consisting of 26 fruits from 9 plants. These were under mature but the pulp was red and rind just beginning to turn.

No 6530 collected at same time and place as No. 6529, sample represented by formula 2-2-1, from 5 plants.

No. 6531 collected at San Luis Potosi, Mexico, June 11, 1904, sample consisting of 11 fruits from 5 plants. In this sample the fruits were better matured, the entire rind being purplish red.

No. 7590 collected at Aguas Calientes, Mexico, March 6, 1905, sample represented by formula 1-0-1-0-1, from 3 plants.

Chemical Analyses

	Green.				Air Dry.			
Sample No.	65291	6530	65311	75.90	65291	6530	65311	7590
Spines	.....	.71	.....	.25	.....	6.43	.....	2.33
Water	88.59	89.62	96.81	89.62	5.41	5.68	6.38	4.55
Ash	1.29	2.95	.26	1.93	10.70	26.81	7.65	17.79
Crude Protein	1.06	.63	.23	.46	8.76	5.70	6.79	4.27
Crude Fat	1.13	.23	.23	.18	9.38	2.13	6.76	1.64
Nitrogen Free Extract	3.84	4.81	1.80	5.98	31.80	43.70	52.72	54.95
Crude Fiber	4.09	1.76	.67	1.83	33.95	15.98	19.70	16.80
Organic Matter	10.12	7.43	2.93	8.45	83.89	67.51	85.97	77.66

1. Fruit.

No. 7633.

NOPAL SAPON LISO.

OPUNTIA ROBUSTA WENDL.

As the Spanish popular name indicates, this is probably nothing more than a spineless form of the wild nopal tapon. It is very commonly cultivated throughout the highland region of Mexico. It appears to differ in no essential respect from the wild form except in the absence of spines. The spicules

are not as formidable on the joints as in the spined variety but are about the same on the fruits. We believe that we have seen this variety in nature but there is always more or less difficulty in distinguishing between native and escaped plants in Mexico.

Collected at San Luis Potosi, Mexico, March 13, 1905, sample represented by formula 1-1-1, from 3 plants.

Chemical Analyses

No. 7633.

	Green.	Air Dry.
Spines	.....	.....
Water	90.25	5.53
Ash	1.43	13.83
Crude Protein	.38	3.72
Crude Fat	.20	1.90
Nitrogen Free Extract	6.95	67.40
Crude Fiber	.79	7.62
Organic Matter	8.32	80.64

Nos. 6562, 6575, 7810 and 7841.

MISSION PEAR, NOPAL DE CASTILLA [1]

OPUNTIA *sp.*

A tall, erect, prolific, cultivated plant, 10 to 15 feet high, with a trunk often 12 in. in diameter; joints obovate or often elliptical, smooth, bright or glaucous green, in proportion of 9 x 18 in. for one-year-old joints; areoles 1¼ to 2 in. apart, oval to circular, ⅛ to ¼ in. long, increasing in size and elongating transversely with age to 1 in. wide on old trunks; spicules yellow, inconspicuous and seldom long enough to seriously annoy one in handling the joints; spines white with translucent tips, turning to a dirty mottled gray with age, erect, divergent, ¼ to 1¼ in. long, flattened, occasionally twisted, 2 to 6 or 7, mostly 3 or 4, but increasing with age to twice that

1. This name is very commonly used among our Spanish population and in a much more restricted sense than in Mexico, where it is applied to a greater variety of species than with us. We do not interpret it to have any reference to the origin of the variety but simply indicates that it is of good quality. The name is used in much the same sense as some of our trade names.

number; flowers orange with bases of petals, filaments and style reddish, and bright, dark green, 8 or 9-parted stigma; fruit subglobose, elliptical or obovate, about 2 x 2¾ in., greenish-yellow throughout.

This is the common cultivated, greenish-yellow fruited, spiny pear of our southwestern states. In California it is known as "Mission pear" on account of its appearance about the old missions to which it was first introduced. It is what is commonly referred to in this country as *O. tuna* Mill. but as recently pointed out by Berger[1], Maiden[2], and others, we cannot tell what *O. tuna* is and can see no immediate prospects of determining. Different authors have referred to it species of very widely differing characteristics. Some forms of this species are very nearly as spineless as what passes for *O. ficus-indica* in this country. (See the next number).

No. 6562 secured from The Albert S. White park, Riverside, California, June 29, 1904, sample consisting of 17 fruits from 5 plants.

No. 6575 collected from same plants as No. 6562 July 7, 1904, sample represented by formula 2-2-1-1.

No. 7810 collected from same plants as above May 1, 1905, sample represented by formula 2-1-½.

No. 7841 collected from same plants as above May 2, 1905, sample consisting of 9 fruits from 4 plants.

1. Eng. Bot. Jahrbuch. *36:* 456. 1905.
2. Agr. Gazette, New South Wales, *9:* 997. 1898.

Chemical Analyses.

	Green.				Air Dry.			
Sample No.	6562[1]	6575	7810	7841[1]	6562[1]	6575	7810	7841[1]
Spines	.....	.32	.04	.....	.....	3.33	.33	.....
Water	89.09	91.07	89.41	85.41	6.20	7.33	6.83	3.97
Ash	.91	2.00	1.60	.77	7.80	20.80	14.05	5.07
Crude Protein	.48	.32	.35	.46	4.16	3.29	3.07	3.06
Crude Fat	.33	.12	.23	.33	2.85	1.20	2.00	2.20
Nitrogen Free Extract	7.31	4.95	7.21	10.03	62.84	51.43	63.48	72.58
Crude Fiber	1.88	1.54	1.20	3.00	16.15	15.95	10.57	13.12
Organic Matter	10.00	6.93	8.99	13.82	86.00	71.87	79.12	90.96

1. Fruit.

Nos. 7519 and 7577.

NOPAL DE CASTILLA

OPUNTIA *sp.*

We consider this to be the same as the Mission pear of southern California. It is cultivated in several situations in and about Laredo, Texas, and apparently has two forms, one somewhat spiny, resembling very closely the mission pear and the other nearly spineless. No. 7519 was from the spiny form; No. 7577 is nearly spineless. We have not seen the fruit of either one of these forms, consequently prefer to keep them separate from the previous numbers.

No. 7519, collected at Laredo, Texas, January 19, 1905, sample sepresented by formula 0-1-0-1-1, from 3 plants. All of the plants have been grown from a single cutting.

No. 7577 collected at Laredo, Texas, February 27, 1905, sample represented by formula 1-1-1, from 3 plants. These plants are supposed to have been introduced from Mexico.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	7519	7577	7519	7577
Spines	.36	.....	1.82	.....
Water	81.16	92.25	5.18	8.12
Ash	4.29	1.75	21.65	20.80
Crude Protein	1.32	.63	6.68	7.53
Crude Fat	.28	.16	1.40	1.85
Nitrogen Free Extract	8.88	4.02	44.56	47.60
Crude Fiber	4.07	1.19	20.53	14.10
Organic Matter	14.55	6.00	73.17	71.08

No. 7733.

NOPAL CHAVENO

OPUNTIA *sp.*

A tall, open branching tree 10 to 12 feet high, with a black, scarly trunk, 8 to 10 in. in diameter; joints obovate in proportion of 9 x 12 in., which is a common size, yellowish-green,

indistinctly short hairy or only pappilate; areoles circular below to broadly obovate above, about 3 16 in. in longest diameter but increasing in size with age, $\frac{3}{4}$ to $1\frac{1}{4}$ in. apart; wool tawny-brown, black where exposed; spicules lemon yellow, very variable in length, at times scarcely reaching surface of joint and at others $\frac{3}{8}$ in. long; spines erect, divergent, 4 to 8 on sides of last year's joints but increasing in number for 8 or 10 years, $\frac{1}{4}$ to $\frac{3}{4}$ in. long, flattened and twisted on older joints; flowers yellow to light orange, with greenish filaments, reddish style and bright, light green stigma; fruit obovate, red, with a deeper red pulp, formidably protected by long, yellow spicules and when young by hair-like, fugacious spines $\frac{1}{2}$ in. long, which drop off at maturity from areoles $\frac{3}{8}$ to $\frac{1}{2}$ in. apart.

In the Chaveño group the Mexicans recognize several varieties. We consider them to be one botanical species separated by minor but quite constant differences. They will receive further treatment in a future publication.

Collected at Aguas Calientes, Mexico, April 10, 1905, sample represented by formula 2-1-1, from 3 plants.

Chemical Analyses.

No. 7733.

	Green.	Air Dry.
Spines	.27	2.08
Water	88.01	6.48
Ash	2.61	20.34
Crude Protein	.47	3.66
Crude Fat	.23	1.87
Nitrogen Free Extract	6.81	52.57
Crude Fiber	1.87	15.08
Organic Matter	9.39	73.18

Analyses of the Ash.

Sample No	Per Cent. Carbon	Per Cent. Sand	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric acid radicle (PO_4)	Sulphuric acid radicle (SO_4)	Chlorine (Cl)	Carbonic acid radicle (CO_3)
7733	.19	2.05	1 55	.15	.26	.16	27.49	3.30	11.20	.29	.33	1.45	.53	53.40

No. 7518.

NOPAL DURASNILLO BLANOQ

OPUNTIA LEUCOTRICHA DC. *Revue de la Fam. d. Cact. 119. 1829.*

A tall, erect, open branching tree, 8 to 15 feet high, with a trunk 8 to 12 in. in diameter; joints obovate, conspicuously pubescent, grayish-green; areoles circular to obovate, less than ½ in. apart; spicules yellow, 1-16 in. or more long; spines varying with age, ¼ to ½ in. long on last year's joints but on four-year-old ones often 3 in. long, 1 to 7 in number, increasing with age, flattened, flexuous, twisted and, upon old trunks, tangled, yellow when young but turning white and giving a gray appearance to the old trunks, very weak and brittle; flowers yellow, 1½ to 2 in. across, with style and filaments white or greenish and stigma bright dark green; fruit light yellow throughout, short-obovate to subglobose, pubes cent, formidably protected by yellow spicules and, when young, with hair-like, fugacious spines from areoles about ¼ in. apart.

The above notes apply to the Nickels' specimen which was probably introduced from Mexico by Mrs. Nickels, although there are no distinct records. Throughout the northern plateau region, especially from Gutierrez to Aguas Calientes and San Luis Potosi, there is another distinct form growing with this one known as nopal durasnillo colorado, which has light purplish-red fruit. In all other respects the two forms are alike, except that there is a greater tendency for the

flowers of durasnillo colorado to be red and the spines shorter. The outer sepals are commonly red on the outside in both forms and this color often extends through the midribs of the inner segments also. (See Pl. IV).

Secured from the private collection of Mrs. Ann B. Nickels, Laredo, Texas, January 18, 1905, sample represented by formula 0-1-1-1, from 3 plants originating from one cutting.

Chemical Analyses

No. 7518.

	Green.	Air Dry.
Spines	.03	.68
Water	95.50	3.95
Ash	1.17	25.08
Crude Protein	.34	7.23
Crude Fat	.12	2.58
Nitrogen Free Extract	2.24	47.21
Crude Fiber	.63	13.95
Organic Matter	3.33	70.97

Nos. 7593 and 7594.

NOPAL JOCONOXTLE

OPUNTIA *sp.*

A tall, open branching tree 7 to 10 feet high, with a black, scaly trunk 6 to 10 in. in diameter; joints obovate in proportion of 7½ x 9 in., which is a common size, gray green, with a very short, scattering pubescence; areoles ½ to ¾ in. apart, broadly oval, 3-16 in. longest diameter but often ¼ in. on edges of joints, spines upon last year's growth 4 to 10, usually 5 to 7, but increasing very much as the joints grow older, up to about the fourth year, when they begin to abraid off, very variable, ¼ to 1 in. in length and lengthening but very little with age, white, soon mottled, flattened, weak, longer ones twisted; flowers yellow; fruits subglobose, depressed, about 1½ in. in longest diameter, truncate at apex, rind comparatively thick and not easily separable from pulp, yellowish-green throughout.

The species is characterized by hairy joints, weak short

spines, yellow spicules and greenish fruit with thick rind. It differs from the forms of durasnillo in being less hairy and having spines, although weak, uniformly short and erect. It also matures its fruit much later than the durasnillo group. This particular form of Joconoxtle has not been found at any other place.

No. 7593 collected at Aguas Calientes, Mexico, March 7, 1905, sample represented by formula 1-1-0-1, from 3 plants.

No. 7594 collected from the same plants at the same time, sample consisting of 20 fruits from 3 plants.

Chemical Analyses.

	Green.		Air Dry.	
Sample No.	7593	75941	75.93	75941
Spines	.45	.....	4.17	.....
Water	89.42	92.35	2.60	2.98
Ash	2.18	1.13	20.08	14.40
Crude Protein	.50	.36	4.60	4.60
Crude Fat	.17	.20	1.60	2.60
Nitrogen Free Extract	6.37	4.97	58.62	63.04
Crude Fiber	1.36	.98	12.50	12.38
Organic Matter	8.40	6.52	77.32	82.62

1. Fruit.

Nos. 7621 and 7623.

