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PREFACE.

Under direction of the Board of Trustees, the twentieth annual report of the Missouri Botanical Garden is presented to the public.

The nineteenth report was issued November 9, 1908, but the following papers contained in it had been previously issued in separate form at the dates indicated:—Bessey, The Florida Strangling Figs, March 4; Sargent, *Crataegus* in Missouri, July 2.

As in the tenth report, an index to the contents of the last ten volumes has been included in the present volume.

These reports are sent to scientific institutions and journals, in exchange for publications and specimens desirable for the library, herbarium or living collections of the Garden. So far as is possible, reprints of the botanical articles they contain are sent to botanists occupied with a study of the subjects to which they pertain.

Any of the Garden publications not out of print may be purchased, at approximately the cost of publication, from Messrs. R. Friedländer & Sohn, Berlin, Germany; W. Wesley & Son, London, England; or the undersigned.

WILLIAM TRELEASE.

ST. LOUIS, MO., November 1, 1909.

(3)

ILLUSTRATED STUDIES IN THE GENUS OPUNTIA—II.

BY DAVID GRIFFITHS.

OPUNTIA RUFIDA Engelm.

It was thought when Griffiths and Hare published a description of this species a couple of years ago that that would suffice to identify it. In that publication* it was specifically stated that *O. rufida* is a very different plant from *O. microdasys*. Later a fairly good description is presented together with notes on the variations in the species. This much of our work has been accepted, but the same authors† who accept this still distribute forms of *O. microdasys* into American collections as *O. rufida*, thus confounding the confusion.

The facts regarding the species appear to be as follows: Engelmann‡ described *O. rufida* and made the statement that it was closely related to *O. microdasys*. Botanists have taken this statement too literally altogether. When some one, therefore, found a red spiculed form of the typical yellow spiculed *O. microdasys* it was called *O. rufida*. Schumann, when he came to go over the material at his command, accepted this determination, and having accepted it, naturally came to the conclusion, as any one who knew anything about the species except that exhibited by a terminal joint would, that the yellow and red spiculed forms of *O. microdasys* represent one species. He was, therefore, considering the evidence at his command, justified in reducing *O. rufida* to a synonym of *O. microdasys*, for the red spicules of the one variety commonly turn yellow at a year or two of age. Near the southern limit of its growth, however, the spicules are sometimes permanently red. But Schumann never saw a specimen of the true *O. rufida*. Indeed, I doubt whether the species has been collected excepting by Trelease, Orcutt, and myself since its discovery.

The accompanying illustrations ought to fix in mind the style of plant that *O. rufida* really is. While Engelmann's

* Bul. 60, Agr. Expt. Sta., New Mex., p. 82. (1906.)

† Smithsonian Miscel. Collections, v. 50, p. 4. (1898.)

‡ Proceedings of the Amer. Acad., 8 : 298. (1856.)

statement that it is related to *O. microdasys* is possibly true, it is, nevertheless, a very different plant. It is arborescent with a distinct trunk, while *O. microdasys* is a low, nearly prostrate species with never a true trunk.* Besides, the joints and flowers are different, as indicated in the original description. The fruits, which I have never seen until the past season, are also quite different from those of *O. microdasys*. They are greenish-red without, green within, decidedly acid, and have very thin rinds. The seeds have very thin integuments compared with the majority of the species of the genus *Opuntia*.

Regarding its relationships, it may be said that Engelmann was only partly right in his opinion. He never saw anything but a few cuttings. He was unacquainted with the habit of the plant. It resembles *O. microdasys* in having some pubescence and no spines. In color of plant body and spicules, however, it resembles *O. basilaris* more closely. Its real resemblances, however, are to the variety *Santarita* of *O. chlorotica*, but this is placed by the monographers in an entirely different group.

The specimen described by Griffiths and Hare† is the true *O. rufida*, but the notes appended regarding No. 8023 D. G. may represent a plant sufficiently different to warrant at least sub-specific rank. The fruits of that number appear from the very casual and imperfect examination to be quite different from those of true *O. rufida*, both in the type locality and in the vicinity of Torreon, Mexico. It is seldom that the fruits of the species in the type locality are entirely red on the outside. Usually the greater part of the fruit is greenish, with only a blush of red on one side. My collection No. 8023, therefore, requires further study.—Plates 3; 12, lower figure; 13, f. 3, 13.

***Opuntia Dillei* sp. nov.**

Plant suberect or ascending, 15 dm. or more high and 18 or 20 dm. in diameter, open branching; joints subcircular to broadly obovate or ovate, often broader than long, sometimes 35 cm. in diameter and 2.5 cm. thick,

* Compare plate 3 with plate 12, lower figure.

† Bul. 60, Agr. Expt. Sta., New Mex., p. 82. (1906.)

but usually smaller, glaucous green turning to yellowish green and finally to scaly gray brown; areoles subcircular to obovate, about 6 mm. in longest diameter, enlarging irregularly in age and becoming conspicuously subareolate, the tissues of some of them proliferating into short columnar structures, invariably surrounded by yellowish brown, apparently dead epidermal tissue not later than the second year; spicules brown with yellowish tips, fading slightly with age, not numerous, scattered, unequal, not formidable, developing very unequally, usually none on sides of joints, commonly about 9 or 10 mm. long when fully developed in occasional areoles; spines mostly none or only a few, white or flesh colored, deeply tinted at base, flattened, but not annular or twisted, one erect or recurved, about 2.5 cm. long; flowers not seen; fruit purple throughout, large, subglobose, about 53 by 60 mm., edible, but with thick rind, smooth with subcircular areoles about 12 mm. apart, tawny with a small central bunch of brown spicules; seeds flattened, slightly angular, quite uniform in size, 3 to 4 mm. in diameter, with conspicuous marginal callus, about 0.5 mm. wide, with a narrowly rounded margin.

