Mexico have generally failed to recognize gypsum. Plants collected on beds of nearly pure gypsum have had the substratum, if mentioned at all, commonly described as "limy," "calcareous," "chalky" or even "saline." Many references to "dry calcareous soil" undoubtedly refer to gypsum. Beds of gypsum, however, may be recognized after attention has been directed to their peculiarities. Gypsum flats have a soil that is whitish, chalky and friable. They commonly sound with a very characteristic hollow ring when pounded or stamped upon. Large flats, on valley-floors, frequently develop sink-holes, opening into ill defined subterranean water-channels. Small gypsum flats are frequently favored by burrowing rodents and they may be marked by an unusually large number of the mounds of these animals.

The plants found on beds of gypsum are of two sorts, those tolerating gypsum, and those demanding it. The tolerant species, which are numerous, are those of non-gypseous soils which also grow on gypsum and which, though perhaps less abundant on gypsum than elsewhere, seem generally unaffected by the differences of substratum. Of this group only a few, such as *Dyssodia pungens, Coldenia hispidissima, Condalia spathulata,* and *Condalia fasciculata,* may, perhaps, be more thrifty on gypsum than off.

Associated with the species that have spread on to gypseous areas from surrounding non-gypseous soils is the much smaller group of species which are never found beyond the margins of gypseous areas of soil. The most abundant and successful plants found on gypsum exposures commonly belong to this smaller second group of plants.

That there are species strictly confined to gypseous soils is manifest in all exposures of gypsum. In fact, it is often dramatically shown by their abrupt disappearance along the margins of those gypsum flats which are sharply circumscribed. I have seen *Dicranocarpus* abounding on a small flat and so scrupulously respecting the well defined gypsum-margin as to suggest a culture of the plant on a carefully tended garden plot. In northern San Luis Potosí, where species of *Flaveria* and *Sartwellia* are not only confined to gypsum but commonly even abound on it, they frequently color gypsum-flats yellow and permit one to recognize these exposures of gypsum miles away on a distant hillside. Another example of the dramatic way in which species refuse to transgress gypsum-boundaries is found in the behavior of two species of *Fouquieria* growing north of Mohovano, Coahuila. One of these species is frequent on gypsum flats while the other replaces it on the surrounding non-gypseous soils. In a few cases I observed the shrubs growing near one another with interlocking branches, but *F. Shrevei* was always rooted

in gypsum and *F. splendens*, beyond an abrupt gypsum boundary, always rooted in non-gypseous soil.

That there are plants which appear to seek out gypsum and are confined to it is well shown by my experiences in the eastern foothills of the Sierra de las Cruces, Coahuila. Here on a large series of gypsum exposure I found a well developed gypsophilous florula containing species of *Notholaena, Sporobolus, Drymaria, Dicranocarpus, Nama* and *Haploesthes*. Searching out the widely scattered gypsum exposures of the region, with the help of Mr. Robert Stewart, a geologist very familiar with the area, we failed to find any of them that did not bear at least *Nama Stewartii* or *Haploesthes Greggii*. These species grew on gypsum and nothing but gypsum, and showed an almost incredible ability to find widely scattered exposures of gypsum, even the isolated ones and those with a few square yards of surface. Only obligate gypsophily and very successful powers of dissemination can explain the remarkable behavior of these plants.

That there is a group of plants which repeatedly seek out gypsum is further shown by a comparison of the lists of those species found restricted to gypsum in widely separated parts of northern Mexico. The most extensive gypsum deposits which I have examined are those forming the great plains between Matehuala and Cedral, in northern San Luis Potosí. Here are found the following gypsophiles:

Muhlenbergia villiflora
Drymaria lyropetala
Nerisyrenia gracilis
Dalea filiciformis
Nama canescens
Dicranocarpus parviflorus
Sartwellia humilis
Flaveria anomala

About 70 miles west of Matehuala, in northern Zacatecas, gypsum exposures near Sierra Hermosa have the following plants restricted to them:

Nerisyrenia gracilis
Phacelia gypsogenia
Dicranocarpus parviflorus
Sartwellia humilis
Nama hispidum var. *gypsicola*

In southeastern Coahuila, about 70 miles north of Matehuala, the following species were found confined to a gypsum flat just north of La Ventura:

Muhlenbergia villiflora
Nerisyrenia gracilis
Dicranocarpus parviflorus
Thelesperma scabridulum
Sartwellia humilis
Flaveria anomala
Nama hispidum var. *gypsicola*

Nearly 250 miles northwest of La Ventura, in western Coahuila near the southeastern corner of Chihuahua, gypsum flats are frequent between

Mohovano and Laguna del Rey. Here there is a well developed gypsophilous flora containing the following:

Selinocarpus Purpusianus
Drymaria elata
Nerisyrenia Castillonii
Fouquieria Shrevei
Petalonyx crenatus
Nama Purpusii
Dicranocarpus parviflorus
Sartwellia mexicana

Over 75 miles northwesterly from the Mohovano-Laguna del Rey area there are gypsum flats south of Jimenez, Chihuahua, bearing the following gypsophiles:

Phacelia gypsogenia *Dicranocarpus parviflorus* *Sartwellia mexicana*

About 75 miles north of Leguna del Rey in western Coahuila, gypseous ridges near Laguna del Jaco produce the following:

Muhlenbergia villiflora
Sporobolus Nealleyi
Nerisyrenia Castillonii
Phacelia gypsogenia
Sartwellia sp.

East from Laguna del Jaco, in the eastern foothills of the Sierra de las Cruces, there is a well developed gypsophilous florula containing the following:

Notholaena bryopoda
Sporobolus Nealleyi
Drymaris lyropetala
Nama Stewartii
Dicranocarpus parviflorus
Haploesthes Greggii

Further north in western Coahuila, over 100 miles north of Laguna del Rey and about 60 miles south of the Big Bend of the Rio Grande, there are gypsum flats at Castillon containing the following gypsophiles:

Sporobolus Nealleyi
Nerisyrenia Castillonii
Loeselia Havardii
Nama Stewartii
Phacelia gypsogenia
Dicranocarpus parviflorus
Sartwellia puberula

At each of the eight widely separated localities just mentioned, the plants listed were confined to gypsum. A comparison of the lists shows the combinations in which the various gypsophiles are associated in the several floristic areas represented. The presence of various species, frequently with several of the same associates, in widely separated gypsum exposures, is evidence that gypsophily is no matter of individual preference nor chance local association. Only the same fundamental requirements could force the species I have listed to foregather repeatedly and always within the confining limits of scattered gypsum exposures. The behavior of these plants is that of an old and established fraternity. This is also suggested by the fact that all the species of such well marked genera as *Dicranocarpus* and *Sartwellia* are gypsophilous

and is further indicated by the fact that such genera as *Nerisyrenia*, *Drymaria* and *Nama* all have groups of species characterized by gypsophily.

Thus far we have been concerned with the behavior of gypsophiles on exposures of gypsum or on soil mixtures evidently containing a high percentage of gypsum. As has been stated, examination of such deposits shows that certain species repeatedly occur on these deposits and fail to transgress their boundaries when these latter are sharply defined. Gypseous soils, however, may contain varying proportions of gypsum, and gypsum deposits may be partially or wholly covered by a mantle of non-gypseous soil of varying thicknesses, spread by water flowing from slopes beyond the gypsum-boundary.

My observations indicate that a gypsum flat overlaid with a fine completely non-gypseous soil, derived either from calcareous or igneous rocks, is practically devoid of gypsophiles when the non-gypseous mantle becomes as much as an inch in thickness. Sometimes an unbroken overlay of half that thickness appears to be an effective barrier to gypsophilous plants. Since gypsophiles show no particular aversion to non-gypseous material when a certain amount of gypsum is also available, as demonstrated by their frequent presence on mixed soils, and since it would seem that the deep roots of mature gypsophiles would have little difficulty in reaching gypsum through a thin overlying non-gypseous mantle, one can only conclude that the absence of gypsophiles on mantled gypsum is in some way associated with an inability of their seeds to germinate or their seedlings to become established in a completely non-gypseous surface layer of soil.

It is not uncommon to find gypsophiles in mixed soils containing sufficient gypsum characteristically to whiten the soil. Such soils, however, obviously contain a high percentage of gypsum. Observation of the gypsophilous florulas found on mixed soils discloses an obvious correlation between the decrease in number of gypsophiles, both as to individuals and as to species, and the decrease in the evident gypsum-content of these soils. This would indicate that the various gypsophiles differ in the minimum amounts of gypsum they require. This is a subject that merits the attention of an ecologist who can supplement his studies with soil analyses.