NOPAL YINATERO

OPUNTIA *sp.*

An open branching tree 12 to 15 feet high, with scaly black trunk 14 in. diameter; joints narrowly obovate, 3½ to 4½ in. by 6 to 8 in., prominently pubescent, soft and silky to the touch, tuberculate, yellowish-green, turning to a light rusty brown and finally black; areoles ⅞ to 1⅛ in. apart, small, sircular, obovate, about ⅛ in. in longest diameter; spicules usually invisible on upper portion of joint but protruding 1-16 in. or more from upper portion of lower areoles or occupying them entirely when no spines are present as is usually the case, brown in situ but yellow when removed; spines translucent, turning to white irregularly but with tips persistently trans-

lucent for 3 or 4 years, commonly ½ to ¾ in. long, 1 to 3 on sides and 2 to 4 on edges of joints, increasing to as many as 6 on 3-year old growth, erect, divergent and but rarely recurved; flowers said by natives to be orange red; fruit oval, about 1⅛ x 1⅝ in., tuberculate, areolate, with areoles ⅜ in. apart and areas between them separated by a dark line, dull red when mature but pulp turns red before outside.

The species is easily recognized by its comparatively small narrowly obovate, pubescent, tuberculate joints.

No. 7621 collected at San Luis Potosi, Mexico, March 11, 1905, sample represented by formula 1-1-2-1, from 1 plant.

No. 7623 collected from the same tree, sample consisting of 12 fruits.

1. The species to which this name is applied about Aguas Calientes and Encarnacion, Mexico, have uniformly larger joints and stouter spines. Only a few plants were found at San Luis Potosi.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	7621	76 231	7621	76231
Spines	.27	.....	2.70	.....
Water	90.45	85.16	4.74	6 71
Ash	2.51	1.56	24.91	9.78
Crude Protein	.65	1.26	6.46	7.92
Crude Fat	.17	.99	1.70	6.25
Nitrogen Free Extract	4.93	6.58	49.27	41.39
Crude Fiber	1.29	4.45	12.85	27.95
Organic Matter	7.04	13.28	70.28	83.51

1. Fruit.

Nos. 6525 and 7640.

PRICKLY PEAR. NOPAL

OPUNTIA MICRODASYS *Lehm. Nov. Act. Nat. Cur.*[2] *16: 317. 1827.*

A low, prostrate or ascending plant, 2 feet or less high; joints in proportion of 4x5 in., which is a common size, obovate, conspicuously pubescent; areoles circular, ¼ to ⅜ in. apart; spicules yellow, prominent, spreading, forming a cap-

2. This reference has not been seen.

like bunch ¼ in. in diameter and developing anew from lower part of areole for at least 3 years, old joints often appearing with old, gray, dirty spicules above and bright new, yellow ones below; spines entirely absent; flowers yellow with white or greenish filaments and style and bright dark green 6 to 8.parted stigma; fruit small, subglobose or obovate, usually less than 1 in. long, with thin rind, green, with a blush of purple on outside but the interior greenish throughout, formidably protected by closely set areoles filled with yellow spicules.

This is one of the most common of the cultivated prickly pears of both garden and conservatory on account of the attractive appearance of its conspicuous bunches of spicules, its hardiness and ease of propagation. Its small size, as well as its numerous small spicules, render it highly improbable that it will ever amount to anything as a stock food. Some forms have brown spicules and are found in some collections under the name of *O. rufida* but the latter is a very different plant.

No. 6525 collected at Alonzo, Mexico, June 10, 1904, sample represented by formula 7-2-1+ 17 small green fruits from 3 plants.

No. 7640 collected from same plants as No. 6525, March 14, 1905, sample represented by formula 1-1-1.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	6525	7640	6525	7640
Spicules	.....	.....	.....	.....
Water	84.58	88.12	6.47	2.80
Ash	3.57	2.18	21.65	17.88
Crude Protein	.72	.49	4.38	4.05
Crude Fat	.31	.20	1.90	1.61
Nitrogen Free Extract	7.53	7.51	45.65	61.42
Crude Fiber	3.29	1.50	19.95	12.24
Organic Matter	11.85	9.70	71.88	79.32

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
6525	.28	11.65	9.00	1.02	.92	.35	25.00	3.40	11.50	.22	.98	1.73	1.26	39.53

Nos. 6690 and 7888.

PRICKLY PEAR. NOPAL

OPUNTIA BASILARIS *Engelm. and Bigel. Pacif. Ry. Rep. 4: 43. Pl. 13, f. 1-5. 1856.*

A low, prostrate or ascending, bluish-green to purplish plant, seldom over two joints high; joints broadly obovate to triangular and often obcordate and contracted below into a stipitate base, pubescent or nearly smooth, blue green to purplish; areoles depressed, transversely elliptical below but vertically elliptical to obovate above, ¼ in. apart; wool tawny, scarce; spicules reddish-brown, numerous, occupying nearly the entire areole; spines none; flowers magenta, 3 in. in diameter, filaments bright red, style a little lighter and 8 or 9-parted, white or reddish tinged stigma; fruit obovate, subglobose to tuberculate, green, dry, with large, white, angular seed.

No. 6690 collected at Hackberry, Arizona, July 25, 1904, sample consisting of 6 joints of the previous year from 6 plants.

No. 7888 collected in same locality May 9, 1905, sample represented by formula 3-1, from 4 plants.

Chemical Analyses.

	Green.		Air Dry.	
Sample No.	6690	7888	6690	7888
Spines	.....	.....	.....	.....
Water	81.00	85.30	6.08	3.13
Ash	4.04	2.70	19.98	17.78
Crude Protein	.76	.63	3.77	4.16
Crude Fat	.38	.34	1.90	2.23
Nitrogen Free Extract	11.43	9.66	56.52	63.64
Crude Fiber	2.38	1.37	11.75	9.06
Organic Matter	14.96	12.00	73.94	79.09

No. 6675.

OPUNTIA TRELEASII KERNI *n. var.*

A low prostrate or ascending, spreading species forming somewhat extensive thickets as well as growing in scattering individuals, seldom a foot high; joints 3 to 4 in. x 5 to 7 in., obovate, with contracted, stipitate base or simply ovate or even tunicate above, gray green with surface of older joints almost black, smooth or indistinctly minutely pubescent; areoles subcircular to obovate, less than $\frac{1}{8}$ in. in diameter and about $\frac{1}{3}$ in. apart, filled with a prominent light brown bunch of spicules $\frac{1}{8}$ to $\frac{1}{4}$ in. long upon last year's joints, in this year's joints they are fewer in number and surrounded by conspicuous white wool, the spicules fading in the third year to a dirty yellow; spines rather weak but persisting indefinitely without increasing in number, erect-divergent, dirty yellow with darker tips, 2 to 4 in number and very variable in length, $\frac{1}{4}$ to $1\frac{1}{2}$ in. long, all from lower part of aroele; flowers magenta, large and showy, differing in no way from those of *O. basilaris*, with filaments bright red, style slightly tinted, stigma yellow, 6-parted; fruit obovate to subglobose, about $1\frac{1}{4}$ x $1\frac{1}{2}$ in., dry, with spicules and spines much like those of the joints, tuberculate, green or with a tinge of purple upon the tubercles; seeds large, angular, white.

This description is very different from the original one for *O. treleasii*, but it fits our plant, which represents the other extreme of the species described by Professor Coulter. In fact, there is in this species a complete gradation from a

perfectly spineless to a densely spiny form. Typical *O. treleasii* resembles *O. brsilaxis* rather closely but it has areoles sunken, joints more rounded at the apex, longer more prominent spicules, and a more glaucous appearance. This type form passes by almost imperceptible gradations into the variety described above. Our collections show a complete connection between *O. treleasii* and this spiny variety.

The botanical type of the variety is No. 8321 D. G. collected near Kern, California, May 27, 1906.

Collected at Bakersfield, California, July 21, 1904, sample represented by formula 4-5-1, from 5 plants.

Chemical Analyses.

	Green.	Air Dry.
Sample No.	6675	66.75
Spines	.63	4.34
Water	82.34	7.90
Ash	3.71	19.33
Crude Protein	.94	4.92
Crude Fat	.39	2.03
Nitrogen Free Extract	9.85	51.37
Crude Fiber	2.77	14.45
Organic Matter	13.95	72.77

No. 7734.

OPUNTIA RUFIDA *Engelm. Proc. Am. Acad. Arts & Sci. 3-298. 1856.*

An erect, open branching plant 3 to 5 feet high, with a distinct trunk 4 to 6 in. in diameter; joints subcircular to broadly obovate in proportion of 7x8½ in. which is rather under size, commonly 10 in. in diameter, pubescent, gray green; areoles subcircular, slightly raised on lower side, 3-16 in. in diameter and ⅝ to 1 in. apart; wool tawny; spicules reddish-brown, in a crescentric bunch in upper portion of areole but soon surrounding it entirely, the center of the areole developing even upon oldest trunks into a cylindrical, curved or coiled structure ½ in. or more long, upon which the spicules develop indefinitely, often nearly covering the entire trunk;

spines entirely absent; flowers yellow to orange with red in portions exposed in the bud, which makes them appear red when closed, with filaments and style from greenish-white to orange, and stigmr dark bright green, 8-parted; fruit not examined.

Our specimens correspond exactly with the type of the species in the herbarium of the Missouri Botanical Garden, but specimens of fruit have never, so far as we are aware, been collected. Our only experience with fruited forms has been from a car window between Torreon and Monterey in July, 1905. They are bright red, resembling in color those of *Opuntia stenopetala* very much from a distance. The plains form of the plant differs in many ways, though, from that growing in the foothills about Torreon, where our sample was collected. Our No. 8023 from Tizoc is a good illustration of the plains form with either subcircular or oval joints, with smaller areoles and a purplish tinge. These are smaller plants throughout than those growing upon the rocky mountain sides.

Collected at La Perla, Mexico, April 11, 1905, sample represented by formula 1-1-1, from 2 plants.

Chemical Analyses

	Green.	Air Dry.
Sample No.	7734	7734
Spines	.....	.....
Water	76.92	5.18
Ash	4.84	19.90
Crude Protein	.85	3.50
Crude Fat	.44	1.83
Nitrogen Free Extract	12.81	52.56
Crude Fiber	4.14	17.03
Organic Matter	18.24	74.92

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric acid radicle (PO_4)	Sulphuric acid radicle (SO_4)	Chlorine (Cl)	Carbonic acid radicle (CO_2)
7734	.62	.78	2.54	.46	.15	.67	34.79	1.66	3.46	.11	.72	1.51	.30	54.17

Nos. 6576, 6577 and 7811.

NOPALEA[1] *sp.*

An erect, profusely branching shrub 5 to 8 feet high; joints small, obovate, 3x6 in., which is a common size for last year's growth, prominently tubercled, bright yellowish-green; leaves about $\frac{3}{8}$ in. long, subulate, mucronate; areoles upon prominent tubercles, which, upon young growth, appear like white or yellowish cushions, so prominent is the wool, obovate, triangular, and perpendicular to surface of joint when young but later simply slightly raised 3-32 to $\frac{1}{8}$ in. above surface of joint, about $\frac{3}{4}$ in. apart; spicules yellow, not prominent; spines very numerous and formidable, erect, divergent in all directions, 4 to 12, yellowish, turning to gray, increasing but little in length or numbers after second year, slightly flattened, usually less than 1 inch long; flowers red with red filaments and style and light green, 5-parted stigma; fruit small, subglobose to obovate, red, deeply pitted at apex, tuberculate, with areoles $\frac{1}{8}$ to $\frac{1}{4}$ in. apart, bearing a small number of spicules and 1 to 3 spines.

This species grows very rapidly and although the joints are small it may have some value as stock food. Botanically it appears to be more closely related to *N. auberi* than any other species but it differs considerably from the descriptions of this and no authentic material has been seen. (See Pl. III, fig. 1.)

1. This genus differs from *Opuntia* mainly in stamens and pistil being longer than the petals which are connivant about the pistil when in full bloom instead of spread ing out into a bellshaped flower like the Opuntias.

No. 6576 secured from The Albert S. White park, Riverside, California, July 7, 1904, sample represented by formula 3-3-2-1, from 3 plants.

No. 6577 secured from the same plants and on same date as No. 6576, sample consisting of 51 fruits from 4 plants. This was all previous year's fruits, which still clung to the shrubs.

No. 7811 secured from the same plants as No. 6576 April 29, 1905, sample represented by formula 1-1-1-1, from 3 plants.

Chemical Analyses

	Green.			Air Dry.		
Sample No.	6576	6577[1]	7811	6576	6577[1]	7811
Spines	1.68	.....	.85	14.41	.....	5.56
Water	89.31	89.36	85.65	8.33	8.00	5.88
Ash	2.86	1.59	2.38	24.49	13.78	15.63
Crude Protein	.42	.56	.41	3.61	4.82	2.70
Crude Fat	.16	.29	.24	1.35	2.50	1.58
Nitrogen Free Extract	5.42	5.58	9.47	46.47	48.22	62.11
Crude Fiber	1.84	2.62	1.85	15.75	22.68	12.10
Organic Matter	7.83	9.05	11.97	67.18	78.22	78.49

1. Fruit.

CANE CACTI (CYLINDROPUNTIA)

Nos. 6253, 6254, 6255, 7801, 7802, 7796, 8170a and 8170b.