The species is most closely related to *Opuntia Engelmanni*, from which it differs in rarity of its spines, which are very conspicuous in that species. The fruits and seeds are also different. It appears to be a rare species. I have seen what I suspect is the same thing from one locality besides the type, both from the Territory of New Mexico. In the type locality about a dozen plants were found, all in situations inaccessible to livestock. Under cultivation the species becomes much more spiny than indicated above.

The type is No. 9460 D. G., collected in San Andreas canyon of the Sacramento Mountains of New Mexico, about 15 miles south of Alamogordo, August 3, 1908. I take pleasure in dedicating this species to Mr. A. B. Dille, who forwarded specimens of it to the United States Department of Agriculture a year or two ago. The type was secured from the same locality in which the original specimens were collected by Mr. Dille. The description was drawn in the field beside the type plants.—Plates 4, lower figure; 2, f. 10; 13, f. 7.

***Opuntia Allairei* sp. nov.**

A spreading, open branching, prostrate or slightly ascending plant, 3 to 4 dm. high, and 6 to 9 dm. in diameter, tuberous rooted; joints obovate, often 9 by 19 to 20 cm., but more commonly 5.5 by 10 to 11 cm. in current year's growth, blue-green, rather glossy with somewhat tubercular raised areoles; leaves circular in section, subulate, cuspidate, pointed, about 6

mm. long; areoles subcircular to obovate, about 3 mm. in longest diameter, but increasing in size with age to even subcircular and 4 mm. in diameter, 2.5 to 3.5 cm. apart; wool tawny brown, giving its characteristic color to the young areoles which, however, is early obliterated by the spicules which are yellow, numerous, formidable, 2 to 4 mm. long, in a compact, mostly connivent tuft, filling nearly the entire areole; spines none, or an occasional one bleached white distally with tinted base, erect, flattened, twisted, faintly annular; flowers yellow; fruit light red, lighter or mottled within, smooth with very small subcircular areoles and but few inconspicuous spicules, obovate-clavate, about 2 by 4.5 cm.; seeds subcircular, rather thick, mostly a little less than 5 mm. in diameter, with narrow marginal commissure.

The species is more closely related to *O. vulgaris* than any other species, but it differs in shape and surface of joints as well as in habit and general aspect of the plant.

The type is No. 322, San Antonio garden. The original material was collected by Mr. Allaire near the mouth of Trinity River, Texas, in April, 1908. This has been grown and has produced flowers and fruit during the past season and was in bloom when received. The description is a compilation of field notes and laboratory studies from abundant living material. I take pleasure in dedicating this species to Mr. C. B. Allaire, who collected it and supplied the material from which plants have been grown and descriptions drawn.—Plates 5; 2, f. 2; 12, upper figure; 13, f. 9.

O. WHIPPLEI Engelm. & Bigel. and *O. ECHINOCARPA* Engelm. & Bigel.

On pages 102 to 105 of Bulletin No. 60 of the Agricultural Experiment Station of New Mexico, published in 1906, Griffiths and Hare discuss two somewhat distinct forms of *O. Whipplei*. An opportunity was had during the past season of studying these forms further. There is no doubt but that the two forms referred to in that publication are the same species. The differences are due to differences of altitude, rainfall or soil conditions, or all combined. This species regularly dwarfs, becomes more proliferous-fruited and more sterile in its seed habits as one goes down the mountain sides from the altitude of Fort Whipple, Arizona, where it may be 5 feet high or more.

On the other hand we have a most curious antithesis in *O. echinocarpa*. This reaches its maximum development of 6 or 7 feet high upon the deserts of Salt River Valley and its tributaries, but decreases in stature as one ascends the mountains. There is consequently the curious anomaly half-way up the San Francisco highlands on the west and south sides, of two dwarfed species of the same genus, one increasing in size toward the summit and the other increasing in size toward the valley. It is also equally strange that the dwarfed condition of both plants is proportionately less productive of seed than the normal larger forms. A few scattering plants of *O. echinocarpa* may be found as high as Fort Whipple, nearly the limit of *O. Whipplei*, but the latter never, so far as I have seen, reaches the desert mesas of the Salt River or Colorado valleys, where *O. echinocarpa* reaches its best development.—Plate 13, f. 11.

***Opuntia tricolor* sp. nov.**

An erect to ascending, spreading, open branching species about 9 dm. high, and 10 to 12 dm. in diameter; joints large, obovate, blue-green turning to a grayish brown and scaly upon old trunks, commonly 20 to 22 by 30 cm. in current year's growth, frequently only 17 or 18 by about 25 cm., obovate and either broadly rounded above or obtusely pointed both above and below; areoles subcircular, about 3 mm. in diameter on the sides, commonly 4 mm. on edges in current year's growth, enlarging in age to 6 or 7 mm., about 3 to 3.5 cm. apart; wool very light tawny; spicules brown with yellow tips or brown throughout when young and always dull, dirty yellow in age; spines bright yellow turning abruptly reddish-brown to black at base, or when young some may be yellow throughout, erect, diverging but slightly, 2 or 3 but 6 or more in age and still erect and only slightly diverging, flattened, twisted, faintly annular, 5 to 7 cm. in length; flowers yellow; fruit reddish-purple.