While most soils reveal their gypsum content by their pale coloration, there are soils which, though probably containing gypsum, give little or no evidence of the fact superficially. In some cases this is the result of mixing gypsum in a dark-colored soil, mixing in organic material, or masking the pale coloration of gypsum by abundant soil moisture. In

a few cases I have observed gypsophiles growing on soils which I could not identify as gypseous, though I strongly suspect that they are so.

While only chemical analyses will finally settle the matter, a surprisingly strong case of circumstantial evidence can be presented for the presumed occurrence of gypsum in nondescript soils where gypsophytes are found. As an illustration of this, a small terrace adjoining a salt-marsh at Hermanas, Coahuila, may be taken. Here, on a kind of light-colored though not pallid clay, which I did not recognize as gypseous, I found concentrated and localized a number of unusual plants, among which were the following:

Drymaria lyropetala
Euphorbia astyla
Nerisyrenia Castillonii
Nama serpylloides var. *velutina*
Sartwellia mexicana
Thelesperma ramosius
Aplopappus Johnstonii
? Gaillardia multiceps

Among this group of plants, the presence of the *Drymaria* and the *Nerisyrenia* is especially noteworthy, for these plants have been discovered elsewhere only on gypsum and are very marked gypsophiles. Habitat data are not at hand for all the available collections of the *Sartwellia,* but most of these are definitely known to have come from gypseous soil, and, from collateral evidence, a gypsum substratum can be confidently assumed for the rest. Hence among the plants congregating on the small terrace near Hermanas there are three species, which, if we may judge from their behavior elsewhere, might be taken as good indicators of gypseous soil. If the small terrace at Hermanas is gypseous, we have a reason for the remarkable concentration of rare plants in this small area. There is, indeed, evidence for believing that all of them are gypsophiles. It would not be surprising if the new *Thelesperma,* found only at Hermanas, proved to be gypsophilous. The genus *Thelesperma* has reacted to gypsum elsewhere; *T. scabridulum* is a marked gypsophile and is known only from a single gypsum flat in southern Coahuila. Among the other new plants found near Hermanas were the *Nama* and the *Aplopappus.* These, and the rare *Euphorbia,* I subsequently found a second time on the saline flat west of Cuatro Cienegas. It is interesting to note that near the margin of this saline flat, not far from where I found the *Nama,* the *Aplopappus* and the *Euphorbia,* I found colonies of *Nama Purpusii,* which is a characteristic gypsophile in the extensive gypsum flats, further west, about Laguna del Rey, where, incidentally, the *Euphorbia* has also been found. I am inclined, also, to attach significance to the fact that near the *Nama, Aplopappus* and *Euphorbia* at Cuatro Cienegas, I found a remarkable new species of *Nerisyrenia* (*N. incana*). Of the four other species

of this genus, three are marked gypsophiles. The odds, therefore, are in favor of *N. incana* also being gypsophilous. The presence of the gypsophilous *Nama Purpusii* in its vicinity seems to make this very probable. In any case, there are reasons for suspecting that gypsum is present west of Cuatro Cienegas. This appears to be the reason why the three rare plants of the supposed gypseous terrace at Hermanas should again appear together, sixty miles to the westward, in the saline flats near Cuatro Cienegas. The rare species localized on the terrace at Hermanas behave, individually and as a group, as gypsophiles. As gypsophiles their presence together, congregated on the small terrace at Hermanas, is understandable if the soil at that particular locality is gypseous. I believe that the congregation of these species indicates the presence of gypsum in the soil, and I am confident that soil analyses would substantiate my faith in the indicator value of these species.

If the localities near Hermanas and Cuatro Cienegas have gypseous soils, they are localities of interest. At both of them, the soils, in addition to their suspected gypsum content, evidently contained large amounts of other salts. Near Cuatro Cienegas the putative gypsophiles were actually associated with pronounced halophytes, such as *Distichlis, Monanthochloe, Suaeda, Atriplex* and *Allenrolfea*. This is the only locality at which I have found possible gypsophiles associating with pronounced halophytes. This would suggest that perhaps some gypsophiles, with their basic requirements of gypsum satisfied, can grow in mixed soils rich enough in other salts to support halophytic plants as well.

Some authors have referred to the plants found growing on gypsum as "halophytes." This is incorrect. If the conventional definition of halophyte, "a plant growing on soils impregnated with salt or alkali," can be stretched to include gypsophiles (plants of calcium sulphate), I do not see why the term can not be made entirely meaningless by including the plants of calcium carbonate, the calciophiles, as well. While some gypsophiles do appear to tolerate concentrations of salt and alkali and might be termed "halophytic gypsophiles," most of them grow on beds of gypsum where the concentrations of salt and alkali are frequently even lower than in the average of desert soils. Beds of gypsum do not produce the common and distinctive plants of salt and alkali flats. With adjacent non-gypseous slopes and flats, they share in the common and widespread species of the region, and their peculiar species have been recruited from among this class of plants. Perhaps the gypsophiles average a bit more succulent, but as a class they are not otherwise dis-

tinguished superficially from the common widely ranging desert plants growing with them on and about gypsum exposures.

Gypsophiles may belong to genera also containing species of common unspecialized desert plants, and even to genera containing more than one gypsophilous species, but only exceptionally do they belong to groups containing halophytes. In their basic requirements and in their phyletic relations gypsophiles and halophytes are fundamentally different. The few exceptions are of interest. The genus *Frankenia* is generally recognized to be an old group and has species widely scattered in the various desert regions of the world. Though most of its species are marked halophytes, the genus does contain some recognized gypsophiles, the two in America being confined to the plateau desert of northern Mexico and to the adjoining, physiographically similar, area to the north. The genus *Sporobolus*, which has a gypsophile in *S. Nealleyi*, also contains some marked halophytes. As a group, however, it is more characteristic of arid regions rather than of halophytic situations. Perhaps also to be included here is an aberrant and curious species of *Atriplex*, *A. reptans*, recently discovered on a flat at the base of a gypseous ridge near Laguna del Jaco, Coahuila. Should this *Atriplex* prove to be gypsophilous, it will be the only Mexican member of that great group of halophytes, the Chenopodiaceae, which is confined to gypseous soils.

It is natural to expect that, if gypsophily is markedly developed in northern Mexico, evidences of it should be found among the plants in the adjoining and physiographically similar parts of the United States. Casual notes in the literature and habitat-data on herbarium specimens suggests that there are a number of gypsophiles in the United States which do not extend south to the Mexican border. I know of only two localities north of the border at which the plants on a gypsum habitat have been described. Both are in New Mexico. Their flora is similar to that which I have described from Mexico.

Probably the most famous deposit of gypsum in the United States is the so called "White Sands" of New Mexico. In a recent account of these gypsum dunes, F. W. Emerson, Ecology **16**: 226–233 (1935), lists 57 species as growing in the gypsum sand. Among the species listed are: *Sporobolus Nealleyi, Nerisyrenia linearifolia, Nama* (*Andropus*) *carnosum, Dicranocarpus parviflorus*, and *Sartwellia Flaveriae*. The *Sporobolus* and *Dicranocarpus* are very definitely restricted to gypsum or gypseous soils in Mexico. The *Nama* is closely related to a group of Mexican gypsophiles, and away from the White Sands is known only from two collections in northern Culberson County, Texas. This latter area is a region of very extensive gypsum deposits, exposures of gypsum

fifty feet thick having been reported in the bluffs of Delaware Creek where this *Nama* has been collected. The *Nerisyrenia* was first collected on the bluffs of Delaware Creek, and has been subsequently found in various parts of adjacent southeastern New Mexico where Wooton & Standley, Fl. New Mex. 270 (1915), report it as a plant of "gypsum soils." It is closely related to the Mexican gypsophile *N. gracilis*. Away from the White Sands the *Sartwellia* has been collected repeatedly in gypseous soil and is probably gypsophilous as are the other, all Mexican, members of its genus. Hence at the White Sands we have growing on gypsum a number of species that are either specifically identical or are closely related to Mexican gypsophiles. Evidence indicates that the latter group may be as strictly confined to gypseous soils as are their Mexican relatives. Other gypsophiles, representing floristic elements not extending into Mexico, are probably also present on the White Sands. Very likely among these are *Selinocarpus lanceolatus, Frankenia Jamesii,* and *Pseudoclappia arenaria* (*"Clappia suaedaefolia"*).