CHOLLA

OPUNTIA FULGIDA *Engelm. Proc. Am. Acad. Arts & Sci. 3: 306. 1856.*

A low, profusely and compactly branched, symetrical tree 4 to 6 or 8 feet high, with a black scaly trunk 3 to 6 in. in diameter; joints cylindrical or ovate, 1½ to 1¾ in. in diameter but very variable in length, bright leaf green, tuberculate, with compressed tubercles having a uniform curvature above and below, completely surrounded by a dark green line; areoles obovate, ¼ to ⅝ in. long and about ¾ in. apart, the tissue enlarging with age and giving rise to a papillate projection ¼ in. or less in height; wool light yellow; spicules white or light yellow, inconspicuous; spines yellowish-white, loosely tunicate with white glistening sheaths, longest 1½ to 2 in. with others shorter, erect-divergent, with lower more or less recurved, 4 to 8 in number upon last year's joints but increasing indefinitely for 8 or 10 years at least from the apical portion of the areolar papillum, flattened but not twisted; flowers greenish yellow; fruit ovate-obovate to subglobose, proliferous, areolate, with white or yellowish spicules, at first deeply depressed at apex but becoming flattened or even convex when fully developed, and three years old or more. (See Pl. VI, fig. 2.)

This is one of the most characteristic cacti of the southern Arizona deserts. It may grow in scattering individuals or form impenetrable thickets which are avoided by cattle except during extreme drouths. It is easily recognized by its succulent, easily separable joints and proliferous fruit. The latter remains upon the trees very often for a period of five or 6 years, fruits giving rise to flowers and subsequently to fruits year after year until a pendant branching bunch containing a score or more of fruits is formed. This is one of the most interestiug charasteristics of the plant. Ordinarily, fruits develop in a single year but in this and a few other species they appear to grow continuously for five years or more. While those produced from June flowers may not

PLATE VI.—CELINDROPUNTIA OR CANE CACTI.

Fig. 1. (*Opuntia Versicolor*) Engelm.

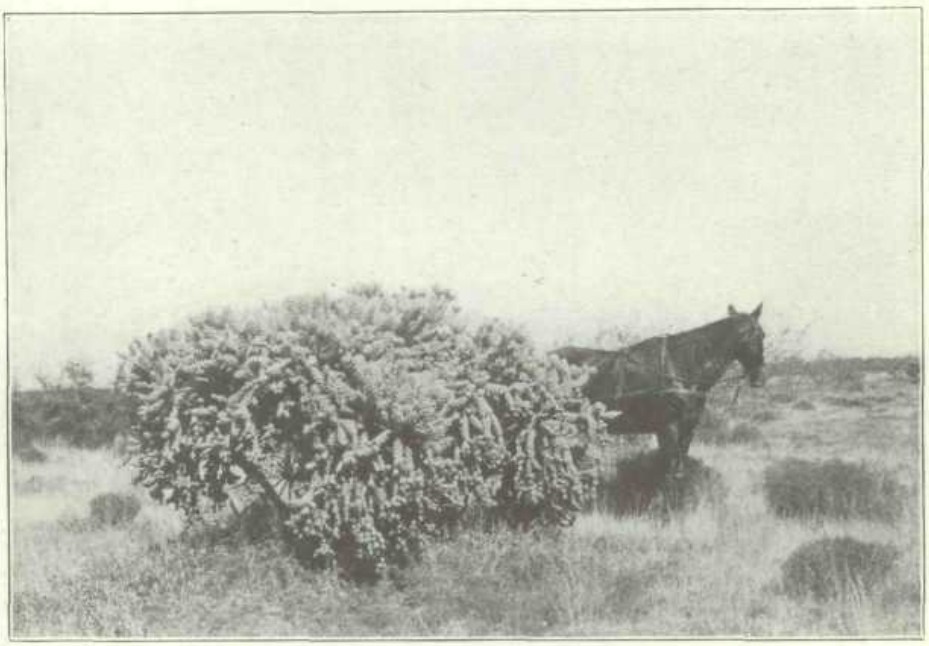

Fig. 2. Cholla, (*Opuntia fulgida.*)

PLATE VII —CYLINDROPUNTIA OR CANE CACTI

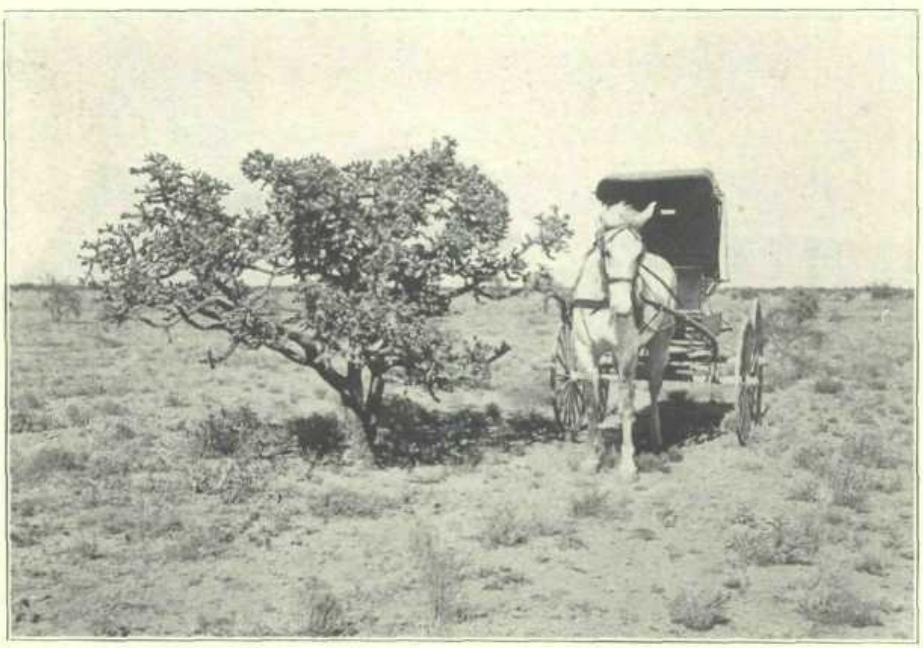

Fig. 1. *Opuntia Spinosior*, (Engelm) Toumey.

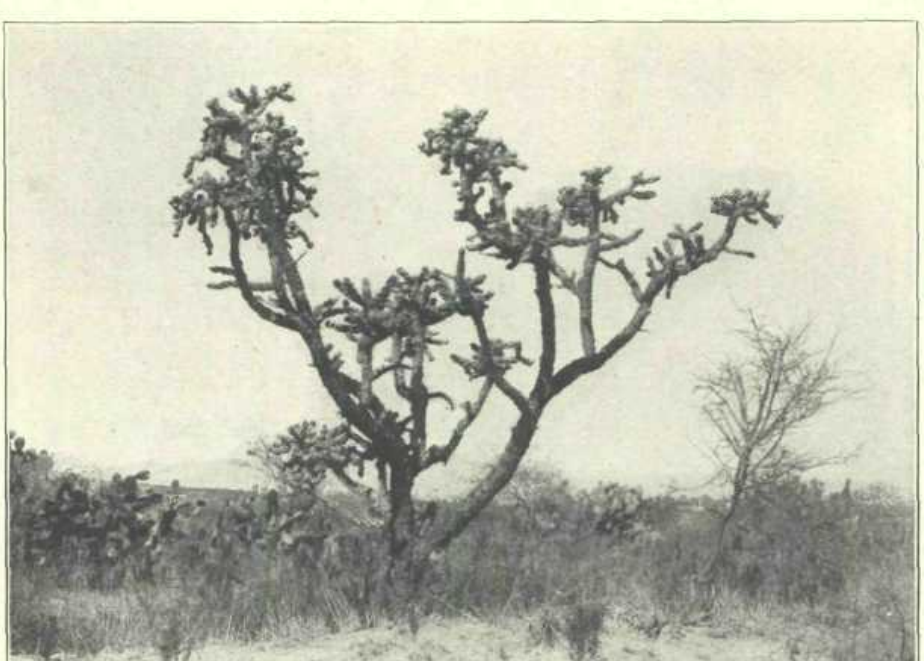

Fig. 2. Cardenche, Goconoxtle. (*Opuntia imbricata*, Haw). D.C.

be over ½ in. in diameter in the fall, when three years old they may be 1½ in. or more in diameter.

A photographic reproduction of a fruited branch of this species will be found in Bull. *4: Pl. 6, f. 2*, Bureau of Plant Industry, U. S. D. A. A photographic reproduction of a very large plant will be found in Gard. and For. *8:* 325. *f. 46*, 1895. (See Pl. VI, fig. 2).

No. 6253 collected in northern foothills of Santa Catalina Mountains, Arizona, May 4, 1904, sample consisting of fruit from 6 plants.

No. 6254 collected at same time and place as No. 6253, sample repretented by formula 0-0-6-1.

No. 6255 collected at same time and place as above, sample represented by formula 6-6.

No. 7801 collected in same locality as above April 25, 1905, sample consisting of fruit 1 to 6 years old from 6 plants.

No. 7802 collected at same time and place as No. 7801, sample represented by formula 2-3-2, from 7 plants.

No. 7796 collected at same time and place as No. 7801, sample represented by formula 0-0-0-1-2-1, from 3 plants.

No. 8170a collected on mesa north of Helvetia, Arizona, October 8, 1905, sample consisting of spiny, largely sterile fruits.

No. 8170b fruit of 8170 analyzed without the seed.

Chemical Analyses

	Green.								Air Dry.							
Sample No	6253[1]	6254	6255	7801[1]	7802	7796	8170a[1]	8170b[1]	6253[1]	6254	6255	7801[1]	7802	7796	8170a[1]	8170b[2]
Spines	.....	1.78	2.27	.....	1.72	.94	.....	.....	.....	6.13	9.60	.....	8.64	2.96	.....	.....
Water	83.48	72.63	78.03	80.29	81.51	70.33	82.84	87.17	4.88	5.60	6.95	5.43	7.10	6.19	5.16	4.55
Ash	2.79	3.88	3.36	3.25	2.21	2.73	2.70	1.58	16.05	13.40	14.25	15.60	11.10	8.63	14.99	11.73
Crude Protein	.59	.95	1.30	.56	.96	.95	.63	.47	3 39	3.29	5.48	2.70	4.82	3.00	3.50	3.50
Crude Fat	.36	.43	.35	.47	.28	.43	.51	.27	2.06	1.48	1.48	2.24	1.41	1.36	2.85	1.98
Nitrogen Free Extract	11.18	20.37	15.37	13.76	14.21	17.99	11.63	9.60	64.36	70.27	65.09	66.05	71.41	56 92	64.12	71.49
Crude Fiber	1.60	1.72	1.59	1·66	.83	7.56	1.69	.91	9.23	5.96	6.75	7.98	4.16	23.90	9.38	6.75
Organic Matter	13.73	23.49	18.61	16.46	16.28	26.94	14.46	11.25	79.07	81.00	78.80	78.97	81.80	85.18	79.85	83.72

1. Fruit.
2. Fruit minus the seed.

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO)
6255	.74	1.65	.63	.21	.53	.09	24.31	8.10	11.89	0.00	2.54	2.00	1.33	42.73

Nos. 6256 and 7800.

CHOLLA

OPUNTIA MAMILLATA *Schott. Proc. Am. Acad. Arts & Sce. 3: 308. 1856.*

The previous numbers are the typical form of *Opuntia fulgida*, with which this species is commonly placed at present but there appears to be a difference which, although not constant, is sufficiently so to warrant our keeping the two forms separate for the purposes of this writing. We doubt whether they are sufficiently distinct to remain separate permanently. Toumey[1] claims that this species increases the number of its spines anp decreases the size of its tubercles when grown upon the desert mesas near Tucson and becomes indistinguishable from the other form. It differs from *O. fulgida* in having larger tubercles and fewer spines.

No. 6256 collected in foothills of Santa Catalina Mountains, Arizona, May 4, 1904, sample represented by formula 5-5-5-1.

No. 7800 collected in the same locality as No. 6256, April 25, 1905, sample consisting of proliferous bunches of fruits 1 to 6 years old from 6 plants.

1. Gard. & For. *8:* 324-326. 1895.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	6256	78001	6256	78001
Spines	.13	.19	.75	1.44
Water	83.60	87.85	6.26	7.63
Ash	2.93	1.95	16.75	14.85
Crude Protein	.96	.66	5.48	5.03
Crude Fat	.30	.38	1.70	2.89
Nitrogen Free Extract	9.57	8.40	54.68	63.87
Crude Fiber	2.65	.75	15.13	5.73
Organic Matter	13.47	10.19	76.99	77.52

1. Fruit.

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (Co_3)
6256	.55	3.57	1.10	.37	.32	.18	23.56	7.62	12.36	.38	1.72	2.44	1.67	45.53

Nos. 6249, 6250, 7795 and 7799.