The species is related to *Opuntia Lindheimeri*, from which it differs in shape of joints, in color, length, position, and general aspect of spines. It is a very striking species and so distinctly different from any of the described forms as to be very clearly marked. The spines are much longer, yellower distally and darker at the base than any of the forms of the variety *cuija*,* with which it also has affinities.

* Bull. 60:44. pl. 2, figs. 1 and 2. (1906.) Agricultural Experiment Station of New Mexico.

The type is specimen No. 8651 D. G., prepared October 2, 1908, from cultivated specimens collected March 29, 1907, near Laredo, Texas, under the same collection number. The description is a compilation of two sets of notes, one taken in the type locality and the other beside the cultivated progeny, supplemented by laboratory studies.—Plate 4, upper figure.

***Opuntia caerulescens* sp. nov.**

Plant open, loose branching, erect, 10 to 15 dm. high and arborescent in form, with a distinct trunk 5 to 8 cm. in diameter; lateral branches (and fruits) breaking off readily and starting new plants, commonly few-spined, 2.5 to 8 cm. long, or subglobose, and resembling fruits in all but the flower scar, others 1.5 to 3 dm. or more in length and more spiny, the central stem losing all semblance of jointedness, glaucous, dark blue-green, and commonly tinged with copper color on one side, changing irregularly to a dirty gray and epidermis falling off in thin papery shreds in age, tuberculate with low, not laterally compressed tubercles about 3 mm. high having gradually descending slope below and more abrupt above where the areole is situated, entirely disappearing on old wood; leaves circular in section, subulate, cuspidate pointed, 5 to 6 or 7 mm. in length; areoles obovate to triangular, 2 to 4 mm. in length on last year's wood, brownish when young but soon turning to a dirty gray, enlarging with age and becoming distinctly sub-areolate; spicules dark reddish-brown, 2 to 3 mm. long, in a compact bunch in upper portion of areole or, at base of some joints, filling the entire areolar area; spines, mostly 1, commonly gray-white at base and reddish-brown distally with sheaths not very loose and dark straw-colored, 1.5 to 2 cm. long, with frequently 2 smaller lateral ones and 3 to 4 evanescent, dirty, blackish bristles, not increasing in either numbers or length with age; flowers greenish-purple, about 2 cm. in diameter, with petals obovate, rounded above, cuspidate pointed, sepals greenish-red, cuspidate pointed, filaments greenish at base, purplish-red above, $\frac{3}{4}$ to $\frac{1}{2}$ the length of the style, which is white below, purplish above, 12 to 15 mm. in length, with stigma white or slightly purplish tinged, 4-parted; ovary obovate, 2 to 3 cm. long, tuberculate, areolate, bearing circular areoles 1 to 2 mm. in diameter and about 6 or 7 mm. apart, beset with abundant bright reddish-brown spicules about 2 mm. in length, proliferous, remaining attached to the plant year after year.

The species is most closely related to *Opuntia Kleiniae*, from which it differs in nature and length of spines, color and general appearance of plant body, as well as in the nature of the fruit. The plant has two distinct forms, one more open, fertile, and less proliferous than the other. When grown to-

gether under cultivation the two forms are indistinguishable, although quite different in habit in their natural habitat.

The type is No. 7632 D. G., prepared from a cultivated specimen April 23, 1908. The original material was collected at San Luis Potosi, Mexico, March 12, 1905. The description is a compilation of a partial description written in the type locality and a more complete one made in the field, of the cultivated, mature, three-year-old plant, supplemented by studies of the living material in the laboratory.—Plates 6, upper figure; 2, f. 9

***Opuntia gilvescens* sp. nov.**

Plant low, prostrate to slightly ascending with main branches on edge on ground and secondary ones short, erect or ascending from them, 7 to 8 dm. high and about 12 dm. in diameter, loosely branched and symmetrical with main branches usually 3 or 4, radiating in all directions; joints obovate, very pale, smooth, glossy, glaucous green changing to a light yellow-green not later than beginning of second year, commonly 20 by 25 cm. but mostly smaller and 12 to 16 mm. thick; areoles obovate, about 4 to 5 mm. in longest diameter, tawny-yellow, enlarging in age to subcircular and often becoming 6 or 7 mm. in diameter, 3 to 4.5 cm. apart; spicules always yellow, mostly about 4 mm. long, nearly or quite surrounding the darker tawny wool, but more abundant above, increasing in age to 9 or 10 mm. in length, mostly in more or less plainly distinguishable concentric circles, the new ones being inside of the old, which become dirty yellow, the marginal areoles completely and compactly filled with spicules after first year, marginal ones more loosely and unequally arranged; spines not numerous, at first translucent, soon becoming bleached white distally with dark bases, and with age changing through flesh-color to chalky white throughout, or the bases may remain somewhat tinted, tips always translucent, 1 or none to 4, mostly less than 2.5 cm. in length the first year, but sometimes even 4 cm., increasing in age to as many as 6 and somewhat longer also, erect, divergent, but sloping downward slightly in age, flattened, annular, seldom twisted; flowers yellow; fruit a light, glossy red with often a tinge of purple below, rind greenish and pulp lighter green, obovate, its areoles about 1.5 to 2 cm. apart, tawny, permanently yellow spicular; seed flattened, irregular, angular, 4 or 5 mm. in diameter, with a prominent, rounded, irregular roughened marginal callus about 1 mm. in width, narrowing toward the prominently notched hilum.