The flora of some extensive gypsum flats, lying beyond the San Andreas Mts. and west of the White Sands, have recently been described by R. S. & I. F. Campbell, Ecology **19:** 572–577 (1938). In their account of the "Vegetation on gypsum soils of the Jornada Plain, New Mexico," they state that only eight phanerogams were found on the gypsum flats described; namely, *Ephedra Torreyana, Sporobolus Nealleyi, Pappophorum Wrightii, Oenothera Hartwegii, Gaura coccinea, Solanum Jamesii, Sartwellia Flaveriae,* and *Dicranocarpus parviflorus*. Except for the *Ephedra,* the *Solanum,* and the *Sartwellia,* which extend scarcely if at all into Mexico, any of these species may be expected on gypsum flats south of the boundary. Of the list only the *Pappophorum, Gaura* and *Solanum* are unreported from the White Sands. Concerning the eight species on the Jornada Plain the authors state that only the *Sporobolus* and the *Gaura* "appear to be limited to the gypsum soils." This must refer only to the areas on the Jornada Plain having maximum gypsum concentration. Both the *Sporobolus* and *Dicranocarpus* are characteristic gypsophiles in Mexico, and *Sartwellia Flaveriae* gives evidence elsewhere of sharing gypsophily with its Mexican congeners. At the three localities where I have seen the *Sporobolus* in Mexico it was confined to concentrated gypsum. The *Dicranocarpus* and the Mexican species of *Sartwellia,* on the other hand, though abounding on gypsum, frequently grow on mixed soils. I have no doubt that the behavior of these gypsophiles at the Jornada is similar to that I have observed in Mexico.

The study of the florulas of the two gypsum beds in New Mexico, just

mentioned, and of all available bits of information concerning the plants found on gypsum-soils in the Southern Great Plains Province, seems to indicate that gypsophily is largely confined there to groups of species recognizable as "southern" or "Mexican" elements in the flora. The plateau deserts of northern Mexico seem to be a center for gypsophiles and perhaps even a center from which they may have spread northward. In any case Texas and New Mexico appear to be a promising field for the study of gypsophiles in the United States. Many promising sites for such studies are described in R. W. Stone's "Gypsum deposits of the United States," U. S. Geol. Surv., Bull. **697:** 1–336 (1920).

ENUMERATION OF SPECIES

In the following catalogue I have listed systematically those plants of the plateau deserts of northern Mexico which are gypsophiles or are suspected gypsophiles. Because of their close relationships with certain Mexican gypsophiles, several gypsophilous species confined to Texas and New Mexico have also been included. Under each species treated I have cited collections examined. Most of these are in the Gray Herbarium (G). Some, however, are from the U. S. National Herbarium (US), and represent portions of a loan kindly sent me by the curator, Dr. W. R. Maxon. Dr. J. R. Swallen has not only critically determined the two grasses, but has also supplied me with a list of the collections by which they are represented in the National Herbarium. On his authority I have included these among the specimens cited.

Notholaena bryopoda Maxon, Proc. Biol. Soc. Wash. **18:** 205 (1905).

NUEVO LEON: base of the Sierra de San Lorenzo, chalky banks, 7500 ft., Nov. 7, 1907, *Pringle 8802* (G, ISOTYPE). COAHUILA: foothills of the Sierra de la Cruces west of Santa Elena Mines, confined to gypsum, locally abounding on flats and on banks of arroyos, about 5500 ft., Aug. 13, 1940, *Johnston & Muller 243* (G).

On the gypsum flats about a mile west of Santa Elena Mines this fern is localized and very common on gypsum. It grows on gypsum flats and on the banks of ravines cut through them, commonly forming dense clumps up to a meter in diameter. In its obvious restriction to gypsum and in its great abundance and vigorous growth on that substratum, it gives every evidence of being a gypsophile. Mr. C. A. Weatherby, who is monographing *Notholaena*, knows of only one other collection of this well marked species, the type-collection made nearly forty years ago in the mountains of southern Nuevo Leon, 15–20 miles south of Doctor Arroyo and not far from the Tamaulipas boundary. At this locality in

Nuevo Leon the fern was collected on "chalky banks." Since dry gypsum is "chalky" and since the fern was confined to gypsum near Santa Elena Mines, I believe it may be accepted as more than merely probable that the original material of *N. bryopoda* was found on a gypsum bank. This fern is probably gypsophilous.

Muhlenbergia villiflora Hitchc. N. Am. Fl. **17:** 470 (1935).

TAMAULIPAS: "Cañon de las Minas et Victoria inter Michiguana et Tanquecillos," *Karwinsky 1012* (US, frag. of type). SAN LUIS POTOSÍ: Charcas, *Lundell 5440* and *Whiting 786* (US); 6 mi. north of San Vicente, gypseous soil, 1938, *Johnston 7615* (G, US). NUEVO LEON: Galeana, bank of stream, *Chase 7689* (G, US); near Pablillo, edge of cienega, 1940, *Shreve & Tinkham 9749* (G). COAHUILA: 6 mi. north of La Ventura, gypsum flat, 1938, *Johnston 7642* (G, US); 10 mi. east of Fraile, with *Stipa,* abounding on floor of valley, 1938, *Johnston 7305* (G, US); gypseous ridge east of Laguna del Jaco, 1940, *Johnston & Muller 1074* (G, US).

I am indebted to Dr. J. R. Swallen for the identification of this species and for data on the specimens of it represented at Washington. Most of the collections cited have been incorrectly identified as "*M. Thurberi.*"

This species is definitely confined to gypsum at four out of the nine stations at which it is known. At these stations the plant behaved as a marked gypsophile. Although the nature of the soil was not noted, the local abundance of the grass in the valley between Carneros Pass and Fraile might well be caused by the presence of gypseous soil. Various gypsophiles have been collected near Pablillo. Gypseous soils are common and widely distributed in northern San Luis Potosí and are to be expected near Charcas. I believe that this grass is gypsophilous.

Sporobolus Nealleyi Vasey, Contr. U. S. Nat. Herb. **1:** 57 (1890).

COAHUILA: gypseous ridge east of Laguna del Jaco, 1940, *Johnston & Muller 1073* (G); foothills of Sierra de las Cruces west of Santa Elena Mines, gypsum flats, 1940, *Johnston & Muller 247* (G); Castillon, gypsum flat, 1940, *Johnston & Muller 1268* (G).

TEXAS: Monahans, Ward Co., very sandy belt, *Silveus 759* (US); Monahans, alkali flat, *Silveus 784* (US); 15 mi. south of Stanton, ? Midland Co., *Tharp 5000* (US); Screw Bean, Reeves Co., Sept. 1893, *Nealley 2305* (G, US); valley of the Pecos, *Wright 727* (G). NEW MEXICO: 35 mi. south of Torrance, Lincoln Co., 1909, *Wooton* (US); San Ysidro, *Arséne 19040* (US); Manzano Nat. Forest, near White Well no. 2, Torrance Co., Forest Service no. 39515, legit *Talbot* (US); near Suwanee, 1906, *Wooton* (US); Arroyo Ranch near Roswell,

Chaves Co., *Griffiths 5759* (G, US); Jornado Range Reserve, in caliche east of Middle Well, Forest Service no. 49290, legit *Schoeller & Campbell 462* (US); on the white sands, Dona Ana Co., *Wooton 160* (G, US).

Where I have seen this grass in Mexico it was very obviously confined to gypsum. Hitchcock, Manual of Grasses, 406 (1935), states that it is a plant of "gypsum sands" in Texas and New Mexico. Wooton & Standley, N. Mex. Agr. Experiment Station Bull. **81:** 84 (1911), state that "it never occurs on anything but 'gyp' soils," being "found only on soils containing large quantities of gypsum." Many of the localities in Texas and New Mexico, represented by the specimens cited above, are those where other gypsophiles have been obtained, and most of them are in areas in which extensive gypsum exposures are known. All the evidence indicates that the species is a marked gypsophile.

Atriplex reptans Johnston, Jour. Arnold Arb. **22:** 111 (1941).

COAHUILA: flats at the base of the gypsum ridge east of Laguna del Jaco, 1940, *Johnston & Muller 1080* (G) and *1081* (G, TYPE).