CHOLLA

OPUNTIA BIGELOVII *Engelm. Pacif. Ry. Rep. 4: 50. Pl. 19, f. 1-7, 1956.*

A compactly and divaricately branched tree 4 to 6 feet high, with a black scaly trunk 3 to 4 in. in diameter; joints easily separable, oblong, cylindrical, 1½ to 1¾ in. in diameter and 4 or 5 in. long, tuberculate, with low compressed tubecles, with lower crest gradual and upper abrupt almost perpendicular to surface of joint; leaves very small, subulate, cuspidate, about ⅛ in. long by 1-32 in. wide; areoles occupying entire upper slope of tubercle, obovate, about 3-16 x ⅛ in.,

very closely set, 3-16 to ¼ in. apart; wool white but yellowish in situ in new growth; spicules almost white, formidable, in a truncate bunch from upper part of areole, ⅛ in. long; spines yellowish-white turning to brown, sheathed comparatively tightly, numerous, 6 to 10 on last year's joints but increasing with age until the stem is completely covered with a loose mass of them often ¼ in. thick, the areolar tissue developing into a tubercle ¼ in. long giving rise to new spines indefinitely, erect-divergent, ½ to 1 in. long; flowers greenish-yellow; fruit greenish-yellow, ovate, depressed at top, areolate like stem, with a circumscribing, dark green line completely surrounding the tubercles, areoles obovate with formidable, yellowish-white spicules and long, delicate, hair-like, fugacious, unsheathed spines.

This is the most formidably protected of any species of this genus known to us. The whole plant is literally covered with erect, divergent, sheathed spines and the joints are very easily separable. The only spcies with which it is likely to be confused in *Opuntia fulgida* in some of its spinier forms, but the more spiny character, smaller tubercles and non-proliferous fruits separate this readily from that species.

No. 6249 collected in foothills of Santa Rita Mountains, Ariz., April 4, 1904, sample represented by formula 8-2-2, from 2 plants.

No. 6250 collected at same time and place as No. 6249, sample consisting of last year's fruit, from 10 plants.

No. 7795 collected in same locality as above April 25, 1905, sample represented by formula 1-1-1-1, from 4 plants.

No. 7799 collected at same time and place as No. 7795, sample consisting of 28 fruits from 8 plants.

Chemical Analyses

	Green.				Air Dry.			
Sample No.	6249	62501	7795	77991	6249	62501	7795	77991
Spines	2.51	1.43	2.58	.....	11.97	6.00	18.18	.....
Water	80.17	77.60	86.75	85.18	5.30	5.89	6.63	5.81
Ash	2.78	3.79	2.12	1.88	13.30	15.88	14.90	11.94
Crude Protein	1.24	1.17	.53	.62	5.91	4.92	3.72	3.94
Crude Fat	.42	.40	.23	.24	2.00	1.70	1.65	1.51
Nitrogen Free Extract	12.03	12.95	8.68	10.33	57.46	54.43	61.20	65.67
Crude Fiber	3.36	4.09	1.69	1.75	16.03	17.18	11.90	11.13
Organic Matter	17.05	18.61	11.13	12.94	81.40	78.23	78.47	82.25

1. Fruit.

Nos. 6245, 6246, 7806, 7778, 8162a and 8162b.

OPUNTIA SPINOSIOR (*Edgelm. and Bigel.*) *Toumey. Proc. Am. Acad. Arts & Sci. 3: 307. 1856; Bot. Gaz. 25; 119-124. 1898.*

A tree 5 to feet high with very open branching habit and a black, scaly trunk 2 to 4 in. in diameter; joints cylindrical, about $\frac{7}{8}$ in. in diameter and of variable length, rather easily separable when young, tubercles flattened, with longest crest downward, completely surrounded by dark green lines; leaves 3 in. long and less than 1-16 in. broad at base, subulate, cuspidate; areoles on upper side of crest of tubercle oval or obovate, $\frac{1}{8}$ in. in greatest diameter, increasing in size with age; wool tawny, varying to dark, dirty gray; spicules yellow, usually inconspicuous but sometimes 1-16 in. long; spines 8 to 12 on last year's joints but increasing with age to three times as many, $\frac{1}{2}$ to $\frac{3}{4}$ in. long, there being a proliferation of areolar tissue outward and upward, the spines developing from this in all directions, sheathed closely for entire length in both large and small spines but sometimes only one-half of smaller ones covered, erect-divergent with usually a few recurved, white or reddish but fadding to a dirty gray; flowers purplish-red, ovary conspicuously and completely covered with tubercles and bearing, besides spicules, fugacious, hair like, unsheathed spines.

This is one of the common species of southern Arizona and has been fed to a limited extent in a few instances. It is rather woody and of less value for feeding purposes than the

cholla with which it is almost invariably associated. The description of the fruit given above applies to that which the writers have ordinaaily met with in the field. When grown under favorable conditions it is much less tubercular than indicated above, indeed well developed fruits may often be found which are almost smooth. This is especially true of those which have remained upon the trees until the following season. This difference is especially noticeable in forms growing in the foothills. These are always more plump and less tubercular than those growing in less favorable situations upon the desert mesas. (See Pl. VII, f. 1.)

No. 6245 collected in northern foothills of Santa Rita Mountains, Arizona, April 30, 1904, sample represented by formula 5-5-3, from 5 plants.

No. 6246 collected at same time and place as No. 6245, sample consisting of last year's fruits.

No. 7806 collected at Tucson, Arizona, April 27, 1905, sample represented by formula 3-2-1-1, from 6 plants.

No. 7778 collected near Helvatia, Arizona, April 17, 1905, sample consisting of 16 fruits from 4 plants.

No. 8162a collected in northern foothills of Santa Rita Mountains, Arizona, October 6, 1905, sample consisting of 64 fruits from 8 plants.

No. 8162b the same as 8162a less the seed.

Chemical Analyses

	Green.						Air Dry.					
Sample No	6245	6246[1]	7806	7778[1]	8162a[1]	8162b[2]	6245	6246[1]	7806	7778[1]	8162a[1]	8162b[2]
Spines	.....	.....	.93	.....	.....	.....	.....	.....	3.92	.....	.....	.....
Water.....	73.43	75.27	77.37	80.97	77.74	83.04	4.58	4.95	4.14	3.51	4.85	5.13
Ash.....	3.31	3.25	4.32	2.77	2.97	3.10	11.90	12.50	18.28	14.04	12.71	17.36
Crude Protein.....	1.58	1.48	1.16	1.38	1.74	.55	5.69	5.69	4.92	7.01	7.44	3.06
Crude Fat.	.47	1.88	.30	1.12	1.11	.24	1.67	7.23	1.40	5.64	4.75	1.35
Nitrogen Free Extract.....	17.26	12.25	14.88	9.55	11.50	11.74	61.91	47.06	62.91	48.43	49.10	65.65
Crude Fiber.....	3.95	5.87	1.97	4.21	4.94	1.33	14.17	22.57	8.35	21.37	21.15	7.45
Organic Matter...	23.26	21.48	18.31	16.26	19.29	13.86	83.52	82.55	77.58	82.45	82.44	77.51

1. Fruit.
2. Fruit less seed.

Nos. 6251, 6252, 7793 and 7797.

OPUNTIA VERSICOLOR *Engelm. Contr. U. S. Nat. Herb. 3: 452, 1896.*

A very loosely branched, symetrical tree, 5 to 10 feet high, with a black or gray scaly trunk 2 to 4 in. in diameter; joints cylindrical, very variable in length, less than 1 inch in diame; ter for two or three years, often only ½ to ¾ in., tuberculate, with compressed, low tubercles having gradual slanting crest downward but abrupt above; leaves ¼ in. or more long and less than 1-16 in. in diameter at base, subulate, cuspidatel areoles oval, about ⅛ x 3-16 in., on upper shorter and steeper slope of tubercle; wool light yellow turning to gray and finally black with age, presenting convex surface and occupying greater part of areole; spicules red in a small inconspicuous bunch on upper side of areole, less than 1-32 in. in length, often not visible; spines numerous, 3 to 7 on last year's joints but increasing on older ones to 10 to 14 or even more, the larger ones completely and the smaller ones only partially sheathed, the distal one-half or less being covered, sheaths gray with brownish tips closely fitting and spines a translucent brown becoming dirty gray with age; flowers varying from greenish yellow through bright yellow to reddish purple with filments green to chocolate or red and stigma yellow, 6 or 7-parted; fruit green, obovate, 1 to 1½ in. x 1¼ to 1¾ in., very tuberculate at first and retuse at apex but, when fully mature and fertile, practically smooth and truncate at top, often even convex, areolate like the stem but with smaller areoles, bearing spicules and long, delicate, fugacious, hair-like, unsheathed spines. (See Pl. VI., Fig. 1).

There is a great variation in the color of spines and flowers in this species, there appearing to be a correlation between the color of spines and flowers, the darker spined forms having more red in the composition of their flowers. In this, as in many other species, the fruit clings to the tree much longer in the lower mountain canyons than it does in more exposed situations in the lower foothills. This circumstance, it is possible, may necessarily be correlated with the difference in temperature in these situations. It is a well known fact that the temperature does not run as low close to the mountains as it does upon isolated ridges lower down in the valleys. In the lower foothills close to the Santa Cruz river the fruit of this

species falls off in early winter but here it remains attached to the tree until April. But influence of a greater supply of moisture in this situation is also to be reckoned with. It should also be noted that the fruit in this locality is very much infected by a dipterous larva which tends to cause it to revert to the vegetative condition, become more or less abnormal in many respects, and remain attached to the plants until the maturity of the insect. Such abnormal fruits are excluded from both our descriptions and our samples. (See Pl. VI. Fig. 1).

No. 6251 collected in upper foothills of Santa Catalina mountains, Arizona, May 4, 1904, sample represented by formula 4-4-4-4-4, from 6 plants.

No. 6252 collected at the same time and place as No. 6251, sample consisting of fruits from 5 plants.

No. 7793 collected in same locality as above numbers Apri-28, 1905, sample represented by formula 2-2-2-2, from 7 plants-

No. 7797 collected at same time and place as No. 7793, sample consisting of 24 fruits from 7 plants.

Chemical Analyses

	Green.				Air Dry.			
Sample No.	6251	62521	7793	77971	6251	62521	7793	77971
Spines	2.09	.....	.26	.....	7.36	.....	1.45	.....
Water	73.16	75.13	80.51	78.10	5.58	3.85	5.96	5.72
Ash	5.69	3.44	3.62	2.65	20.00	17.30	17.49	11.40
Crude Protein	2.24	1.30	1.30	1.12	7.88	5.04	6.28	4.82
Crude Fat	.45	.84	.33	.64	1.60	3.23	1.58	2.75
Nitrogen Free Extract	12.82	11.68	10.53	10.72	45.09	45.15	50.84	46.16
Crude Fiber	5.64	7.61	3.70	6.77	19.85	29.43	17.85	29.15
Organic Matter	21.15	21.43	15.86	19.25	74.42	82.85	76.55	82.88

1. Fruit.

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
6251	.66	1 29	.49	.26	0.00	.16	29.53	4.76	6.59	1.67	2.49	2.55	2.38	45.37

Nos. 7735 D. G. and 3019, 3070a, 3070b and 3071 E. O. W.

CANE CACTUS, CANDEL ABRUM-CACTUS

OPUNTIA ARBORESCENS *Engelm. (Wisliz. Rep.) U. S. Sen. Miscel. Doc. No. 26 Sess. I, 30th Cong. 90, 1848.*

A large, open branching tree form, 5 to 8 feet high, with trunks 3 or more inches in diameter; last year's joint commonly 6 to 8 in. long, others longer, whirled or alternate, about 1 in. in diameter, with prominent compressed tubercles about 1½ in. long, with curvature of upper and lower portion of crest equal; leaves subulate, ½ in. long by ⅛ in. wide; areoles about ¼ x 3-16 in. on last year's joints, situated about midway on upper slope of tubercle, gray; wool prominent, projecting slightly in smooth surface, tawny-yellow; spicules yellow, short, inconspicuous, in triangular area in upper part of areole; spines red, tunicate, with sheath white below and tinted outward, 2 to 7 on last year's joints, up to 11 or 12 on year before last's and ir creasing constantly as the joints grow older, erect-spreading, with lower ones recurved when they become numerous, occasionally 2 or 3 hair-like, unsheathed additional ones on edge of areole; flowers purple with obovate, spatulate, mucronate, truncate floral segments, 2 in. or more across, reddish style, dark chocolate to red filaments and white 6 or 7-parted stigma; ovary pyriform, prominently tubercled, with areoles on upper almost perpendicular side of crest, bearing 1 to 4 or 5 long, hair-like, fugacious spines, sheathed at apex only, tubercles becoming less prominent as ovary approaches maturity.

The statement made above with reference to color of spines

holds in general but many plants are found, especially northward, with yellowish spines. We are unable to distinguish any constant differences between *Opuntia arborescens* which grows in the foothills regions from Pueblo, Colorado, southward and believe the same species ranges from southern Colorado to some distance south of Torreon. See notes after next number.

No. 7735 D. G. eollected at Torreon, Mexico, April 11, 1905, sample represented by formula 2-1-1-1, from 5 plants.

No. 3019 E. O. W. collected at El Rito, New Mexico, August 18, 1904, specimen consisting of joints.

No. 3070a E. O. W. collected at Agricultural College, New Mexico, December 22, 1904, sample consisting of joints.

No. 3070b E. O. W. same as 3070a, sample consisting of spines only.