The species belongs to the *O. phaeacantha* group but differs from that species in its many variations in being a larger jointed plant, being lighter and more glossy in color, and decidedly different in the nature and number of its spines. It

inhabits sparingly the gravelly banks of arroyos in the open foothills region just below the steep mountain ascents.

Attention should be called here to the abnormality in some of the fruits shown in the photograph. Many are affected by a dipterous parasite which deposits its eggs in the young ovary and emerges in the imago stage the following April. In all fruits so injured the areoles, wool, and spicules are enormously developed, and in many cases the latter show traces of brown. As stated in a previous publication, the effect of this insect is to turn the young fruit into a vegetative organ, all of the seeds becoming aborted. It remains attached to the plant until the following season, and drops off after the insects have escaped. Engelmann has figured what appears to be this same dipterous larva effect in Pacific Ry. Report, 4, *pl.* 7, *f.* 3. 1856.

The type is No. 9619 D. G., collected in the foothills of the Santa Rita Mountains, Arizona, September 23, 1908. The description was drawn in the field beside the plant when the type specimens were collected.—Plates 7; 2, *f.* 5; 13, *f.* 6.

***Opuntia congesta* sp. nov.**

A low, spreading, very compactly branched, cylindrical-jointed species, 4 to 5 dm. high and 9 to 12 dm. in diameter, having such a congested habit of growth that there is invariably a great deal of dead stuff in the center; joints variable, 1 to 2 dm. long and 8 to 12 mm. in diameter, tubercular with a low, flat tubercle about 8 mm. long, the upper slope more abrupt than the lower, sharply defined by a slightly but sharply sunken dark green line, which although becoming less distinct is perfectly distinguishable for two or three years, bright, moderately dark green turning dull and darker to even glaucous and finally scaly, gray-black upon old trunks; leaves 3 to 5 mm. long, subulate, mucronate, circular in section, and reddish tinged toward tip; areoles broadly obovate, 3 to 5 mm. long and about 1 cm. apart, tawny when young, but turning through light gray to black in age but having a proliferating tissue in its upper portion which develops new wool even upon three or four-year-old wood, this new growth continuing tawny during the current year, often eclipsing the earlier blackened growth, thus elevating the areolar area slightly higher than its original flattened state, often subareolate even when young; spicules yellow in compact tuft in upper portion of areole, commonly less than 1 mm. long, increasing slightly but less than 2 mm. and more numerous with age, often scarcely visible until late in the first season; spines normally 1, sometimes 2 or even 3, nearly erect, when more than one the lower more or less recurved and in age in all cases always sloping downward, medium loosely

sheathed with white glistening sheaths which are yellow distally, but spines at first red turning to flesh-colored, becoming chalky white later; flowers not seen; fruit distinctly and characteristically proliferous but usually producing some seed, tubercular, like stem even in age with the same sharp limiting dark lines surrounding the tubercles, its areoles obovate, about 2 mm. in greatest diameter, bearing a prominent bunch of yellow spicules about 1 mm. in length and the upper one usually bearing a typically sheathed spine 6 to 7 mm. long and 2 to 4 delicate, fugacious bristles 2 to 3 mm. long in lower portion of areole in addition to the regular tuft of shorter spicules, green or slightly yellowish tinged when mature but always greenish within, very variable in size, the proliferous forms being 1.5 cm. by 3 to 4 cm., while the less proliferous and fertile forms are 1 cm. by 1.5 to 2 cm.

The relationships of this species are somewhat ambiguous. It has some ear marks of *Opuntia neoarbuscula*, which it resembles in habit, but from which it differs decidedly in its proliferous, tuberculate fruits, fewer spines, usually poor seed habits, and tuberculate stems. It resembles in some respects *Opuntia Kleiniae*, but its habit is entirely different and the fruits and stems are too tubercular to be admitted into that species. It grows associated with a dwarf form of *Opuntia Whipplei*, some varieties of which it resembles in the tuberculation of its fruits, but these fruits are smaller, the plant is in general much less spiny, the stems are smaller and less tuberculate. On the whole, it probably belongs closer to *Opuntia neoarbuscula* than any other species. A single joint or some stems might be selected which would pass fairly well for *Opuntia arbuscula*, but the fruits will not admit of its being referred to this species.

In the above description the spicules are said to be yellow, and this is true of the type specimen. However, specimens were found after the description was written having reddish-brown spicules. So we must consider the spicules in this species, as in scores of others, to vary from yellow to reddish-brown when young. Upon old joints the reddish-brown spicules become a dirty yellow.

The type is No. 9568 D. G., collected near Hillside, Arizona, September 10, 1908. The description is a compilation of field notes taken beside the yellow-spiculed plant supplemented by laboratory studies of both varieties.—Plates 8; 2, f. 4 and 7; 13, f. 5.