This remarkable *Atriplex* was locally very abundant in a narrow belt at the base of a gypsum ridge. It was the dominant and by far the most conspicuous plant in the scant flora at this locality. It was not seen elsewhere. The species is probably gypsophilous.

Selinocarpus Purpusianus Heimerl, Oesterr. Bot. Zeitschr. **63:** 353 (1913).

COAHUILA: 16 mi. south of Laguna del Rey, road to Mohovano, confined to gypsum flats, *Johnston 7807* (G); Sierra del Rey, 1910, *Purpus 4505* (G, ISOTYPE).

This plant was uniformly associated with *Fouquieria Shrevei* and *Petalonyx crenatus* in the region about Laguna del Rey, and like these species always growing on gypseous soil. The plant is a marked gypsophile.

The genus *Selinocarpus* has more than one gypsophile. *Selinocarpus lanceolatus* Wooton is definitely gypsophilous. It is known only from the White Sands of New Mexico and to the south, in the great gypsum area in northeastern Hudspeth County, Texas. *Selinocarpus Palmeri* Hemsl., known only from San Lorenzo de la Laguna, Coahuila, may possibly be another.

Anulocaulis leiosolenus (Torr.) Standley, Contr. U. S. Nat. Herb. **12:** 373 (1909).

TEXAS: Tornillo Creek, Brewster Co., 1883, *Havard* (US); 5¼ mi. E. of Terlingua, 1938, *Cory 30251* (G); bluffs of Delaware Creek, 1881,

Havard 87 (G); Millers Bros. Ranch, Culberson Co., 1928, *Cory 1532* (G).

The type of this species is given as collected by Parry in the "Great Canyon of the Rio Grande, 70 miles below El Paso, in gypseous soil." This is probably the canyon of the Rio Grande at the southeast corner of Hudspeth County, Texas. Gypseous soils are known in Tornillo Creek, and, of course, gypsum occurs in unusual abundance in northern Culberson County where Havard and Cory have collected the plant. The species is almost certainly a gypsophile. The plants of Nevada, which have been referred to *Anulocaulis leiosolenus* represent a well marked, undescribed species.

Drymaria lyropetala Johnston, Jour. Arnold Arb. **21:** 68 (1940).

San Luis Potosí: 3.5 km. south of Cedral, gypsum flats, 1938, *Johnston 7594* (G, type); 63 km. south of Matehuala, gypsum flats, 1938, *Johnston 7513* (G). Coahuila: 1 mi. south of Hermanas, locally common in heavy alkaline soil, 1938, *Johnston 7064* (G); foothills of the Sierra de las Cruces west of Santa Elena Mines, local on gypsum flats, 1940, *Johnston & Muller 241* (G).

This species is probably a pronounced gypsophile. At three of the four localities at which it has been collected it was definitely confined to gypsum. As has been discussed earlier in this paper, the locality at Hermanas is probably gypseous also.

Drymaria elata Johnston, Jour. Arnold Arb. **21:** 68 (1940).

Coahuila: 10 km. south of Laguna del Rey, local in gypseous silt, 1938, *Johnston 7823* (G, type); Sierra del Rey, 1910, *Purpus 4496* (G).

This species is endemic to the region about Laguna del Rey where I found it only on gypseous soils. I believe it may be accepted as a marked gypsophile.

Drymaria suffruticosa Gray, known only from San Lorenzo de la Laguna, Coahuila, is a close relative of *D. elata* with which it may share gypsophily. Various gypsophiles have been collected at San Lorenzo.

Nerisyrenia gracilis, sp. nov.

Planta humilis perennis multicaulis gracilis, maturitate pilis stellatis sparse vestitas grisella; caulibus gracilibus numerosis 1–2 dm. longis decumbentibus saepe longiramosis; foliis linearibus 2–5 cm. longis saepe 1–1.5 mm. raro ad 2 mm. latis; sepalis oblongis ad 6 mm. longis 1.5 mm. latis; petalis albis ad 9 mm. longis obovatis supra medium ad 4.5 mm. latis deinde basim versus in unguiculum ad 1.5 mm. longum ad 1.3 mm. latum margine denticulatum contractis; pedicellis 5–10 mm. longis

decurvatis vel recurvatis; siliquis 1–2 cm. longis curvatis paullo compressis ca. 1 mm. altis et 1.25 mm. crassis, in racemis breviter pedunculatis terminalibus 1–5 cm. longis gestis; stylo 2.5–3 mm. longo; ovulis 60–100; seminibus compresse ellipsoideis ad 0.8 mm. longis ca. 0.5 mm. latis.

SAN LUIS POTOSÍ: 38 mi. south of Matehuala, gypsum flat, 1938, *Johnston 7509* (G); 5 mi. south of Cedral, gypsum plain, 1938, *Johnston 7525* (G); 2 mi. south of Cedral, gypsum plain, 1938, *Johnston 7583* (G, TYPE); 6 mi. north of San Vicente, gypseous soil, 1938, *Johnston 7616* (G). ZACATECAS: Hac. de Sierra Hermosa, gypsum bank, 1938, *Johnston 7402* (G). COAHUILA: 6 mi. north of La Ventura, gypsum flat, 1938, *Johnston 7638* (G).

This well marked species most suggests *N. linearifolia* of gypsum soils in New Mexico and Texas, from which it differs in being a low, spreading and herbaceous, rather than an erect, tall, frutescent plant, and in having shorter less exserted inflorescences, smaller corollas, longer styles, and weakly compressed fruits. The plant is a marked gypsophile. All the known collections of the species were obtained from gypseous soils, and at all the known stations it was confined to that substratum.

Nerisyrenia linearifolia (Wats.) Greene, Pittonia **4:** 225 (1900).

NEW MEXICO: White Sands, Otero Co., *Wooton 158* (G, US) and *Wooton 2781* (US); Lakewood, Eddy Co., 1909, *Wooton* (US); plains 35 mi. south of Torrance, Lincoln Co., 1909, *Wooton* (US); road between Fort Sumner and Roswell, sandy roadside, *Nelson 11311* (G). TEXAS: bluffs of Delaware Creek, Culberson Co., 1882, *Havard 221* (G, TYPE).

In their Flora of New Mexico, Wooton & Standley, Contr. U. S. Nat. Herb. **19:** 270 (1915), state that this is a plant of "gypsum soils." The type-locality in western Texas, near the New Mexico line, is in an area of extensive gypsum deposits. The species, like its Mexican relative, *N. gracilis*, is evidently a gypsophile.

Nerisyrenia Castillonii Rollins, Contrib. Dudley Herb. **3:** 181 (1941).

COAHUILA: 16 mi. south of Laguna del Rey, gypsum plain, 1938, *Johnston 7814* (G); 1 mi. south of Hermanas, dry heavy alkaline soil on terrace, *Johnston 7067* (G); gypseous ridges east and south of Laguna del Jaco, 1940, *Johnston & Muller 1078* and *1099* (G); Castillon, gypsum flat, *Johnston & Muller 1264* (G, TYPE).

This newly described species resembles *N. camporum* var. *angustifolium* Coult., but is a perennial and has subterete rather than compressed fruit. Except those from near Hermanas, the above-cited speci-

mens were all obtained from soils recognized as gypseous. The soil at this locality, as discussed earlier in this paper, is probably gypseous also. The species is apparently gypsophilous.

Nerisyrenia incana Rollins, Madroño **5:** 132 (1939).

COAHUILA: 4 mi. west of Cuatro Cienegas, alkaline flats, 1938, *Johnston 7130* (G, TYPE).

This species may be gypsophilous, as are all the other species of the genus, save only *N. camporum*. Plants found near it, in and adjacent to the saline flats, seem to indicate the soil at this locality may be gypseous.

Dalea filiciformis Robins. & Greenm. Proc. Am. Acad. Sci. **29:** 382 (1894).