No. 3071 E. O, W. collected at same time and place as No. 3070, sample consisting of fruits.

Chemical Analysfs

	Green					Air Dry				
Sample No.....	7735	3019	3070a	3070b	3071	7735	3019	3070a	3070b	3071
Spines.....	.65	.86	2.82	.....	.....	2.27	7.89	8.94	.....	.....
Water.....	72.67	89.97	69.66	8.73	66.57	5.26	7.43	3 85	.....	4.97
Ash.....	7.99	2.10	6.03	3.73	4.45	27.71	19.35	9.13	4.09	12.66
Crude Protein.....	1.58	1.16	2.97	1.60	2.62	5.48	10.73	9.42	1.75	7.45
Crude Fat..... ...	.40	.15	.75	.88	2.52	1.40	1.35	2.38	.95	7.15
Nitrogen Free Ex.	13.40	5.43	16.55	40.89	15.02	46.43	50.14	52.44	36.08	42.67
Crud Fiber.....	3.96	1.19	4.03	44.17	8.82	13.72	11.00	12.78	48.40	25.10
Organic Matter....	19.34	7.93	24.31	87.54	28.98	67.03	73.22	77.02	87.18	82.37

Nos. 6523, 6527, 6540, 7595 and 7597.

GOCONOXTLE, CARDENCHE, TUNA JUELL

OPUNTIA IMBRICATA *(Haw) D. C. Prodramus 3: 47, 1828, Cereus imbricatus Haw. Rev. Pl. Suc. 70, 1821.*

An open branching shrub 5 to 10 feet high, with a trunk 3 to 5 in. in diameter; joints cylindrical, oval, very variable in length and diameter, 1 to 2 by 3 to 12 in.; prominently tuber-

culate with tubercles compressed, ⅜ to ½ in. wide by 1½ in. long at base and ½ in. high, the furrows between the tubercles being distinctly marked by a dark green line, upper and lower curvature of crests equal; leaves ¾ in. long by ⅛ in. in greatest diameter at base, subulate, cuspidate; areoles oval, 5-16 to ⅜ in. long, tawny, increasing in size with age; wool tawny; spicules yellowish, 1-16 in. or more long; spines white or yellowish, divergent in all directions, the most prominent centrally located in lower part of areole, about 1 in. long with smaller ones surrounding it, largest ones completely and loosely tunicate, with white glistening sheaths, but the smaller only partially sheathed with close fitting covering, 5 to 10 in number on younger joints, increasing to 20 or more on 2 and 3 year old wood; flowers purple with reddish-purple style, chocolate colored filaments and 6 or 7-parted, yellowish-white stigma; fruit oval to subglobose, remaining attached to trees 3 to 5 years and continuing to develop to 2 in. in diameter, green, at first tuberculate, but nearly smooth later, and russet after two or three years old.

This is one of the common characteristic cylindrical-jointed species of the plateau region of Mexico. It is a conspicuous plant from San Luis Potosi to Gutierrez and southward.

Like *Opuntia fulgida*, the fruit remains attached to the trees in this species for several years. One has no difficulty, however, in recognizing fruits one, two or three years old by their general appearance. The younger ones are always smaller, more tuberculate and depressed at the apex. One will usually find a series of sizes, indicating the different years' growths. Stock does not appear to disturb the fruit in the open country but the natives singe the plant with brush and feed it.

It is our judgment that *O. arborescens* Engelm. and *O. imbricata* (Haw.) DC. had better be treated as distinct species. In this treatment we consider the latter to be the form from the highlands of central Mexico. Weber was of the opinion that they should be united but he was evidently better acquainted with the central Mexican forms than those of northern Mexico and southern United States. It appears to us that the two are wholly different in fruit characters as well as in some other minor details. In *O. imbricata* the fruit remains attached

to the trees for three years or more, continuing to develop constantly into an almost smooth subglobose, fleshy russet body, while in the *O. arborescens* it is decidedly tuberculate and never remains on the trees longer than the following spring. In some cases the fruit of *O. imbricata* is also proliferous. (See Pl. VII, Fig. 2.)

No. 6523 collected at San Luis Potosi, Mexico, June 9, 1904, sample consisting of 15 fruit from 6 plants, all over one year old.

No. 6527 collected at Alonzo, Mexico, June 10, 1904, sample represented by formula 5-4, from 5 plants.

No. 6540 collected at San Luis Potosi, Mexico, June 12, 1904, sample consisting of 15 fruits from 5 plants.

No. 7595 collected at San Luis Potosi, Mexico, March 8, 1905, sample represented by formula 2-1-1-1, from 3 plants.

No. 7597 collected at same time and place as No. 7595, sample consisting of 15 fruits from the same plants.

Chemical Analyses

	Green.					Air Dry.				
Sample No.	65231	6527	65401	7595	75971	65231	6527	65401	7595	75971
Spines	.....	1.18	.....	.63	....	.....	9.02	.....	3.31	.....
Water	92.08	87.97	90.92	82.29	83.45	6.22	8.13	4.37	6.43	4.90
Ash	1.07	2.29	1.37	2.79	1.48	12.70	17.53	14.43	14.73	8.48
Crude Protein	.46	.70	.58	1.26	.86	5.48	5.37	6.13	6.68	4.92
Crude Fat	.38	.33	.56	.31	.79	4.50	2.50	5.85	1.66	5.10
Nitrogen Free Extract	3.68	6.42	3.66	11.31	8.90	43.12	48.97	38.60	59.74	51.15
Crude Fiber	2.33	2.29	2.91	2.04	4.43	27.58	17.50	30.62	10.76	25.45
Organic Matter	6.85	9.74	7.71	14.92	15.07	81.08	74.34	81.20	78.84	86.62

1. Fruit.

Analyses of the Ash

Sample No.	Per Cent. Carbon.	Per Cent. Sand.	Per Cent. in Pure Ash,											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric acid radicle (PO_4)	Sulphuric acid radicle (SO_4)	Chlorine (Cl)	Carbonic acid radicle (CO_3)
6527	.26	2.98	1.96	.31	.27	.25	25.27	4.56	12.89	.03	1.73	2.25	4.65	37.84

Nos. 6565, 6566, 7852 and 7853.

OPUNTIA PROLIFERA *Engelm. Am. Jour. Arts. & Sci. 142: 338. 1852.*

A low, open and divaricately branched form, usually growing in tangled, impenetrable thickets, 3 to 4 feet high, with a trunk 3 to 4 in. in diameter: joints from 2 to 6 or 8 in. by 1¼ to 1¾ in., very variable in length, with tubercles compressed, their upper crests slightly more abrupt than the lower, easily separable; leaves subulate, mucronate, about ¼ in. long; areoles ovate to obovate, ¼ to ⅜ in. by ⅛ to 3-16 in.; wool short, tawny, yellow; spicules yellow, in a prominent segment in upper portion of areole, ⅛ in. long or less; spines 6 to 10, increasing with age to 20 or more, erect-divergent or the outer, lower recurved, yellow to reddish, loosely tunicate with sheaths light yellow below, deeper outward, about ¾ in. long; flowers scarlet purple, small, 1 in. across with filaments and style purplish tinted and 5-parted stigma yellowish-white; fruit proliferous, tuberculate, obovate to subglobose or hemispherical, or sometimes pyriform, deeply pitted at top, when young it is tuberculate and beset with long, reddish-brown, hair-like spines sheathed at their tips, these persisting for a year or more but when old the fruit is bare save for the spicules.

As mentioned in the original description and as suggested in the name, the fruit is proliferous and sterile. We have sometimes found one perfect angular, subglobose seed but only very rarely. Like *Opuntia fulgida* and *O. imbricata*, the fruits here continue to develop as long as they remain attached to the tree.

No. 6565 collected at San Diego, California, June 30, 1904, sample represented by formula 1-3-1-1½-1, from 4 plants.

No. 6566 collected at the same time and place as No. 6565, sample consisting of 22 fruits from 8 plants.

No. 7852 collected at San Diego, California, May 3, 1905, sample represented by formula 3-3-2, from 7 plants.

No. 7853 collected at same time and place as No. 7852, sample consisting of 25 fruits from 7 plants.

Chemical Analysis

	Green				Air Dry			
Sample No.	6565	6566[1]	7852	7853[1]	6565	6566[1]	7852	7853[1]
Spines	.34	.....	.46	.....	2.02	.....	3.19	.....
Water	71.70	82.10	86.52	89.81	10.12	8.15	6.18	6.90
Ash	2.93	2.98	1.11	1.23	9.30	15.30	7.75	11.30
Crude Protein	1.31	.79	1.17	.84	4.16	4.05	8.15	7.66
Crude Fat	.59	.26	.24	.22	1.88	1.35	1.73	1.98
Nitrogen Free Extract	17.65	12.54	9.30	6.96	56.06	64.35	64.61	63.48
Crude Fiber	5.82	1.33	1.66	.94	18.48	6.80	11.58	8.68
Organic Matter	25.37	14.92	12.37	8.96	80.58	76.55	86.07	81.80

1. Fruits.

Nos. 6693 and 7887.

OPUNTIA ECHINOCARPA *Engelm. and Bigel. Pac. Ry. Rep. 4; 49. Pl. 18, f. 5-10, 1856.*

An open, divaricately branched, woody form 5 to 8 feet high, with a black, scaly trunk 3 to 5 in. in diameter; joints cylindrical, 1 to 1¼ in. in diameter, varying in length, commonly 4 to 6 in., yellowish green, tuberculate, with tubercles slightly compressed and having long slope of crest downward, abrupt above, not easily separable; leaves subulate, cuspidate; areoles elliptical, gray but becoming dirty black, occupying entire upper slope of tubercle from crest to nearly the base; wool tawny; spicules light yellow in an unequal, small bunch in upper part of areole with occasionally a few scattering ones below, often invisible and never prominent; spines light yellow or occasionally tinged with brown at base, 14 to 18 in number and increasing very little with age, turning white to opaque and dirty black and falling away from old trunks, the

central larger ones sheathed but the outer naked, erect-divergent in all directions, with the outer especially lower ones recurved; flowers greenish yellow to deep purplish red with filaments and style greenish white to reddish tinged or even purple and stigma greenish yellow to occasionally slightly tinged with purple; fruit dry, obovate, tuberculate, depressed at apex with upper portion thickly beset with spines about ½ in. long, the central longer ones sheathed and the outer smaller ones naked.

This species is exceedingly hard and woody and is probably of little, if any, conomic value. It is conspicuous upon the edge of the driest deserts of the Colorado Valley.

No. 6693 collected at Hackberry, Arizona, July 26, 1904, sample represented by formula 5-5-2-2, rom 5 plants.

No. 7887 collected at Hackberry, Arizona, May 9, 1905, sample represented by formula 2-2-1, from 5 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	6693	7887	6693	7887
Spines	1.62	1.24	3.83	4.69
Water	60.99	74.76	7.72	4.98
Ash	8.28	5.31	19.60	20.00
Crude Protein	1.62	2.10	3.83	7.92
Crude Fat	.71	.37	1.68	1.38
Nitrogen Free Extract	22.52	14.55	53.27	54.78
Crude Fiber	5.88	2.91	13.90	10.94
Organic Matter	30.73	19.93	72.68	75.02

Nos. 6696, 6698, 7893 and 7894 D. G. and 3008 and 3009 E. O. W.

OPUNTIA WHIPPLEI *Engelm. and Bigel. Pac. Ry. Rep. 4: 50. Pl. 17, f. 1-4. 1856.*

An ascending, low shrub growing in tangled bunches 2 to 8 feet in diameter and a foot or two high; joints cylindrical, terminal ones separating easily, whirled or congested near apex of stem, about 3 in. long and ½ in. in diameter, prominently tubercled, with tubercles but slightly compressed, with long crest downward, with deep, sharp furrow between and

delimited by a dark green line; areoles elliptical to obovate, extending from crest of tubercle to nearly its base, gray; wool tawny gray; spicules yellow, in small bunch in upper angle of areole, 1-16 in long, formidable, although rather inconspicuous; spines most prominent near apex of joint, 1 to 1¼ in. long, reddish-brown at base, lighter outward, sheath white but yellow at apex, lower spine largest, recurved downward with 1 to 3 erect, divergent, short, stout ones above and 1 to 4 more delicate, radiating, unsheathed ones surrounding these larger ones; fruit green with tinge of red; obovate, tuberculate, with prominent bunch of yellow spicules 1-16 to ⅛ in. long in each areole, seldom producing fertile seed here.

This species is common on rocky slopes in this vicinity and is probably the same species as the next but on account of the difference in altitude, habit, fertility of seed and proliferation of fruit, we think it advisable to keep them separate. It is a low, woody species of doubtful value as stock food but may be fed with other species with which it grows.

No. 6696 collected at Hackberry, Arizona, July 26, 1904, sample consisting of 8 branches cut just above the ground from 8 plants.

No. 6698 collected at same time and place as No. 6696, sample consisting of fruit.

No. 7893 collected at Hackberry, Arizona, May 9, 1905, sample consisting of 4 branches from 4 plants cut just above the ground.

No. 7894 collected from same plants as No. 7893, sample consisting of 25 fruits from 5 plants.

No. 3008 E. O. W. collected in Western Socorro Co., New Mexico, July 25, 1904, sample consisting of joints.