***Opuntia canāda* sp. nov.**

Plant erect and ascending, spreading, rather compactly branched, about 9 dm. high and 12 or more dm. in diameter, growing commonly in thickets, but also frequently as isolated individuals; joints obovate to ovate, mostly broadly rounded above, about 16 by 22 cm. in second year joints but quite variable, yellowish, smooth and shining green when young, turning darker and more or less glaucous the second year; leaves circular in section, subulate, mucronate pointed, about 1 cm. in length; areoles sub-circular, brown when young, turning through dirty gray to black, but often retaining a brown center surrounded by a grayish or black zone owing to continued development of new wool from the central areolar area, broadly obovate, 5 mm. in greatest diameter but increasing in size with age and becoming subcircular, very prominent; wool light tawny when removed, but dark brown in situ, prominent; spicules very variable, often few or none until 1 or 2 years old, when they become conspicuous, unequal, often 12 mm. in length, upon last year's joints when present they are 2 to 3 mm. long, always unequal, scattered, light reddish-brown when young, turning yellow or dirty yellow in age; spines exceedingly variable in every characteristic, bleached white with usually tinted bases mostly completely white after a year or two, commonly yellow when young, but soon presenting the bleached, white appearance, flattened, sometimes twisted slightly, never annular, but minutely longitudinally striate under a lens, 1 to 4 or 5, mostly 2 or 3, 12 to 15 mm. in length on second year joints, but frequently increasing in both length and numbers upon old trunks; flowers yellow with tinge of red or deep orange on inside at bases of petals and often outside as well, stigma bright green and style varying from white to reddish-tinged; fruit light red, often mottled yellow and red, usually not uniformly colored, rind greenish-yellow and pulp lighter in color, its areoles usually gray on border and tawny brown within, the spicules being very light brown; seeds flattened but mostly quite thick, angular, between 3 and 3.5 mm. in diameter, with a prominent, rounded, roughened marginal callus, and prominently notched hilum.

The species is most closely related to the spiny form of *Opuntia laevis*, from which it differs in greater spininess, difference in color of plant body, larger, more robust plant, and in the nature of its fruit. The seeds of the two species are also different. It commonly grows upon the sides of arroyos and canyons from the lower foothills to the beginning of the oak timber and is rather common throughout the locality mixed with the spiny forms of *Opuntia laevis*, from which it is sometimes difficult to distinguish it, except in flower and fruit.

The type is No. 9593 D. G., collected in the foothills of the Santa Rita Mountains, Arizona, September 17, 1908, The

description is a compilation of four sets of field notes supplemented by laboratory studies.—Plates 6, lower figure; 2, f. 6; 13, f. 2 and 12.

***Opuntia megacarpa* sp. nov.**

An ascending, spreading, bushy, open-branched plant 6 to 10 dm. high and 12 to 15 dm. in diameter, the main branches resting on edges of joints and ascending at the extremities, the secondary ones of a joint or two in length growing erectly from them; joints obovate, mostly pointed above, glaucous, turning yellowish-green the second year, commonly 20 by 25 cm. and often widest at middle and tapering each way, often slightly purplish about the areole; areoles subcircular to obovate, 4 to 6 mm. in diameter, tawny brown turning gray in age and its tissues proliferating into a convex gray surface when not covered with spicules; spicules reddish brown in a rather compact, quite equal, crescentic bunch in upper portion of areole, about 3 mm. long but increasing with age in both numbers and length, becoming unequal and even 12 or 13 mm. in length, sometimes filling the entire areole; besides the regular spicules there are a few scattering fugacious bristles all through the areolar area of young joints; spines very long, formidable, often 7 or 8 cm. in length, one or none below to as many as six above, 8 cm. in length, changing successively from white through mottled flesh-color to reddish-brown at base, and in age dull, dirty brown throughout, tips always more or less translucent, bone-like even in age, flattened, twisted, sometimes striate, very faintly when at all annular, and this lasting only through the growing season, at first spreading in all directions but later sloping downward; flowers not seen; fruit dull, purplish red, often with a bleached yellowish appearance, about 38 by 82 mm., rind greenish, streaked with red, and pulp greenish; seeds very large, flattened, irregularly angular, often 8 mm. in diameter but more commonly about 7, with very prominent, more or less wavy, sharp marginal callus about 1.5 mm. wide, prominently notched at hilum.

It is difficult to express satisfactorily the relationship of this species. The spines in color might pass for some forms of *O. phaeacantha*. So might the seeds, so far as everything but size is concerned. The general habit of the plant is that of *Opuntia procumbens*, but, as indicated in the description, it is difficult to admit it even into the same group with either one of these species. Its main characteristics are its spininess, large, long fruits, and exceedingly large flat seeds.

The type specimen is No. 9501 D. G., collected near Banning, California, August 25, 1908. The description given above is a revision of one made in the field when the plant was collected.—Plates 2, f. 3; 13, f. 10.

***Opuntia texana* sp. nov.**

Plant erect to ascending, spreading, rather open, about 9 dm. high and 12 to 15 dm. in diameter when full grown; joints obovate, often 20 by 28 cm., but more commonly smaller, about 16 by 20 cm., glaucous, gray-green, turning to a scurfy brown and finally dull, dirty gray and scaly upon old trunks; areoles obovate, 3 to 4 mm. in longest diameter on sides of joints but larger and subcircular on the edges, all becoming larger and subcircular with age, brown turning to dirty black or obscured entirely by the spicules in age, 3.5 to 5 cm. apart on sides of joints; wool brown in situ, light tawny when removed; spicules yellow, formidable, unequal, scattered, but always more numerous above, mostly 10 to 13 mm. in length, becoming both longer and more numerous with age; spines yellow throughout and remaining so for two or three years, then becoming dull, dirty yellow, slightly sloping downward, mostly one on sides of joints first year and 1 to 3 or 4 on edges, increasing with age to as high as 6 or 8 but mostly 3 or 4, the longest 5 to 6 cm. long, mostly 2.5 to 4 cm., flattened, twisted, faintly annular; flowers yellow, stigma deep, dark green, 6 to 9 parted; fruit obovate, purplish red throughout, about 4 by 6.5 cm.