NUEVO LEON: foothills below Pablillo, 15 mi. sw. of Galeana, abundant over small areas in pinyon-belt, 1934, *Muller 530* (G). SAN LUIS POTOSÍ: 2 mi. south of Cedral, gypsum plain, 1938, *Johnston 7585* (G); 35 mi. south of Matehuala, gypsum flats, 1938, *Johnston 7516* (G); Villar, limestone hills, 1893, *Pringle 5472* (G, TYPE); Minas de San Rafael, 1910, *Purpus 4834* (G). AGUASCALIENTES: Aguascalientes, *Rose & Haye 6204* (G) and *Rose & Painter 7706* (G). HIDALGO: El Salto, dry calcareous soil, 1904, *Pringle 11959* (G); Tula, 1905, *Rose, Painter & Rose 8315* (G). FEDERAL DISTRICT: above Santa Fe, thin gravelly soil, *Pringle 8522* (G). PUEBLA: near El Riego, Tehuacan, *Rose & Painter 10010* (G); *Purpus 1204* (G); vicinity of Puebla, Acatzinco, *Arséne 3570* (G).

At the two localities where I have collected this plant, south of Cedral and Matehuala, it grew only in pure gypsum. The behavior of the plant at these localities was that of a pronounced gypsophile. Most of the collections above cited have no habitat data. It is to be noted, however, that Pringle's collection from Hidalgo is given as from "dry calcareous soil," a descriptive phrase which various botanists have applied to gypseous soils. The collection from Nuevo Leon, from the area about Pablillo where various gypsophiles have been collected, probably came from gypsum, and I suspect that most of the collections cited from central Mexico may have come from that substratum. The plants from the state of Puebla are more fruticulose, more branched and have fewer leaflets than the other material cited. Perhaps they should not be included in the above enumeration of specimens.

Euphorbia astyla Engelm. ex Boiss. in DC. Prodr. **15**[2]**:** 40 (1862).

TEXAS: Pecos County, July 21, 1928, *Cory 1960* (G).

COAHUILA: 1 mi. south of Hermanas, heavy alkaline soil, 1938, *Johnston 7060* (G); 3 mi. west of Cuatro Cienegas, saline flats, 1938, *Johnston 7135* (G); 3 mi. south of Cuatro Cienegas, salt land, 1939, *White 1924* (G); Sierra del Rey, 1910, *Purpus 4512* (G). DURANGO: valley of the Nazas, April 15, 1847, *Gregg 457a* (G, TYPE).

This plant is probably a halophytic gypsophile. The associates of this species have been discussed earlier in this paper.

Frankenia gypsophila Johnston, Jour. Arnold Arb. **20:** 237 (1939).

SAN LUIS POTOSÍ: 6 mi. north of San Vicente, local on gypseous soil, 1938, *Johnston 7614* (G, TYPE).

This remarkable species is known only from the type-collection which was obtained from a colony localized on gypseous soil. One of its closest American relatives, *F. Jamesii* Torr. of Texas, New Mexico and Colorado has been collected on gypsum and may also be gypsophilous.

Petalonyx crenatus Gray ex S. Wats. Proc. Am. Acad. **17:** 358 (1881–82).

COAHUILA: San Lorenzo de la Laguna, 1880, *Palmer 853* (G, TYPE); Sierra del Rey, sandy plains, 1910, *Purpus 4466* (G); 16 mi. south of Laguna del Rey, confined to gypsum flats, 1938, *Johnston 7808* (G); about 30 mi. south of Sierra Mojada, 1937, *Wynd 769* (G); 21 mi. west of El Oro, 1939, *White 2006* (G).

The collections by Purpus and by Wynd come from the region about Laguna del Rey where I have observed the plant and found it confined to gypseous soils. There is probably gypsum at San Lorenzo de la Laguna. Several of the species found confined to gypsum in the area between Mohovano and Laguna del Rey are otherwise known only from collections made by Palmer at San Lorenzo de la Laguna.

Fouquieria Shrevei Johnston, Jour. Arnold Arb. **20:** 238 (1939).

COAHUILA: road to Mohovano, 16 mi. south of Laguna del Rey, confined to gypsum flats, 1938, *Johnston 7815* (G, TYPE); San Lorenzo de la Laguna, 1880, *Palmer 2001* (G).

This species was observed at various places between Mohovano and Laguna del Rey and was always confined to gypseous soils. I believe that the species may be accepted as a marked gypsophile.

Loeselia Havardii Gray, Proc. Am. Acad. Sci. **19:** 87 (1883).

TEXAS: 12 mi. south of Persimon Gap, Brewster County, *Cory 18709* (G).

CHIHUAHUA: Presidio del Norte [Ojinaga], March 1881, *Havard*

247 (G, TYPE). COAHUILA: Castillon, confined to gypsum flats, 1940, *Johnston & Muller 1263* (G).

The species was clearly confined to gypsum at Castillon. Gypseous soils are frequent about Ojinaga and in the Big Bend area of Texas where the species has also been collected. I believe that the species is gypsophilous.

Nama Stewartii Johnston, Jour. Arnold Arb. **22:** 114 (1941).

COAHUILA: south base of Picacho de San José, southeastern foothills of Sierra de las Cruces, gypsum flats and cliffs, 1940, *Johnston & Muller 814* (G, TYPE); eastern foothills of Sierra de las Cruces west of Santa Elena Mines, gypsum flats, 1940, *Johnston & Muller 228* (G); Castillon, confined to gypsum flats, 1940, *Johnston & Muller 1271* (G); between Carrizo and Carricito, gypseous ridge, 1940, *Johnston & Muller 159* (G); Picachos Colorados, slope at west end of cliffs, 1940, *Johnston & Muller 139* (G).

The material from the Sierra de las Cruces and that from Castillon was collected in pure gypsum, and that from between Carrizo and Carricito came from pale evidently gypseous soil. Sr. Tirso Castillon informs me that gypsum crops out from under the red cliffs of the Picachos Colorados near the place where I collected the plant. The species is a marked gypsophile.

Nama Havardii, of the Big Bend area, in Brewster County, Texas, is most closely related to *N. Stewartii.* It occurs in a region containing gypseous soil and some of the collections of the plant are given as from that substratum. The species is to be expected on the Mexican side of the Rio Grande and may prove to be a gypsophile.

Nama Purpusii Brandegee, Univ. Calif. Publ. Bot. **4:** 186 (1911).

COAHUILA: Mohovano, 1910, *Purpus 4562* (UC, TYPE); 16 mi. south of Laguna Del Rey, on road to Mohovano, gypsum plain, 1938, *Johnston 7812* (G); 5 mi. west of El Oro, 1939, *White 2003* (G); 4 mi. west of Cuatro Cienegas, 1938, *Johnston 7141* (G).

Gypsum deposits are very common between Mohovano and El Oro and the collections of Purpus and White may well have come from gypsum, for in the same region, south of Laguna del Rey, I observed the plant only on gypsum flats. The collection from west of Cuatro Cienegas came from local colonies of the plant in barren grayish silt among the desert scrub not far from the edge of the salt-marsh in which a number of suspected halophytic gypsophiles were found. The plants from near Cuatro Cienegas, hence, probably grew in gypseous soil. I believe that *Nama Purpusii* is gypsophilous.

Nama stenophyllum Gray is a close relative of *N. Purpusii*. It is known only from about 25 mi. northeast of Parras, about the base of the Parras Mts., and near Viesca. Like its relative, the species may be gypsophilous.

Nama canescens C. L. Hitchc. Amer. Jour. Bot. **26:** 345 (1939).

SAN LUIS POTOSÍ: 38 mi. south of Matehuala, gypsum plain, 1938, *Johnston 7510* (G, TYPE); 2 mi. south of Cedral, gypsum plain, 1938, *Johnston 7584* (G).

Both of the known collections of this species were discovered on concentrated gypsum. The plant is a marked gypsophile.

Nama serpylloides Gray var. **velutina** C. L. Hitchc. Amer. Jour. Bot. **26:** 342 (1939).

COAHUILA: 2 mi. west of Cuatro Cienegas, bank of very alkaline soil, edge of salt-marsh, 1938, *Johnston 7126* (G); 1 mi. south of Hermanas, dry heavy alkaline soil on terrace near salt-marsh, 1938, *Johnston 7063* (G, TYPE).

I believe that this plant is a halophytic gypsophile. The cited material, all that is known of the variety, was collected before I had come to recognize gypsum as a special habitat. The chalky mounds on which the *Nama* was growing west of Cuatro Cienegas were probably gypseous. My reasons for believing that the locality near Hermanas was also gypseous have been discussed earlier in this paper.

Nama hispidum Gray var. **gypsicola,** var. nov.