No. 3009 E. O. W. fruits of No. 3008 E. O. W., only partially ripened.

Chemical Analyses

	Green.						Air Dry.					
Sample No ...	6696	66981	7893	78941	3008	30091	6696	66981	7893	78941	3008	30091
Spines	2.56	.....	.85	.....	.....	.....	8.91	.....	3.51	.....	.....	.....
Water	73.66	75.76	77.32	82.73	76.77	84.75	8.31	9.70	6·08	6.68	7.80	9.62
Ash.....	6.50	3.22	4.19	2.62	4.94	2.41	22.63	11.98	17.35	14.13	19.60	14.28
Crude Protein	1.58	2.03	1.85	1.34	1.82	1.77	5.49	7.56	7.66	7.23	7.23	10.50
Crude Fat.....	.49	.32	.41	.81	.46	.71	1.70	1.18	1 68	4.40	1.83	4.20
Nitrogen Free Extract.....	14.62	17.81	13.72	11.49	12.77	8.20	50.92	66.38	56.82	62.10	50.69	48.60
Crude Fiber..	3.15	.86	2.51	1.01	3.24	2.16	10.95	3.20	10.41	5.46	12.85	12.80
Organic Matter.....	19.84	21.02	18.46	14.65	18.29	12.84	69.06	78.32	76.57	79.19	72.60	76.10

1. Fruit.

Nos. 7350a, 7350b, 7899 and 7900.

OPUNTIA WHIPPLEI *Engelm. and Bigel. Pac. Ry. Rep. 4: 50, Pl. 17, f. 1-4, 1856.*

This we consider to be the same species as the preceding, although it is a much larger, more erect form, with fruits less strongly protected with spicules and although occasionally proliferous, bearing an abundance of fertile seed. We find no other difference excepting that this one seems to be much later in blooming but the altitude may well account for this.

No. 7350a collected at Prescott, Arizona, September 9, 1904, sample consisting of 57 fruits from 7 plants.

No. 7350b collected at the same time and place, sample represented by formula 1-3-5-5-6-6-8, from the same plants.

No. 7899 collected at Prescott, Arizona, May 11, 1905, sample represented by formula 7-4-3, from 4 plants.

No. 7900 collected at the same time and place as No. 7899, sample consisting of 30 fruits from 5 plants.

Chemital Analysis

	Green				Air Dry			
Sample No	7350a[1]	7350b	7899	7900[1]	7350a[1]	7350b	7899	7900[1]
Spines	.....	1.34	1.16	.....	.....	4.44	4.30	.....
Water	77.24	71.42	74.68	75.66	4.50	5.35	6.28	5.84
Ash	3.06	3.44	2.64	2.86	12.85	11.40	9.78	10.63
Crude Protein	2.09	2.15	1 92	1.94	8.76	7.12	7.12	7.23
Crude Fat	1.60	.58	.46	1.21	6.70	1.91	1.71	4.50
Nitrogen Free Extract	10.14	15.50	16.10	13.15	42.54	51.32	59.57	52.55
Crude Fiber	5.87	6.92	4.20	5.18	24.65	22.90	15.54	19.25
Organic Matter	19.70	25.14	22.68	21.48	82.65	83.25	83.94	83.53

f. Fruits

Nos. 6244, 7785 and 7786.

Opuntia Arbuscula *Engelm. U. S. & Mex. Bound. Sur. 2: 60. 1859.*

A tree 5 to 10 feet high with a symetrical, densely branched top and a trunk 10 in. in diameter; joints cylindrical ¼ to ½ in. in diameter and very variable in length, all latera new ones easily separable, indistinctly tuberculate or entirely without tubercles, branching alternate and congested near the apex of the previous year's joints, many of which drop off; areoles obovate, triangular, about 3-16 in. in greatest diameter, ⅜ to 1 in. apart, depending upon the length of the joint and vigor of development; wool gray tawny; spicules yellow externally but usually brown where protected, 1-16 in. long, in a small unequal bunch on upper side of areole; spines loosely tunicate with sheath silvery white at base but brown or yellowish outward, yellow or with tinge of red at base, flattened, mostly single and erect, in rare instances 2 or 3, ¼ to 1¼ in. long; flowers greenish-yellow tinged with red exteriorly; fruit pyriform, areolate like stem with spicules less numerous and spines hair-like and unsheathed, about 1 x 2 in., commonly proliferous, but apparently more often so when sterile.

The species grows commonly in washes and canyons and less frequently upon the mesas. It is easily recognized by its symetrical, compact, tree-like habit and single, erect, loosely sheathed spines. In respect to the latter, however,

it should be stated that they are exceedingly variable in size and when small, tightly sheathed. Often one will find plants which are uniformly 3-spined. It is a rather woody plant and probably of but little value as stock food aside from the fruits which are quite abundantly produced. A branch of this species is shown in Pl. IV, f. 1, Bull. 4, Bureau of Plant Industry, U. S. D. A.

No. 6244 collected in northern foothills of Santa Rita Mountains, Arizona, April 30, 1904, sample consisting of four branches 5 to 6 joints long, from 4 trees.

No. 7785 collected from same trees April 19, 1905, sample consisting of two branches 5 and 6 joints long, from 2 trees.

No. 7786 collected at same time and place as last, sample consisting of 30 fruits from 6 trees.

Chemical Analyses

	Green.			Air Dry.		
Sample No.	6244	7785	7786[1]	6244	7785	7786[1]
Spines	1.35	.45	.....	4.69	1.27	.....
Water	72.87	66.75	76.58	6.01	5.31	4.48
Ash	4.20	5.14	2.64	14.55	14.55	10.76
Crude Protein	3.57	4.23	1.83	12.35	12.35	7.45
Crude Fat	.58	.57	.66	2.00	1.61	2.70
Nitrogen Free Extract	14.36	16.39	13.57	49.78	46.63	55.35
Crude Fiber	4.42	6.93	4.72	15.30	19.75	19.26
Organic Matter	22.93	28.11	20.78	79.44	80.04	84.76

1. Fruit.

Analyses of the Ash

Sample No.	Per Cent. Carbon	Per Cent. Sand	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
6244	.37	1.42	.39	.15	0.00	.22	29.41	5.18	7.98	1.03	2.29	1.17	1.22	47.69

Nos. 6328, 7749, 7474a and 7474b.

TASAJILLA

Opuntia Leptocaulis Dc. *Rev. d. 1, Fam. d. Cact. (Paris) 118. 1829.*

An irregular, divaricatingly branched shrub 2 to 4 feet high, with a trunk 2 in. or less in diameter, usully erect but sometimes spreading; joints exceedingly variable, sometimes subglobose, ¼ in. in diameter but usually cylindrical, with length varying from 2 in. to one foot but constrictions entirely obliterated in the axial growth, but the lateral joints, usually congested near the apex, fall off readily, indistinctly tuberculate; areoles ovate, 1-16 to ⅛ in. by 1-16 to 3-32 in.; spicules yellow, in three bunches in upper portion of areole, often but one in apex but at other times 2 a little below and to either side of this; spines tunicate, mostly single and erect, varying upon the same joint from 1-16 in. long at the base to 2½ in. outward; sheathes loose papery, white at base but darkening to a rich yellow or brown outward, flattened but not twisted; flowers greenish-yellow; fruit obovate, pyriform ½ in. in length, red, areolate, formidably protected by spicules ½ to ¾ in. long by ⅜ to ½ in. wide.

There have been a great many species and varieties described from this group of forms based largely upon spine characters but also in one case at least on an apparent variation in the shape of the joint. Our experience throughout the entire range of this plant does not enable us to satisfactorily segregate any constant forms. It is true that the prostrate, spreading plants in pastures in the vicinity of San Antonio, Texas, and portions of the southern Arizona deserts are very different from the more erect, symetrical forms along the Rio Grande. The variation occurs in habit as well as spine characteristics. Upon the same plant the spines vary from ¼ to over 2 in. long. Some plants have uniformly short spines but in very few cases indeed do we find all the spines long. It seems to us that there is here an endless, confusing variation which cannot be satisfactorily and constantly recognized. It must be admitted, however, that the different forms are very different in aspects and in taxonomic features which are often considered weighty and it may be

that some of the forms are worthy of sub-specific rank but we are unable at present to recognize the dividing lines. The above description, together with our specimens, are sufficiently distinct we believe to indicate the form which we discuss.

This plant is regarded as a weed in southern Texas. The readiness with which the branches break off and are carried about by stock assists its dissemination very effectualy so that in many pastures it has increased during recent years to an alarming extent. Stock will eat it, however, when the spines are properly singed off and in those pastures where the prickly pear grows a little time spent in singeing it while the pear is being fed would aid very decidedly in keeping it in check. Pacific Ry. Rep. *4: Pl. 20, f. 4* represents our plant fairly well except that ours bears an occasional long sheathed spine like fig. 2 on the same plate.

No. 6328 collected at Eagle Pass, Texas, May 10, 1904, sample consisting of 12 to 16 in. of the main stem with flowers and fruits attached, from 4 plants.

No. 7749 collected in the same locality April 12, 1905, sample consisting of 8 branches 18 in. to 2 feet long with attached branches, flowers and fruits from 8 plants.

No. 7474a collected at Encinal, Texas, January 9, 1905, sample consistings of fruits.

No. 7474b collected at the same time and place as No. 7474a, sample consisting of fruits.

Chemical Analysis

	Green				Air Dry			
Sample No.	6328	7749	7474a[1]	7474b[1]	6328	7749	7474a[1]	7474b[1]
Spines	1.39	1.43	.....	.....	4.19	4.05	.....	.....
Water	68.89	66.64	75.42	75.63	6.05	5.34	6.70	7.50
Ash	8.21	5.90	3.15	3.16	24.80	16.75	11.95	11.98
Crude Protein	1.88	2.11	1.27	1.27	5.69	6.00	4.82	4.93
Crude Fat	.87	.67	1.54	1.59	2.63	1.92	5.85	6.05
Nitrogen Free Extract	12.77	16.37	14.73	14.23	38 53	46.40	55.93	54.49
Crude Fiber	7.38	8.31	3.89	4.12	22.30	23.59	14.75	15.05
Organic Matter	29.90	27.46	21.43	21.21	69.15	77.91	81.35	80.52

1. Fruits.

Analysis of the Ash

Sample No.	Pet cent. Carbon	Per cent. Sand	Per Cent. in Pure Ash											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
6328	.21	1.14	1.25	.20	.19	.27	33.98	2.28	4.44	.13	.69	1.35	.57	53.54

No. 7503.

TASAJILLA

OPUNTIA LEPTOCAULIS DC. *Rev. d. l. Fam. d. Cact. (Paris) 118. 1829.*

Many varieties have been described under this species. The one which we have here is the yellow fruited variety which was originally described by Dr. Engelmann as *Opuntia vaginata* from the type specimens of Dr. Wislizenus, collected in 1846. Our plant, however, differs very decidedly from the type in having much fewer spines. Indeed, the long sheathed spines are rare upon our plant, which is a large one 4 feet high. We can distinguish no difference between this and No. 7474, abundant in this locality excepting in color of fruit.

The yellow fruited from is common on the Rio Grande at Laredo but there it is a more symetrical shrub with an abundance of the long, loosely sheathed, yellow spines.

Collected at Encinal, Texas, January 14, 1905, sample consisting of fruit from one plant.

Chemical Analyses

75031	Green.	Air Dry.
Spines	...	...
Water	76.14	6.15
Ash	4.28	16.85
Crude Protein	1.25	4.93
Crude Fat	1.44	6.45
Nitrogen Free Extract	13.55	53.29
Crude Fiber	3.13	12.33
Organic Matter	19.57	77.00

1. Fruit.

Nos. 7628 and 7629.

TASAJILLA

OPUNTIA KLEINIAE DC. *Rev. d. 1. Fam. d. Cact. (Paris) 118. 1829.*

An open, widely branching shrub 3 to 5 feet high, erect, often growing in tangled thickets but more commonly in isolated impenetrable bunches; joints cylindrical, $\frac{3}{8}$ to $\frac{1}{2}$ in. in diameter, varying from short and globular to a foot in length, the central axial ones being firmly attached and the laterals, especially the shorter ones, very easily separable, slightly tuberculate, with low, gradually descending crest below but more abrupt above, not compressed and not over $\frac{1}{8}$ in. high, usually about 1-16 in. and entirely disappearing in old wood; leaves small, subulate, $\frac{1}{8}$ to 3-16 in. long, pointed or often nearly circular in vertical section; areoles obovate-triangular; wool tawny; spicules reddish-brown, 1-16 in. long, commonly inconspicuous; spines long, formidable, loosely sheathed, yellowish, straw color or darker, circular or slightly flattened in cross section, usually single but sometimes three or four and often one or two smaller ones accompanying the large ones in lower angle of areole, erect, almost perpendicular to the joint; flowers pink, about $1\frac{1}{4}$ in. across when fully expanded with filaments and style pinkish and stigma white; fruit red, persisting for one or two years, obovate or ovate, slightly tuberculate but almost smooth when mature, especially when containing an abundance of fertile seed.