This species is most closely related to *Opuntia Lindheimeri*, from which it differs mostly in the color, arrangement, and position of its spines. It is usually more productive of fruit, more subject to disease, and less vigorous than that species.

It has been with considerable difficulty that I have been able to settle upon the exact type of *Opuntia Lindheimeri*. The species was collected originally by Lindheimer at New Braunfels, Texas, and forwarded to Dr. Engelmann, who evidently grew the cuttings forwarded to him in the greenhouse. The only specimens preserved are imperfect ones which he cultivated under artificial glass house conditions at St. Louis. At New Braunfels, however, the largest and most numerous plants are those of what I consider to be a typical *Opuntia Lindheimeri*. The species described above also occurs commonly, but not so abundantly as the other. However, I am free to confess that the type specimen, as preserved in the Engelmann collection, might easily pass for either species. There is one statement in the Engelmann description, "setis flavidis," which would lead one to suspect that Engelmann possibly might have had the species here described rather than *Opuntia Lindheimeri* as I understand it; but, on the other hand, he states that the plant is erect, often six or

eight feet high, which applies much better to *Opuntia Lindheimeri* than to this species. Again, the spines of *Opuntia Lindheimeri*, under many conditions, might be considered yellow rather than white. However, should the translucent, bone-like appearance of the spines of some forms of *O. Lindheimeri* be called yellow, they are very different indeed from the yellow of the species here described.

The type is No. 9640 D. G., collected at San Antonio, Texas, October 1, 1908. The description is a compilation of one made when the type specimen was collected and previous field notes, together with laboratory examinations of fresh living material.—Plates 9; 13, f. 1.

***Opuntia arizonica* sp. nov.**

A prostrate to ascending species, 8 to 10 dm. high and often widely spreading, sometimes 2.5 m. in diameter but usually about 18 dm., the joints of the main branches mostly on edge and radiating outward but often flattened upon the ground; joints large, subcircular, commonly 2.7 dm. in diameter but mostly about 22 cm., glaucous, blue-green but becoming yellowish green with age; areoles tawny, turning gray-black, large, obovate, about 8 mm. in longest diameter on sides of joints but on edges some, at least, are subcircular and often 10 to 13 mm. in diameter, not enlarging much with age but finally becoming black, and central tissue proliferating irregularly into a low cone; spicules reddish-brown, with abrupt yellow tips, becoming lighter with age, somewhat mottled brown and yellow, about 6 to 10 mm. long, unequal, scattered, but more abundant in upper portion of areole, increasing with age from central proliferating areolar tissue, sometimes becoming 12 or 13 mm. long, sometimes flattened and twisted; spines large, stout, formidable, reddish-brown throughout, soon bleaching distally, becoming irregularly mottled reddish-brown and flesh-colored, then yellow with reddish bases, or yellow throughout, and finally on very old joints dirty gray, flattened, twisted, faintly annular in color but not in structure, 2 to 6, mostly 3 or 4, erect, divergent, but the lower ones usually recurved, and all having a tendency to slope downward in age, the longest 4 to 5 cm. in length; flowers not seen; fruit large, subglobose, somewhat tubercular, pitted at apex, reddish-purple with greenish rind which has some red in its vascular system and pulp mottled, its areoles large, subcircular to obovate, about 4 mm. in diameter, tawny to light gray, bearing spicules about 3 mm. long, and in upper areoles 1 or 2, delicate, fugacious, mottled yellow and brown spines 12 to 25 mm. in length; seeds flattened, angular, quite uniform in size but somewhat irregular in shape, with marginal callus, rather prominent and 1 mm. wide, with distinct deeply notched hilum, about 4 mm. in diameter.

The species differs from *Opuntia Engelmanni*, to which it is most closely related, especially in habit, and in nature of spines and fruit. No. 9560 D. G. is considered to be the same, although its spicules are yellow and its spines much lighter in color. The color of spines and spicules, while of value in taxonomy, can not be used to differentiate species unless accompanied by other characters. There are a score or more of species which have both yellow and brown or reddish-brown spicules.

The type is No. 9559 D. G., collected near Kirkland, Arizona, September 8, 1908. The description was drawn in the field beside the brown spiculed form.—Plates 10; 2, f. 8; 13, f. 8.

***Opuntia subarmata* sp. nov.**

Plant tall, rather compactly branched, erect or ascending, making a shrub 12 to 15 dm. high and 18 or more dm. in diameter; joints broadly oval to obovate, commonly 17 to 25 cm. in diameter, broadly to narrowly rounded above, blue glaucous green changing through yellowish to brownish and finally gray scaly; areoles elliptical to ovate or even subcircular, 3 to 6 mm. in longest diameter, 3.5 to 4.5 cm. apart, tawny changing to gray or black, enlarging but slightly with age; spicules yellow, about 2 mm. in length, never formidable and not increasing with age; spines none; fruit purple throughout, bearing light, tawny, subcircular areoles, 1 or 2 mm. in diameter, having a small central tuft of yellow spicules; seeds flattened, regular, about 4 mm. in diameter, prominently notched at hilum, with marginal callus about $\frac{1}{2}$ mm. in width.

The species is rather closely related to *Opuntia texana*, which in turn belongs to the *O. Lindheimeri* group. It differs from that species mainly in the absence of spines, difference in areoles, and a decidedly larger seed than either of the foregoing species.

The type is No. 9422 D. G., collected near Devils River, Texas, July 22, 1908. The description was written beside the type plants in the field.—Plates 11; 2, f. 1; 13, f. 4.