A forma typica differt caulibus gracilibus 5–18 cm. longis 0.5–1.5 mm. crassis valde depressis sparse strigosis; foliis acutiusculis linearibus 0.7–1 mm. latis 5–12 mm. longis pilos rigidos sparsos gerentibus margine incrassatis; limbo corollae 5–7 mm. diametro.

ZACATECAS: Hac. de Sierra Hermosa, prostrate on gypsum banks, 1938, *Johnston 7406* (G). COAHUILA: 6 mi. north of La Ventura, rare on gypsum flats, plant depressed-spreading, corolla blue-purple, Sept. 13, 1938, *Johnston 7633* (G, TYPE).

The very slender depressed strigose stems and the very narrow elongate sparsely strigose leaves readily separate these two collections from all the many specimens of *N. hispidum* and varieties as represented in the Gray Herbarium. The two collections were both localized on gypsum and, though collected over a hundred miles apart, are so similar in aspect as well as in details, that they might pass as parts of a single collection. Hitchcock, Amer. Jour. Bot. **26:** 347 (1939), commented

on their peculiarities but gave them no name. They evidently represent a marked gypsophilous variation of the species.

Nama carnosum (Wooton) C. L. Hitchc. Amer. Jour. Bot. **26:** 345 (1939).

NEW MEXICO: White Sands of Dona Ana County, *Wooton 164* (US, TYPE).

TEXAS: bluffs of Delaware Creek, Culberson Co., *Havard 15* (G); Millers Ranch, Culberson Co., gypsum ridge, June 17, 1928, *Cory 2291* (G).

This is a marked gypsophile. The presence of the species on the White Sands and on the gypsum ridge near Millers Ranch as well as its presence on the bluffs of Delaware Creek, where thick beds of gypsum are exposed, is indicative of its soil requirements.

Nama flavescens Brandegee is a Mexican relative of *N. carnosum*. It has been collected near Parras and near San Lorenzo de la Laguna in Coahuila, and near Cedros in Zacatecas. Various pronounced gypsophiles have been collected near San Lorenzo and near Cedros. The species may possibly be a gypsophile.

Phacelia gypsogenia, sp. nov.

Planta erecta rigida 2–4.5 dm. alta infra medium simplex supra medium ramulos ascendentes 1–2 dm. longos gerens glandulifera hispidula; caulibus hispidulis minute adpresseque villosulis viscidis basim versus 3–5 mm. crassis; foliis inferioribus sub anthesi delapsis; foliis mediis et superioribus numerosis viridibus sparse hispidulis viscidis 3–6 cm. longis 1–1.5 cm. latis conspicue irregulariter lobatis; lobis foliorum saepe utroque 5–7 irregulariter eroso-dentatis vel inciso-lobulatis; spicis numerosis densis multifloris solitariis vel geminatis, maturitate saepe ca. 5 cm. longis sed non raro duplo vel triplo longioribus ad 8 mm. latis; lobis calycis oblanceolatis vel late oblanceolatis hispidulis glanduliferis, ad anthesim 3–4 mm. longis et 1–1.5 mm. latis, fructiferis ad 5 mm. longis et 1.2–1.8 mm. latis; calycibus fructiferis subglobosis; corolla subtubulari dilute lavendulacea marcescente ca. 5.5 mm. longa imam ad basim 1.5 mm. crassa, supra (infra lobis) 2.5 mm. crassa; limbo ca. 3 mm. diametro; lobis ascendentibus vel stricte ascendentibus glaberrimis ad 2 mm. longis et latis apice rotundis margine erosis vel raro integris; filamentis ca. 1 mm. supra basim corollae affixis ca. 7 mm. longis longe exsertis; appendiculis staminalibus ad 0.8 mm. longis basim versus latioribus (ca. 0.3 mm. latis) deinde apicem versus gradatim angustioribus, basi abrupte contractis rotundis; stylis 7–8 mm. longis ad 2–2.5 mm. supra basim connatis et sparse hispidulis deinde liberis

et glabris; ovario supra medium dense hispidulis; capsula subglobosa ad 2.5 mm. longa glandulifera supra medium sparse antrorse hispidula; seminibus 4, foveolatis ca. 2.5 mm. longis et 1.5 mm. latis, dorse convexis haud corrugatis, ventre excavatis, marginem versus carinae medialis prominentibus et nuculae latus inferius versus aliquantum tumulosis.

ZACATECAS: Hac. de Sierra Hermosa, local on gypsum banks, 1938, *Johnston 7403* (G). CHIHUAHUA: 5 mi. south of Jimenez, gypsum flat, 1938, *Johnston 7843* (G). COAHUILA: gypseous ridge east of Laguna del Jaco, 1940, *Johnston & Muller 1072* (G); Castillon, on gypsum flats, 1940, *Johnston & Muller 1266* (G, TYPE).

This very distinctive plant belongs to the group of *Phacelia integrifolia* Torr., in which it is characterized by its stiff erect habit, grayish viscid hispidulous stems, irregularly much dissected elongate leaves, small fruits, small hispidulous subglobose calyx, and small subtubular glabrous corollas.

The plant is a marked gypsophile. At all the four localities at which it has been found it very definitely grew on gypsum and was obviously confined to gypseous soil.

Aplopappus Johnstonii Blake, Proc. Biol. Soc. Washington **54:** 18 (1941).

COAHUILA: 1 mi. south of Hermanas, dry heavy alkaline soil, 1938, *Johnston 7066* (G); 4 mi. west of Cuatro Cienegas, alkaline flat, 1938, *Johnston 7131* (G).

Though the substratum of the plants was not recognized as gypseous when the specimens were collected, as has been discussed earlier in this paper, I now believe that the plant was growing in gypsum-containing soil. I believe that this bizarre species is a gypsophile.

Dicranocarpus parviflorus Gray, Mem. Am. Acad. Sci. n.s. **5:** 322 (1854).

SAN LUIS POTOSÍ: 35 mi. south of Matehuala, gypsum flat, 1938, *Johnston 7514* (G); 2 mi. south of Cedral, gypsum flat, 1938, *Johnston 7588* (G); near Salado, gypsum plains, 1939, *Shreve 9353* (G); Catorce, alkaline plain, 1934, *Lundell 5736* (US). ZACATECAS: Sierra Hermosa, gypsum banks, 1938, *Johnston 7407* (G); Hac. de Cedros, on flats, a garden pest, 1908, *Lloyd 173* (US). DURANGO: Mapimi, cultivated fields, *Palmer 537* (G, US). COAHUILA: 6 mi. north of La Ventura, gypsum plain, 1938, *Johnston 7641* (G); 16 mi. south of Laguna del Rey, gypsum plain, 1938, *Johnston 7805* (G); Sierra de las Cruces, foothills west of Santa Elena Mines, gypsum flats,

1940, *Johnston & Muller 242* (G); Castillon, gypsum flat, 1940, *Johnston & Muller 1271* (G). CHIHUAHUA: 5 mi. south of Jimenez, gypsum flat, 1938, *Johnston 7842* (G); plain below San Carlos, Oct. 1852, *Parry 70* (G).

TEXAS: plains between the Guadalupe Mts. and the Pecos, Oct. 20, 1849, *Wright 348* (G, TYPE; US). NEW MEXICO: San Andreas Mts., ? Dono Ana Co., on gypsum soil, 1914, *Wooton* (US); White Sands, 1904, *Wooton 2545* (US).

This species, constituting the monotypic genus *Dicranocarpus*, gives every evidence of being a pronounced gypsophile. Most of the specimens cited above are definitely known to have been collected on gypsum and most of the remaining few are from localities where gypsum deposits are known to occur. Curiously, the plant at Cedros (where numerous gypsophiles have been collected) and at Mapimi, is noted by the collectors as becoming a weed in cultivated fields.

Thelesperma scabridulum Blake, Jour. Wash. Acad. **25:** 317 (1935).

COAHUILA: endemic on a gypsum flat 6 mi. north of La Ventura, *Lundell 5728* (US, TYPE) and *Johnston 7646* (G).

This well marked species is known only from one locality. It is there confined to a gypsum flat.

Thelesperma ramosius Blake, Proc. Biol. Soc. Washington **54:** 20 (1941).

COAHUILA: one mile south of Hermanas, heavy alkaline soil, 1938, *Johnston 7059* (G, TYPE).

This plant occurs with a number of other unusual species localized on heavy soil near Hermanas. As discussed earlier in this paper, the soil at this locality, though originally not recognized as such, is almost certainly gypseous. The plant, I believe, is a gypsophile.