This species has two well marked forms in this locality

which are comparable with two similar forms of *Opuntia leptocaulis* of southwestern Texas. The one described here is the more open branching of the two which produces red, fertile fruit. The other is more prolific in the production of both fruit and branches and is seldom fertile. This plant we consider to be the more typical form.

No. 7628 collected at San Luis Potosi, Mexico, March 12, 1905, sample consisting of 4 stems with lateral branches 2 feet long from 4 plants.

No. 7629 collected at same time and place, sample consisting of 40 fruits from 4 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	7628	76291	7628	76291
Spines	2.76	.....	9.70	.....
Water	72.95	89.23	4.90	6.65
Ash	3.21	2.12	11.30	18.33
Crude Protein	2.10	.75	7.40	7.40
Crude Fat	.59	.35	2.08	2.99
Nitrogen Free Extract	14.47	6.29	50.12	53.68
Crude Fiber	6.88	1.26	24.20	10.95
Organic Matter	24.84	8.65	83.80	75.02

1. Fruit.

Nos. 7630 and 7631.

OPUNTIA *sp.*

An erect plant resembling in some of its smaller forms the habit of *Opuntia kleiniae* but entirely different, suggesting in some respects both the latter and the large *Cylindropuntia (O. imbricata Haw.)* of this region; very open branching, 4 to 6 feet high, with a trunk 3 or 4 in. in diameter; joints cylindrical, about $\frac{3}{4}$ in. in diameter and of various lengths, the terminal ones varying between 3 and 8 inches, tuberculate, with tubercles flattened, with long crest downward and separated by a dark green line completely surrounding each one; areoles oblong, about $\frac{1}{4}$ x $\frac{3}{8}$ in., extending from crest to nearly the base of the tubercle; wool gray in situ, tawny when removed; spicules brown in small bunch 1-16 in. long in upper edge of

areole; spines tunicate with yellow sheath, which is usually darker toward tip, flattened, tinted with red, 2 to 6 in number, with central which is the largest, about 1 in. long, others varying to as low as ¼ in., the central ones erect, others divergent; fruit g obular, 1¼ in. in diameter, practically smooth when mature, but the tubercles which are plainly visible in young specimens usually more or less outl ned. having areoles nearly circular or slightly obovate, about ⅛ in. greatest diameter, with a lenticular bunch of spicules above, nearly ⅛ in. long and when young, bearing a few long, fugacious, hair-like spines, all seen having depressed umbilicus.

In the locality where collected this species is not at all abundant. In many of its characters, especially in size, it is midway between *Opuntia imbricata* and *Opuntia kleiniæ*.

No. 7630 collected near San Luis Potosi, Mexico, March 12, 1905, sample represented by formula 3-2-1, from 2 plants.

No. 7631 collected at the same time and place, sample consisting of 20 fruits from 2 plants.

Chemical Analysis

	Green		Air Dry	
Sample No	7630	7631	7630	7631
Spines	.25	.....	1.04	.....
Water	77.26	86.00	7.15	7.09
Ash	3.75	3.14	15.32	20.85
Crude Protein	.75	.53	8.07	3.50
Crude Fat	.54	.43	2 20	2.85
Nitrogen Free Extract	13.68	9.07	55.86	53.56
Crude Fiber	4.02	1.83	16.40	12.15
Organic Matter	18.99	10.86	77.53	72.06

1. Fruit.

Nos. 7601 and 7649.

CLAVELINA (At Ypina)

OPUNTIA TUNICATA Hort. *Berol. ex-Pfeiff. Enum. Cact. 170. 1837.*

A low, erect or ascending plant a foot or two high, forming large clumps 2 to 4 feet in diameter, the whole presenting a glistening, silvery white appearance; joints cylindrical, 1 in. or

less in diameter and varying from 6 to 8 or 10 in. long for the axial to 2 or 3 in. for the lateral, the latter being very easily separable, prominently tuberculate, with tubercles $\frac{5}{8}$ in. high by $1\frac{1}{2}$ in. long by $\frac{3}{8}$ in. wide, surrounded by a sharp furrow marked by a rather indistinct dark green line, upper slope more abrupt than the lower; areoles narrowly oblong, 3-16 in. by $\frac{1}{2}$ in. with wool protruding 1-16 in. and its surface subareolate; spicules white, in a comparatively small, lenticular area in upper part of areole protruding not over 1-16 in.; wool white; spines long, white, conspicuous, 6 to 10 in number, erect-divergent in all directions, the lower and smaller ones curved backward against the tubercle, longest 2 to $2\frac{1}{2}$ in., with loose, somewhat saccate, white, glistening sheath contracted at the very base, all completely tunicate, triangular-flattened, about 1-16 in. in diameter, with sheath $\frac{1}{8}$ in. distinctly annular, horn-like; flowers greenish-yellow; fruit obovate, with low tubercles, prominent triangular areoles, white prominent spicules $\frac{1}{8}$ in. long surrounding upper one-third to one-half of areole, the lower ones having 1 to 3 sheathed spines often an inch long like those of stem, yellowish-green, with very mucilaginous pulp.

This plant occasionally has red spines but even then the sheaths are white, the spines showing dark or reddish through them. Sometimes one will find white or yellowish-white and red spines on the same plant and even on the same stem. This is a very conspicuous and characteristic plant of the highlands of Mexico, so admirably protected by spines that no animal can molest it. In the State of San Luis Potosi there are large areas where it is difficult for a man to travel on account of the abundance of this species. A recognizable photographic reproduction of it can be found in "The Garden" *62*: 425. 1902.

No. 7601 collected at San Luis Potosi, Mexico, March 9, 1905, sample represented by formula 2-$\frac{1}{2}$, from 3 plants.

No. 7649 collected at Alonzo, Mexico, March 14, 1905, sample consisting of 24 fruits from 3 plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No	7601	76491	7601	76491
Spines	8.79	.....	39.58	.....
Water	79.34	82.52	7.00	7.40
Ash	5.17	3.33	23.25	17.64
Crude Protein	1.17	.83	5.26	4.34
Crude Fat	.35	.95	1.56	5.03
Nitrogen Free Extract	11.88	9.72	53.53	51.51
Crude Fiber	2.09	2.65	9.40	14.04
Organ Matter	15.49	14.15	69.75	74.96

1. Fruit.

Nos. 3022 and 3026 E. O. W.

OPUNTIA CLAVATA *Engelm. U. S. Sen. Miscel. Doc. No. 26, 30th Cong. 1st Sess. (Wisliz. Rep.) 95. 1848.*

This low, prostrate, spreading, clavate-jointed Cylindropuntia with abundant yellow spicules and flat, slghtly recurved, unsheathed spines can scarcely ever become of any economic value except it be in a limited way in certain ornamental plantings. Its flat, recurved spines, bright yellow flowers and peculiar whorled arrangement of the spicules around the large white wool area of the areoles of the fruit render it rather attractive. Upon the native range country it is probably detrimental occupying ground that might be occupied by grasses.

No. 3022 E. O. W. collected at Tesuque, New Mexico, Aug. 20, 1904, sample consisting of joints.

No. 3026 E. O. W. collected at Carizozo, New Mexico, Aug. 27, 1304, sample consisting of fruit.

Chemical Analysis

	Green		Air Dry	
Sample No	3022	30261	3022	30.261
Spines	1.84	.....	6.32	.....
Water	72.54	78.17	6.10	8.25
Ash	9.56	6.99	32.03	29.50
Crude Protein	1.47	2.78	5.04	11.72
Crude Fat	.53	.75	1.70	3.15
Nitrogen Free Extract	11.65	7.08	41.73	29.53
Crude Fiber	4.25	4.23	13.40	17.85
Organic Matter	17.90	14.84	61.87	62.25

1. Fruit.

MISCELLANEOUS SPECIES

Nos. 8173a and 8173b D. G. and 3068 and 3072 E. O. W.

VIZNAGA. NIGGER HEAD. BARREL CACTUS

ECHINOCACTUS WISLIZENI *Engelm. U. S., Sen. 30th 1st Cong. Sess., Miscel. Doc. No. 26 (Wisliz. Rep.) 96. 1848.*

This species is typical of a large group of desert plants, growing almost invariably in scattering individuals from the Organ Mountains of Now Mexico southwestward to Lower California and southward through the highlands of Mexico. Like many other species, they are not abundant enough to furnish any great amount of stock feed. There are instances on record, however, where they have been used in seasons of great drouth. Mr. C. R. Orcutt informs us that these species have been fed in Lower California to some extent. *Echinocactus orcutti* especially abundant in places and flocks of sheep have been kept alive during severe drouths by having these plants cut down and slashed open with a machete for them to feed upon. Detailed drawings of this species will be found in U. S. & Mex. Bound Sur. *2: Pl. 3, f. 1-2*, 1859.

No. 8173a collected near Tucson, Arizona, October 7, 1905, sample consisting of seed from several plants.

No. 8173b collected at same time and place and consisting of the fruit minus the seed.

No. 3068 E. O. W. collected at Agricultural College, New Mexico, December 22, 1904, sample consisting of sections of the trunk of the plant.

No. 3072 E. O. W. collected at same time and place, sample consisting of fruit of the same plants as the above.

Chemical Analyses

	Green.				Air Dry.			
Sample No.	8173a[1]	8173b[2]	3068	3072[3]	8173a[1]	8173b[2]	3068	3072[3]
Spines	.....	.....	.62	.....	.....	.....	7.90	.....
Water	8.59	94.14	87.81	78.26	8.38	6.50	4.56	4.15
Ash	3.09	.96	1.70	1.47	3.10	13.67	13.33	6.50
Crude Protein	10.92	.63	.71	2.80	10.94	10.06	5.58	12.33
Crude Fat	15.46	.06	.13	2.50	15.50	.95	1.05	11.03
Nitrogen Free Extract	36.59	3.05	7.49	9.56	36.65	50.24	58.53	42.14
Crude Fiber	25.37	1.16	2.16	5.41	25.43	18.58	16.95	23.85
Organic Matter	88.31	4.90	10.49	20.27	88.52	79.83	82.11	89.35

1. Fruit without the seed. 2. Seed. 3. Fruit.

Nos. 6331 and 7748.

PITALLA, MEXICAN STRAWBERRY

ECHINOCEREUS ENNEACANTHUS *Engelm. Wisliz. Rep. U. S. Sen. Misc. Doc. No. 26, 30th Cong. 1st Sess. 111. 1848.*

This is a low plant growing in hemispherical clusters of erect, spiny columns less than one foot high and 12 to 18 in. in diameter. It is exceedingly abundant in the valley of the Rio Grande in Texas and adjacent Mexico. Its application in feeding stock is very limited although in a few localities where it grows thick enough it can be fed by singeing like the pear of the same region. Dr. Engelmann subsequently figured this in U. S. & Mex. Bound, Sur. *Pl. 49* 1859.

No. 6331 collected at Eagle Pass, Texas, May 10, 1904; sample consisting of 8 pieces cut near the surface of the ground from as many plants.

No. 7748 collected at Eagle Pass, Texas, April 12, 1905, sample consisting of 5 pieces cut in the same way from as many plants.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	6331	7748	6331	77.48
Spines	.52	.38	3.33	3.17
Water	85.23	88.72	4.80	6.03
Ash	2.76	1.18	17.78	9.82
Crude Protein	1.22	1.01	7.88	8.43
Crude Fat	.27	.23	1.77	1.91
Nitrogen Free Extract	9.37	8.08	60.44	67.27
Crude Fiber	1.14	.78	7.33	6.54
Organic Matter	12.01	10.10	77.42	84.15

Analyses of the Ash

Sample No.	Per Cent. Carbon	Per Cent. Sand	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_3)	Iron (Fe)	Aluminum (Al)	Manganese (Mg)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric acid radicle (PO_4)	Sulphuric acid radicle (SO_4)	Chlorine (Cl)	Carbonic acid radicle (CO_3)
6331	.26	3.31	.80	31	.13	.09	22.66	5.07	16.61	.62	1.20	2.35	2.90	42.63

Nos. 6526 and 7644.

PITALLA

ECHINOCEREUS ACIFER *Lem. Cact. Gen. Nov. Spec. Nov. 57, 1839.*

This species has very much the same general habit as *Echinocereus enneacanthus.* It is exceedingly abundant in the vicinity where collected, forming large hemispherical, succulent bunches, one foot high and two feet in diameter.

No. 6526 collected at Alonzo, Mexico, June 10, 1904, sample consisting of 5 columnar pieces cut off close to the ground from 5 plants.

No. 7644 collected in the same locality March 14, 1905, sample consisting of similar specimens from 3 plants.

Chemical Analysis

	Green		Air Dry	
Sample No	6526	7644	6526	7644
Spines	.92	2.55	14.29	30.95
Water	93.90	92.32	5.63	6.87
Ash	1.27	1.67	19.65	20.30
Crude Protein	.74	1.07	11.39	12.96
Crude Fat	.11	.14	1.65	1.75
Nitrogen Free Extract	3.12	4.25	48.30	51.42
Crude Fiber	.86	.55	13.38	6.70
Organic Matter	4.83	6.01	74.72	72.83

Nos. 6697 and 7895.

PITALLA

Echinocereus Mojavensis (Engelm.) Rumpler. Forster's Handbuch d. Cact. 803. 1886. *Cereus Mojavensis* Engelm, Pacific. Ry. Rep. *4:* 33 in text but *C. bigelovii* in *Pl. 4, f. 9.* 1856.