EXPLANATION OF PLATES.

Plate 2.—Diagrams of *Opuntia* fruits, natural size. Outlines were prepared in the field by bisecting the fruit in the median longitudinal plane. The cut surface was then placed upon a piece of paper and a pencil tracing made of it. This plate is prepared from tracings of these field sketches. 1, *Opuntia subarmata*; 2, *O. Allairei*; 3, *O. megacarpa*; 4 and 7, *O. congesta*, the first is the sterile form of the fruit; 5, *O. gilvescens*; 6, *O. cañada*; 8, *O. arizonica*; 9, *O. caeruleascens*; 10, *O. Dillei*.

Plate 3.—Above, *Opuntia rufida* from type locality near Presidio, Texas. The plant is not quite normal on account of the main stem having been injured. Below, a cultivated two-year-old plant from a cutting secured near Torreon, Mexico.

Plate 4.—Above, *Opuntia tricolor*, a two-year-old plant under cultivation from a single joint cutting. Below, *O. Dillei* upon limestone ledges in the Sacramento Mountains of New Mexico.

Plate 5.—*Opuntia Allairei*, joints and fruit (see also plate 2), all of current year's growth.

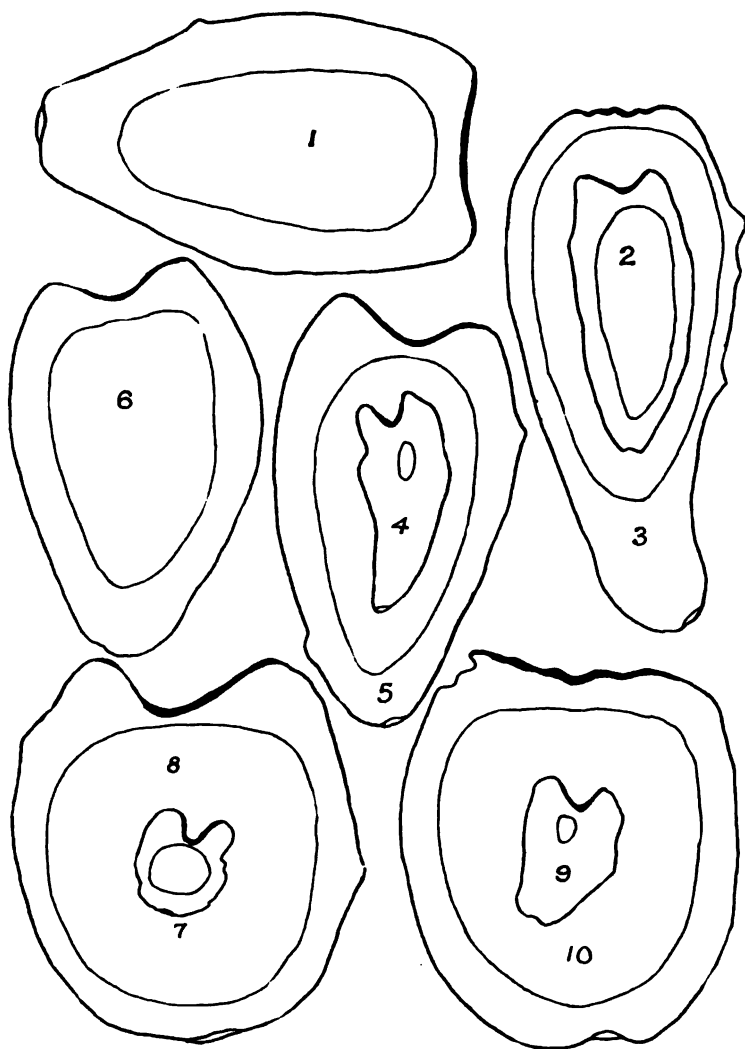
Plate 6.—Above, *Opuntia caeruleascens*, marked by the hat. Cultivated four-year-old specimens. Below, *O. cañada*.

Plate 7.—*Opuntia gilvescens*. Plate 8.—*Opuntia congesta*. Plate 9.—*Opuntia texana*. Plate 10.—*Opuntia arizonica*.

Plate 11.—*Opuntia subarmata* upon calcareous soil of western Texas.

Plate 12.—Above, *Opuntia Allairei*, one season's growth from single joint cutting. A flower was produced on last growth of season. Below, *O. microdasys*. Compare the habit in this figure, which is from a native plant in the State of San Luis Potosi, Mexico, with that of *O. rufida* in Plate 3.

Plate 13.—*Opuntia* seeds, natural size. 1, *Opuntia texana*; 2, *O. cañada*; 3, *O. rufida*; 4, *O. subarmata*; 5, *O. congesta*; 6, *O. gilvescens*; 7, *O. Dillei*; 8, *O. arizonica*; 9, *O. Allairei*; 10, *O. megacarpa*; 11, *O. echinocarpa* (there are forms of this species with smooth seeds); 12, *O. cañada* (compare with fig. 2); 13, *O. microdasys*.



FRUITS OF OPUNTIA.



OPUNTIA RUFIDA.



OPUNTIA TRICOLOR AND O. DILLEI.



OPUNTIA ALLAIREI.