Flaveria anomala Robins., Proc. Am. Acad. Sci. **27:** 178 (1892).

SAN LUIS POTOSÍ: plains about Matehuala, 1904, *Pringle 8801* (G); 35 mi. south of Matehuala, gypsum flats, 1938, *Johnston 7515* (G); 14 mi. south of Matehuala, local, silty valley floor, 1938, *Johnston 7518* (G); north of Matehuala, gypsum plain, 1938, *Johnston 7524* (G); plains at Venegas, 1890, *Pringle 3669* (G, TYPE); near Salado, gypsum plain, 1939, *Shreve 9354* (G). COAHUILA: 6 mi. north of La Ventura, gypsum plain, *Johnston 7647* (G). NUEVO LEON: near Pablillo, floor of cienega, 1940, *Shreve & Tinkham 9754* (G).

This plant abounds on the gypsum flats north and south of Matehuala.

Gypsum almost certainly occurs about Pablillo, for several gypsophiles have been found localized in that area. The present species appears to be a marked gypsophile.

Flaveria oppositifolia (DC.) Rydb., while apparently not always confined to gypseous soils, seems to luxuriate on this substratum and at some localities is actually restricted to it. Further observations on the soil-preference of this species are needed.

Gaillardia multiceps Greene, Bull. Torr. Bot. Cl. **24:** 512 (1897).

COAHUILA: 1 mi. south of Hermanas [ca. 46 mi. south of Sabinas], local on dry heavy alkaline soil, 1938, *Johnston 7062* (G); on the desert 25 mi. southwest of Sabinas [road to Hermanas], 1936, *Wynd & Muller 209* (NY, US).

TEXAS: Ables, Hudspeth Co., 1927, *Cory 2756* (G). NEW MEXICO: dry plains east of Carlsbad, Eddy Co., 1924, *Standley 40293* (US). ARIZONA: south of Woodruff, Navajo Co., 1892, *Wooton* (TYPE, US); Holbrook, Navajo Co., 1901, *Ward* (NY, US); Holbrook, 1896, *Zuck* (Mo); Camp No. 6, Little Colorado River [ca. 15 mi. w. of Holbrook], 1852, *Sitgreave Exped.* (G); between Winslow and Flagstaff, Coconino Co., 1934, *McKelvey 4535* (G).

Through the kindness of Prof. Marion Ownbey, of the State College of Washington, I am able to cite above the specimens which his student, Miss Susann Fry who is monographing *Gaillardia,* has provisionally referred to *G. multiceps.* Prof. Ownbey writes me that the two Mexican collections closely resemble one another, but differ markedly in habit and general appearance from all the other collections cited.

Near Hermanas the plant is associated with a number of gypsophilous species. Earlier in this paper I have discussed the reasons for believing that the soil was gypseous at this locality. I have no information as to the soil 20 miles further north in Coahuila, where Wynd & Muller also collected the same form. It is interesting to note, however, that Cory collected the species at Ables, in northeastern Hudspeth County, Texas, where he has obtained various markedly gypsophilous species, and that Standley has obtained the only known New Mexican collection of the species west of the Pecos and north of the Texan boundary in a region where extensive gypsum deposits are known. In New Mexico, Texas and Coahuila the species behaves suspiciously like a gypsophile. Should this plant prove to be a gypsophile, its distribution would appear unique. I know of no gypsophilous plant which ranges in eastern New Mexico, western Texas and adjacent Mexico, and also occurs in northern Arizona.

Sartwellia mexicana Gray, Proc. Am. Acad. Sci. **19:** 34 (1883).

COAHUILA: Monclova, *Palmer 687* (G, TYPE; US); 1 mi. south of Hermanas, dry heavy alkaline soil, 1938, *Johnston 7058* (G); San Lorenzo de la Laguna, 1880, *Palmer 683* (G, US); 4 mi. north of Parras, silty soil in bottom of valley, 1938, *Johnston 7705* (G); road to Mohovano, 16 mi. south of Laguna del Rey, gypsum plain, 1938, *Johnston 7818* (G); Carro de Cypriano [near Mohovano], 1901, *Purpus 4476* (G, US). CHIHUAHUA: 5 mi. south of Jimenez, gypsum flat, 1938, *Johnston 7844* (G); between Chapo and Mula, gypseous soil, 1940, *Johnston & Muller 1438* (G).

I believe that this species is restricted to gypsum or mixed gypseous soils. The plant grows on mixed gypseous soil north of La Mula. The soils in which I found it near Hermanas and Parras are probably similar. Gypsum is common in the Laguna del Rey – Mohovano area in which Purpus collected the plant. Various gypsophiles have been collected near San Lorenzo where Palmer found the plant.

Sartwellia puberula Rydb. N. Am. Fl. **34:** 141 (1915).

COAHUILA: Castillon, gypsum flat, 1940, *Johnston & Muller 1267* (G).

At Castillon this plant abounded on a gypsum flat and was obviously confined to it. It agrees with the original description of *S. puberula* Rydb., collected by Parry on "the plains below San Carlos" (where he collected *Dicranocarpus*), south of the Rio Grande in northeastern Chihuahua where gypsum deposits have been reported. The species may be no more than a puberulent variety of *S. mexicana* Gray.

Sartwellia humilis, sp. nov.

Planta perennis humilis; caulibus numerosis decumbentibus vel laxe ascendentibus 5–15 cm. longis simplicibus vel ascendenter ramosis, internodiis 8–15 mm. longis; foliis linearibus glabris quam internodiis 1–2-plo longioribus 10–45 mm. longis 0.5–1 mm. latis carnosulis; capitulis campanulatis in corymbos terminales saepe ca. 15 mm. diametro densos aggregatis; tegulis 5 late elliptico-obovatis herbaceis 2 mm. latis ad 3 mm. longis cum nervis 5–9 nigrescentibus ornatis, margine anguste scariosis; receptaculo obcampanulato 4–5 mm. alto 5–6 mm. crasso apice rotundo glabro; corollis ligularibus ad 5, limbo obovato trinervato ad 1.5 mm. longo et ad 1 mm. lato apice emarginato (bidentato); tubo gracillimo ca. 1 mm. longo; corollis tubulosis ca. 20, tubo ad 1.4 mm. longo, faucibus ad 1 mm. longis, lobis 5 ad 0.5 mm. longis triangularibus; stylo lobato ad 7 mm. longo lineari apicem versus latiore, antheris ca. 0.9 mm. longis appendiculis oblongis ad 0.15 mm. longis terminalibus

ornatis; achaeniis nigris 5-costatis paullo curvatis ca. 1.2 mm. longis apice setas 5 et paleas 5 basim versus connatas proferentibus, paleis oblongis 0.5–0.8 mm. longis supra medium latioribus apice rotundis et laceratis, pilis 0.6–0.9 mm. longis barbellatis.

SAN LUIS POTOSÍ: 4 mi. south of Cedral, gypsum plain, 1938, *Johnston 7567* (G, TYPE). ZACATECAS: Hac. de Sierra Hermosa, gypsum bank, 1938, *Johnston 7405* (G); Cedros, calcareous hills, *Lloyd & Kirkwood 145* (G); Cedros, hills, very calcareous soil, 1907, *Lloyd 14* (US). COAHUILA: 6 mi. north of La Ventura, gypsum plain, 1938, *Johnston 7634* (G). LOCALITY UNKNOWN: Vanegas to Saltillo road, alkaline plain, 1934, *Lundell 5719* (US).

This plant is related to *S. mexicana* but differs in having numerous very short spreading stems and slightly larger heads. A low spreading compact plant, it differs greatly in appearance from the erect, loose, long-stemmed northern *S. mexicana.* I know this species only from gypsum soil. Lloyd reports his collection from "very calcareous soil" and Lundell gives his as from an "alkaline plain." Since botanists frequently allude to gypseous soils in such terms, I am confident they also collected the plant on gypsum. I believe this plant is gypsophilous.

Sartwellia Flaveriae Gray, Pl. Wright. **1:** 122. *t. 6* (1852).