This is a somewhat conspicuous species growing in cespitose, hemispherical masses 8 to 12 in. high, on rocky hillsides, having much the same general habit as *Echinocerous enneacanthus.* Its suculence and abundance in certain limited localities would enable its being fed in connection with other large species of prickly pear with which it usually occurs.

No. 6697 collected at Hackberry, Arizona, July 25, 1904, sample consisting of one column cut 2 inches above the ground from each of 6 plants.

No. 7895 collected at Hackberry, Arizona, May 9, 1905, sample consisting of 4 columns cut close to the ground, from 4 plants.

Chemical Analysis

	Green		Air Dry	
Sample No.	6697	7895	6697	7895
Spines	2.99	3.66	9.09	28.57
Water	69.70	87.96	8.00	5.98
Ash	3.84	1.06	11.65	8.33
Crude Protein	2.38	.94	7.22	7.34
Crude Fat	.49	.42	1.48	3.27
Nitrogen Free Extract	19.73	8.32	59.90	64.93
Crude Fiber	3.87	1.30	11.75	10.15
Organic Matter	26.46	10.98	80.35	85.69

No. 7807.

ECHINOCEREUS FENDLERI (?) *(Engelm)*, *Rumpler. Forster's Handb. d. Cact.,801, 1886: Mem. Am. Acad. 4: 51, 1849.*

This is another low, cespitose species having much the same habit as *Echinocereus enneacanthus* but differing in many botanical details. It is common upon the deserts and abundant in places in the foothills in the Santa Cruz valley of Arizona and adjacent Sonora. It can be fed the same as the other closely related species mentioned above. It appears to differ slightly from *E. fendleri* and we are doubtful about its identity.

Collected near Tucson, Arizona, April 27, 1905, sample consisting of 4 columns cut close to the ground, from 4 plants.

Chemical Analysis

	Green	Air Dry
Spines	2.35	20.00
Water	88.79	4.50
Ash	1.78	15.13
Crude Protein	.48	4.05
Crude Fat	.11	.90
Nitrogen Free Extract	7.88	67.28
Crude Fiber	.96	8.14
Organic Matter	9.43	80.37

Nos. 6561, 6699 and 7805.

SAGUARRO, GIANT CACTUS, GIANT CEREUS, ETC.

CEREUS GIGANTEUS *Engelm. Emory's Rep. of Mil. Rec. 195. 1848.*

This familiar and conspicuous giant cactus of Arizona and adjacent Mexico may be fed to stock with very little difficulty. All the preparation necessary is the chopping up of the plant sufficiently so that animals can get at the pulpy interior. The plant is neither abundant nor rapid enough in its growth to be of any great economic importance, excepting as a temporary expedient in tiding over a period of extreme drouth. Illustrations of this are common. A very diagrammatic drawing occurs in U. S. & Mex. Bound. Sur. *2:* Pl. O. and photographic reproductions in Bull. *4:* Pl, 2 of the Bureau of Plant Industry, U. S. D. A.

No. 6561 collected at Tempe, Arizona, June 27, 1904, sample consisting of fruits from 16 plants.

No. 6699 collected at Tucson, Arizona, July 28, 1904, sample consisting of 4 triangular sections 3 or 4 inches thick, taken frem the periphery to the center of the columnar stem, including 3 ribs 4 feet from the ground in plants 7 to 9 feet high.

No. 7805 collected at Tucson, Arizona, April 26, 1905, sample consisting of 3 triangular sections taken from the periphery to the center, including 2 ribs 2 inches thick, from 3 plants similar to those of No. 6699.

Chemical Analyses

	Green.			Air Dry.		
Sample No.	6561[1]	6699	7805	6561[1]	6699	7805
Spines	.....	.92	.28	.....	6.63	3.41
Water	91.62	87.31	92.36	5.88	8.98	5.80
Ash	.98	2.20	1.30	11.05	15.75	15.98
Crude Protein	1.05	.81	.67	11.83	5.80	8.28
Crude Fat	.61	.17	.16	6.86	1.20	1.94
Nitrogen Free Extract	3.64	8.07	4.45	40.73	57.92	54.95
Crude Fiber	2.10	1.44	1.06	23.65	10.35	13.05
Organic Matter	7.40	10.49	6.34	83.07	75.27	78.22

1. Fruit.

Analyses of the Ash

Sample No.	Per Cent. Carbon	Per Cent. Sand	Per Cent. in Pure Ash.											
			Soluble Silica (SiO_2)	Iron (Fe)	Aluminum (Al)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Sodium (Na)	Phosphoric Acid radicle (PO_4)	Sulphuric Acid radicle (SO_4)	Chlorine (Cl)	Carbonic Acid radicle (CO_3)
6839	.17	.44	.37	.30	.07	.15	31.64	5.78	6.66	0.00	.88	4.12	3.32	41.06

Nos. 6518 and 7622.

GARRAMBULLOS

CEREUS GEOMETRIZANS *Mar. Mart. Pfeiff. Enum. Cact. 90. 1837.*

So different from the majority of the species of this genus, this one forms a handsome, symmetrical tree with a compact crown and well marked trunk a few feet long. It is one of the most attractive of the species of the genus, so far as its vegetative state is concerned, but the flowers are comparatively small and unattractive. It is abundant in the foothills and plains, especially in the vicinity of San Luis Potosi.

No. 6518 collected at Bocas, Mexico, June 9, 1904; sample consisting of 3 terminal pieces from 3 branches of 3 trees, ranging from 3 to 10 inches in length.

No. 7622 collected at San Luis Potosi, Mexico, March 11, 1905, sample consisting of sections from branches of 2 trees not over 18 inches from apex.

Chemical Analyses

	Green.		Air Dry.	
Sample No.	6518	7622	6518	7622
Spines	.34	.80	2.02	5.74
Water	84.77	86.92	10.80	5.92
Ash	2.40	1.74	14.05	12.50
Crude Protein	.79	.61	4.60	4.38
Crude Fat	.59	.66	3 43	4.75
Nitrogen Free Extract	9.47	7.60	55.52	54.65
Crude Fiber	1.98	2.47	11.60	17.80
Organic Matter	12.83	11.34	75.15	81.58

Nos. 6512 and 7598.

ORGANO

CEREUS MARGINATUS DC. *Rev. d. l. Fam. d. Cact. (Paris) 116, 1829.*

This columnar, branchless cereus grows to a height of 15 feet or more and is extensively cultivated for hedges and fences in the plateau region of Mexico. It very seldom branches excepting as a result of injury to the apex of the columnar, ribbed stem.

No. 6512 collected at San Luis Potosi, Mexico, June 8, 1904 samples consisting of the tops of 2 medium sized branches from 2 plants.

No. 7598 collected at San Luis Potosi, Mexico, March 8, 1905, sample consisting of one section from top of young plant, one from 7-foot plant one foot from ground, and one from 3-foot plant 18 in. from ground.

Chemical Analysis

	Green		Air Dry	
Sample No	6512	7598	6512	7598
Spines	.45	.67	4.48	6.98
Water	92.96	91.14	8.84	7.69
Ash	.91	1.25	11.75	12.97
Crude Protein	1.07	.81	13.91	8.43
Crude Fat	.18	.20	2.28	2.11
Nitrogen Free Extract	3.60	5.13	46.64	53.50
Crude Fiber	1.28	1.47	16.58	15.30
Organic Matter	6.13	7.61	79.41	79.34

COMPILATION OF ANALYSES.

The following pages contain a compilation of all the chemical analyses found in this bulletin, together with such other data as will be found necessary in making a rapid study and comparison of the information presented. In the seventh column headed "Formula and Remarks" is given the formula of the specimens analyzed. For an explanation of this formula see page 7.

SOME LITERATURE DEALING WITH THE CHEMISTRY OF THE CACTI.

Adriance, Duncan, Tilson, P. S. & Harrington, H. H.

Texas Agric. Exp. Station Bull. *35:* 604. 1895. Analyses are given of stem and fruit and comparisons made. Statements made that animals eat the fruit readily and that deer and hogs do well on it.

Anonymous.

Texas Agric. Exp. Station Annual Rep. No. *6:* 377. 1893. Pear is said to cause bloat.

Bourde, Paul.

La Revue Tunisienne, organe de L'Institut de Carthage, Tunis, 1894. Translation by J. H. Maiden in Agric. Gaz. N. S. W. *7:* 651. 1896.

DeGraffe, Bertha L.

Am. Jour. Pharm. *68:* 169-177, Pl. 1896. *Opuntia vulgaris.* Chemistry and discussion of history, etc.

Ewell, E. E.

The Chemistry of the Cactaceae. Jour. Am. Chem. Soc. *18:* July 7, 1896. A study of the alkaloids of species of *Anhalonium.*

Forbes, R. H.

Ariz. Agric. Exp. Station 15th Ann. Rep. 496, 1904. Analyses are given of *O. fulgida* joints and fruit, *O. spinosior* stems and fruit, *O. Engelmanni* stems and *O.* ("Spinless Sicilian") stems.

Goss, Arthur.

N. Mex. Agric. Exp. Station Bull. *17:* 36, 1896. Chemical analyses of *O. camanchica* are given. In Bull. *18:* Prof. E. O. Wooton discusses briefly the sample used in the analyses.

N. Mex. Agric. Exp. Station Bull. *44:* 4, 1903. Analyses are given of *Opuntia camanchica, O. macrocentra* and *O. arborescens.*

Guthrie, B. F.

Agric. Gaz. N. S. W. *11:* 671. 1900. Analyses of *O. ficus-indica. O. elatior, O. brasiliensis, O. coccinellifera* are given. Comparisons are made with Wolff's analyses of fruits and conclusion drawn that fruit is of less value as forage than the joints because they contain less nutritious substance and more fiber.

Harrington, H. H.

Texas Agric. Exp. Station Annual Rep. No. *1:* 28, 1888. Analyses are given and comparisons are made with carrots and turnips analyzed by Mass. Exp. Station in 1887. Considered an economic thing.

Jaffa, M. E.

Cal. Agric. Exp. Station Rep. *22:* 49, 1904. Analyses of "Cactus Plant" is given. This is probably an *Opuntia.*

Juritz, Chas. F.

Rep. Senior Analyst Cape of Good Hope for 1898, p. 63, 1899. Analyses made of different portions of the plant and conclusions drawn that portions neither too old nor too young are most valuable as stock feed

Lima, Dr. Gaetano Mancuao.

Le Stazioni Sperimentale Agraric. Ital. (Rep Ital. Exp. Station Modena, Italy *28:* 805, 1895.) The most comprehensive analyses of fruit and stems of *O. ficus-indica* we have seen.

Maiden, J. H.

Agric. Gaz. N. S. W. *7:* 651, 1896. Trans. of Bourde's article in La Revue Tunisienne in 1894. Considerable chemical data given. Plan for studying pear outlined.

INDEX TO POPULAR AND SCIENTIFIC NAMES

NDEX TO COLLECTION NUMBERS.

ERRATA.

Page 22, table No. IV, insert comma "," after "Cane Cacti" on first line and "Prickly Pears" on third line.

Between pages 32 and 33—Plate IV, change "leuotricha" to "leucotricha," and "P. D. C." to P. DC."

Page 37—Line 5, second word read Engelmannii.

Page 42—Line 19, second word first letter change "O" to "o."

Page 65—Line 9, between second and third word insert "Lem."

Page 70—Line 17, second word read "TAPON."

Page 75—Line 3, third word read "BLANCO."

Page 82—Line 2, third word read "basilaris."

Page 87—Line 16, between fourth and fifth word insert "I."

Page 92—Line 3, third word read "Engelm."

Page 105—Line 3, second word change "A" to "a."

Page 107—Line 3, second word change "L" to "l."

Page 107—Line 3, third word change "c" to "C."

In tables of ash analysis change "Sio_3" to "SiO_3" on pages 34, 37, 41, 46, 57, 58, 65, 67, 75, 80, 84, 89, 90, and 96.

Omit all periods "." placed in sample numbers.

Page 34—Analyses of the Ash, No. 7515 under iron read 20.

Page 44—Under Chemical Analyses No. 7429 crude fiber, change 1.14 to 1.19.

Page 45—Chemical Analyses No. 7596, water, change 97.76 to 87.76.

Page 52—Analyses of the Ash, No. 7784 read Iron .15.

Page 53—Chemical Analyses change sample No. 7750 to 7759.

Page 53— " " change sample No 7709 to 7009.

Page 55— " " No. 3101, spines, insert 17.95.

Page 95— " " No. 6252, ash, change 17.30 to 13.30.

Page 106— " " No. 7785, ash, change 14.55 to 14.65.

Page 106— " " No. 7785, crude protein, change 12.35 to 12.05.

Page 111— " " No. 7628, organic matter, change 24.84 to 23 84.

Page 112— " " No. 7630, crude protein, change 8.07 to 3.07.

" " " " No. 7631[1] Nitrogen free extract, change 9.07 to 8.07.

NOTE:—In the list of some literature dealing with the Chemistry of Cacti on p. 124, thru an oversight no note was made of the work reported by E. F. Ladd, in the 6th Annual Report of the New York Experiment Station p. 419.