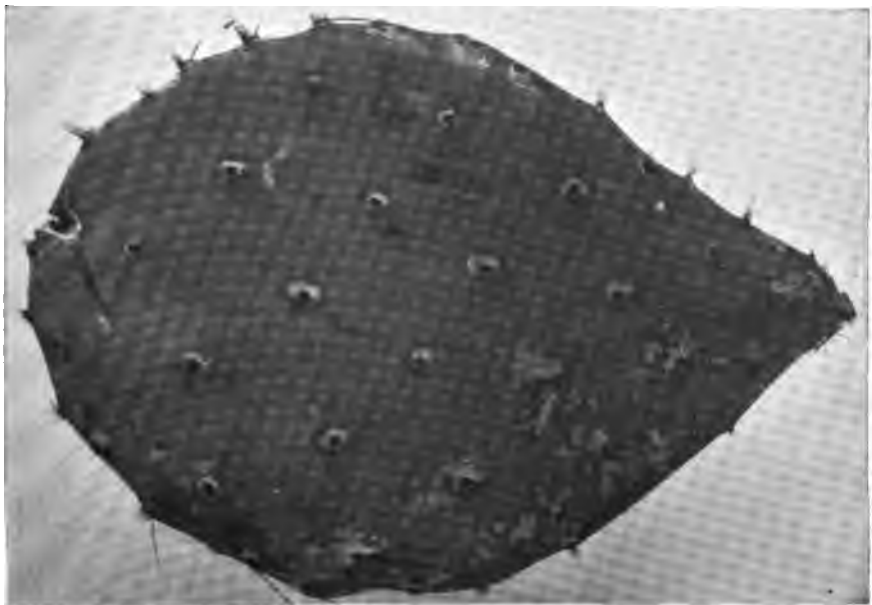
OPUNTIA CAERULESCENS AND O. CAÑADA.



OPUNTIA GILVESCENS.



OPUNTIA CONGESTA.



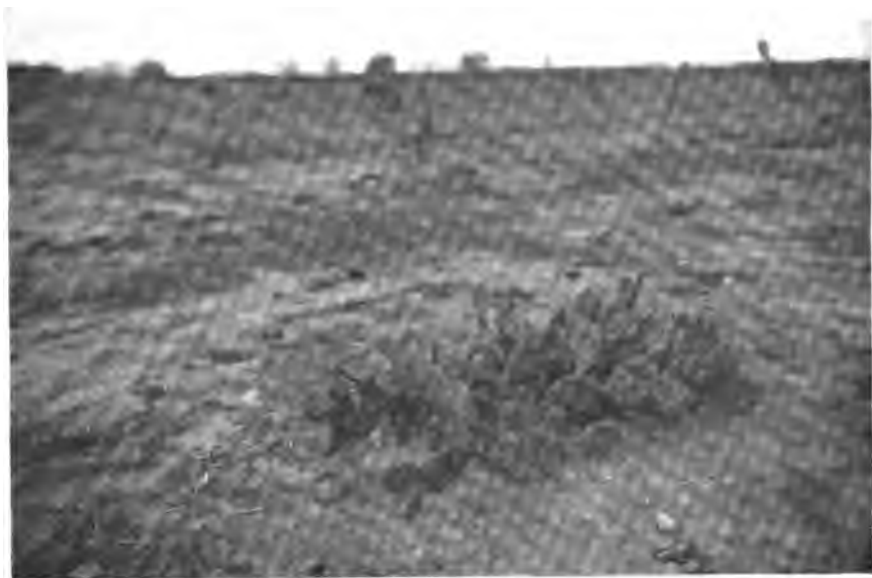
OPUNTIA TEXANA.



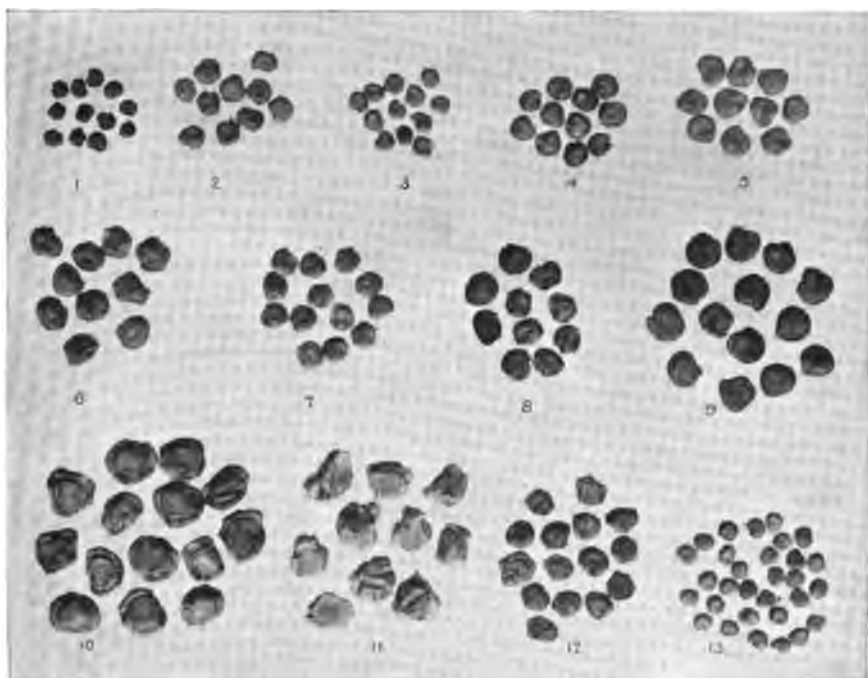
OPUNTIA ARIZONICA.



OPUNTIA SUBARMATA.



OPUNTIA ALLAIREI AND O. MICRODASYs.



SEEDS OF OPUNTIA.