NEW MEXICO: Roswell, Chaves Co., 1900, *Earle 340* (G, US); White Mts., Lincoln Co., 1897, *Wooton 383* (G, US); hills south of road from Rentfrow Ranch to "upper crossing of malpais," Socorro Co., 1923, *Eggleston 19432* (US); White Sands, Otero Co., 1904, *Wooton 2619* (G); 7½ mi. east of Carlsbad, Eddy Co., 1935, *Cory 17615* (G); Pecos Valley near Texas line, Eddy Co., 1901, *Bailey 743* (US). TEXAS: vicinity of Pecos City, Reeves Co., 1913, *Rose & Fitch 17905* (US); Dale, *Havard 92* (US); Screw Bean, 1889, *Nealley 691* (US); Pecos County, 1933, *Cory* (G); common on the Rio Pecos, *Havard 95* (G); western Texas, 1849, *Wright 386* (G, US).

The genus *Sartwellia* consists of three Mexican species, all of which appear to be gypsophilous, and this, the original and most distinct member of the genus, is known only from Texas and New Mexico. It has been collected on gypsum, and its presence in southeastern New Mexico, where gypsum deposits are widely distributed, and in the Pecos Valley of Texas where gypsum also occurs, suggest that *S. Flaveriae* may favor gypseous soils if not actually confined to that substratum. All the species of *Sartwellia,* therefore, give evidences of gypsophily.

Haploesthes Greggii Gray, Mem. Amer. Acad. Sci. n.s. **4:** 109 (1849).

COAHUILA: near Cienega Grande, northeast of Parras, May 18, 1847,

Gregg 68 (G, TYPE); Sierra de la Paila, 8000–9000 ft., 1910, *Purpus 4708* (G, US); south base of Picacho de San José, eastern foothills of Sierra de las Cruces, confined to gypsum exposures, frequent, shrubby, 6–24 in. tall, 1940, *Johnston & Muller 813* (G); eastern foothills of Sierra de las Cruces, near Santa Elena Mines, confined to gypsum flats, frequent, 6–24 in. tall, 1940, *Johnston & Muller 244* (G).

In the eastern foothills of the Sierra de las Cruces, near Santa Elena Mines, and near the base of the Picacho de San José, this plant is locally frequent on exposures of gypsum and confined to them. The plant was so definitely confined to gypseous soils at these localities that I strongly suspect that the other localities at which it has been found have gypseous soils also.

This typical form of the species was first collected by Gregg northeast of Parras at what is now called "Cienega Grande." It is a slender, small, shrubby plant becoming 2 feet tall. Its heads are elongate and similar in form to those of the var. *texana,* but they do not become dusky or blackish green in drying as in the northern variety. Its ligulate flowers are also larger, being usually 3.5–4.5 mm. long and 2–3 mm. wide, rather than 2.5–3.5 mm. long and 1–2.5 mm. wide as in the Texan plant. The elongate tegules of typical *H. Greggii* and its var. *texana* are coriaceous and usually become rugulose in drying.

The recently described *H. robusta* Johnston, Jour. Arnold Arb. **22**: 121 (1941), from the salt-flats near Cuatro Cienegas, is most closely related to the typical form of *H. Greggii,* having the elongate heads and the coriaceous rugulose elongate tegules which do not become dusky in drying. It is, however, a very much more robust plant, coarser in all its parts and not at all shrubby. Gypseous soils are suspected near Cuatro Cienegas and, accordingly, there is a possibility that *H. robusta* may be gypsophilous.

Haploesthes Greggii var. **texana** (Coulter), comb. nov.

Aplopappus texanus Coulter, Contr. U. S. Nat. Herb. **1**: 40 (1890).

CHIHUAHUA: Presidio del Norte [Ojinaga], July 1852, *Parry 68* (G).

TEXAS: Chisos Mts., Brewster Co., 1889, Nealley 203 (US, TYPE); near Lajitas, Brewster Co., infrequent, 1–2 ft. tall, yellow, 1937, *Warnock 727* (US); Presidio Rio Grande [Eagle Pass], Sept.–Oct. 1848, succulent, indicating salt, *Wright 404* (G, US); 10 miles east of Rankin, Upton, 1936, *Cory 15392* (G); Odessa tank, Staked Plains, Ectos Co., 1881, *Havard 96* (G, US); Sweetwater, Nolan Co., 1913, *Wooton* (US); 8 mi. west of Claremont, Kent Co., 1935, *Cory 13846*

(G); O'Donnell, Lynn Co., 1931, *Reed 3436* (US); Estelline, Hall Co., rocky soil, *Reverchon 3991* (G, US); Gambeles Ranch, Armstrong Co., gypseous bank of canyon, 1918, *Palmer 13997* (US); Breckenridge, Stephens Co., open plains, 1925, *Ruth 1271* (US). NEW MEXICO: Round Mt., along Tularosa Creek, Otero Co., July 20, 1905, *Wooton* (US). OKLAHOMA: Hollis, Harmon Co., grassy valley, 1913, *Stevens 1076* (G, US); Antelope Hills, gypsum hills, Roger Mills Co., 1853, *Bigelow* (G); Shattuck, Ellis Co., moist grassy place, 1914, *Clifton 3200* (G).

This northern plant differs from typical *H. Greggii* in its heads, which average smaller and are characteristically dusky or dusky-green when dry. Its ligules average much smaller.

Several of the above cited collections are stated to have been collected on gypsum and most of them are from areas in which large gypsum-deposits and gypseous soils are known. The plant is probably a gypsophile.

Haploesthes Greggii var. **multiflora,** var. nov.

Planta a varietate genuina differt capitulis hemisphaericis multifloris latioribus quam latis, tegulis laevioribus suborbiculatis; ligulis florum marginalium ad 5 mm. longis et 2.5–3 mm. latis.

COAHUILA: Saltillo, common on bottom-lands in good soil, very woody plant with bright yellow flowers, found only in its prescribed area, 1898, *Palmer 206* (G, TYPE); mountains east of Saltillo, 1880, *Palmer 649* (G, US). NUEVO LEON: Monterey, 1924, *Orcutt 1278* (US); open pine-forest [5 mi. NW of Pablillo] 14 mi. south of Galeana, 1940, *Shreve & Tinkham 9755* (G).

This eastern variety of *H. Greggii* is readily recognized by its broad hemispherical heads which contain nearly twice as many florets as do those of other forms of the species. Its ligules become larger than those in the typical form.

I have no information as to whether or not this plant is gypsophilous. It is to be noted, however, that Shreve & Tinkham obtained the plant near Pablillo, in the area in which such gypsophiles as *Muhlenbergia villiflora, Dalea filiciformis* and *Flaveria anomala* have been collected. Furthermore, the note by Palmer, "found only in its prescribed area" is most suggestive of the restricted occurrence of most gypsophilous plants.

ARNOLD ARBORETUM,
HARVARD UNIVERSITY,

THE COMPARATIVE MORPHOLOGY OF THE ICACINACEAE
II. VESSELS

I. W. Bailey and R. A. Howard

With six plates

INTRODUCTION

In anatomically primitive xylem of dicotyledons and monocotyledons, the vessel members resemble scalariform-pitted tracheids in size, form and structure, but differ from them in dissolving certain of their pit membranes during the later stages of tissue differentiation. In the secondary body of less specialized dicotyledons, the fusiform initials of the cambium and the scalariform vessel members are relatively long and have extensively overlapping ends. Furthermore, the vessels tend to be isolated from one another and to be more or less uniformly distributed throughout the wood.

The most significant lines of specialization in the vessels of dicotyledons involve (1) conspicuous changes in the size and form of the vessel members, (2) structural modifications of the scalariform pits and the scalariform perforations and (3) a not uncommon tendency for the vessels to aggregate in multiples, chains or clusters. During the first of these major trends of specialization, the vessel members shorten and frequently increase in diameter. As the vessel members shorten and widen, their perforated facets become less and less acutely, and ultimately transversely, oriented. In other words, with increasing specialization of the vessels, their constituent cells become less and less tracheidlike in size and form, Bailey and Tupper (2) and Frost (4 and 5). These changes in the vessels are closely synchronized with concomitant modifications of the cambium, the fusiform initials becoming shorter and elongating less after anticlinal divisions, Bailey (1). In addition, the salient trends of specialization in the size and form of the vessel members frequently are more or less closely paralleled by structural modifications of the perforations and of the pitting of the vessels. The numerous scalariform perforations of the less specialized types of vessels are ultimately replaced by a single, large, elliptical or circular perforation, and the scalariform pits of the non-perforated parts of the vessel members are superseded by smaller pits having first an opposite and subsequently an alternating arrangement, Bailey and Tupper (2), Frost (6).