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A STUDY OF THE GENUS PENSTEMON IN NEW MEXICO

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A Thesis

Presented to

the Faculty of the Department of Biology

University of New Mexico

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Biology

---

by

Gladys Turner Nisbet

May 1942

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This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

E P Hammond
DEAN

May 6, 1942
DATE

Thesis committee

E F Castetter
CHAIRMAN

Wm. J. Koster

W A Bell

75975

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CHAPTER I

INTRODUCTION

I. THE PROBLEM

Statement of the problem. The purpose of this study has been: (a) to present a systematic treatment of those members of the genus Penstemon that are found in New Mexico; (b) to give a full description of each species including a consideration of its relationships with other species of the genus; (c) to ascertain and map, in so far as possible, the distribution of the various species in New Mexico.

Importance of the study. The species of Penstemon are easily recognized because of the uniformity of the capsules and seeds and of the unusual structure of the sterile posterior stamen. Nevertheless, few genera show such diversity in shape, size, and color of the corolla; in shape, size, and texture of the leaves; in height and other growth habits; and in habitat. In fact, individuals of a single species may show marked variation among themselves. Pennell[1] reports that there are some three hundred species of Penstemon found in North America and one other which occurs in Japan.

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[1] Francis W. Pennell, The Scrophulariaceae of Eastern Temperate North America, The Academy of Natural Sciences of Philadelphia, Monograph I, 1935, p. 197.

Moreover, most of them are native to the western part of the continent. A few of the species are widespread, but most of them are comparatively restricted in range.

The taxonomic treatment of this genus in the past has been in a very confused state, which has undoubtedly been due to the extreme variability of the species and the fact that much of western North America has not even yet been thoroughly botanized. Present day taxonomists are rapidly building on the excellent foundation laid by the early botanists. Aided by better facilities for field work, the larger amounts of material available for study, and the modern conception of what constitutes a species, modern workers are gradually bringing order out of this confusion. Since the publication of Wooton and Standley's Flora of New Mexico[2] in 1915, nothing has been done to reorganize the species of Penstemon of this state as a whole, although a number of the species have been treated in different publications at different times. In line with the stated purpose of presenting a taxonomic treatment of the New Mexican members of the genus, the present study represents specifically an effort to bring together all corrections and changes that have previously been

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[2]E. O. Wooton and Paul C. Standley, Flora of New Mexico, Contributions from the United States National Herbarium, Vol. XIX (Bulletin of the U. S. National Museum. Washington: Government Printing Office, 1915), pp. 579-86.

made of Wooton and Standley's presentation of Penstemon, as well as all available new data on those species of the genus that are native to the state.

Students of New Mexican systematic botany have found the penstemons an extremely difficult group with which to work. The keys that have been available are entirely inadequate. Wooton and Standley's Flora of New Mexico is difficult for the beginner to use because the short descriptive statements in the key are the only descriptions provided. It contains some errors and, moreover, has been out of print for many years. A Flora of Arizona and New Mexico[3] by Tidestrom and Kittell, which was published in 1941, is no improvement over Wooton and Standley's Flora of New Mexico, which was published in 1915, as far as the genus Penstemon is concerned. A number of publications are available that contain adequate treatments of certain of the species found in New Mexico. These publications will be discussed in Chapter II. However, the majority of the New Mexican species are not adequately treated in any publications that are available to the average student. The very apparent need of New Mexican students of botany for a concise and available treatment of this quite common and very attractive genus has been one of

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[3]Ivar Tidestrom and Sister Teresita Kittell, A Flora of Arizona and New Mexico, (Washington, D. C.: The Catholic University of America Press, 1941), pp. 602-10.

the motivating factors back of this study.

II. EXPLANATIONS OF TERMS USED

Life Zones. For this study Merriman's[4] terminology for life zones has been used and the following descriptions are based largely on Bailey's discussion of life zones in Life Zones and Crop Zones of New Mexico.[5]

New Mexico is a large state covering some one hundred twenty thousand square miles, which includes several high mountain ranges, many groups of low rugged mountains or flat-topped mesas, great open plains, and extensive valleys. The great variation in habitat afforded by these different physical features is reflected in the great variation in type of vegetation in different sections of the state.

Lower Sonoran Zone. This zone comes into New Mexico on the southern border and extends up the Pecos Valley to Roswell, with traces as far north as Fort Sumner, and up the Rio Grande Valley to Socorro. A narrow strip along the valley

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[4] C. Hart Merriman, Life Zones and Crop Zones of the United States, U. S. Department of Agriculture, Biological Survey Bulletin 10, (Washington: Government Printing Office, 1898), 79 pp.

[5] Vernon Bailey, Life Zones and Crop Zones of New Mexico, U. S. Department of Agriculture, Biological Survey Bulletin 35, (Washington: Government Printing Office, 1913), 100 pp.

of the Canadian River to Tucumcari, the Tularosa Basin, most of the Deming Plain, and the valleys in the region west of this plain to the Arizona line lie in the Lower Sonoran Zone. Altitude in these areas is from three thousand to four thousand or four thousand five hundred feet. The dominant vegetation is mesquite and creosote bush. The ocotillo, century plant, allthorn, and many cacti are also prominent in this zone.

Upper Sonoran Zone. The Upper Sonoran Zone covers approximately two-thirds of New Mexico. It is made up of grassy plains, the foothill country, and most of the valleys lying above five thousand feet. On steep, barren slopes locations as high as eight thousand feet may still lie in the Upper Sonoran Zone, while on northeast slopes the upper limit may be below seven thousand feet. The plains are characterized by abundant grass - grama, dropseed, and others - with scattered yucca, Opuntia, and herbaceous plants. The foothill country is dominated by the juniper-piñon association. Scrub oaks are common and rabbit-bush and Apache plume are noticeable in the gullies. Sagebrush is a conspicuous part of the vegetation of many of the valleys.

Transition Zone. This zone is composed of the middle slopes of the higher mountains and the upper slopes and tops of the lower ranges. It runs approximately from seven thou-

sand to eight thousand five hundred feet on northeast slopes and from eight thousand to nine thousand five hundred feet on southwest slopes. Western yellow pine is characteristic of this zone, except in some of the higher valleys where, in the absence of pine, sagebrush may be dominant.

Canadian Zone. Spruce, fir, and aspen cover most of the Canadian Zone except in burned-over areas or on slopes too steep to support trees. The lower edge of this zone varies from eight thousand five hundred to nine thousand five hundred feet and the upper edge from eleven to twelve thousand feet, depending upon the direction of exposure and other local conditions.

Hudsonian and Arctic-Alpine Zones. These zones in New Mexico are represented by relatively small areas on or near the tops of the highest peaks in the Sangre de Cristo Range. Mount Taylor, the White, Capitan, Mogollon, and Jemez mountains also show these zones to some extent, particularly on cold slopes. The Hudsonian Zone is recognized by its dwarfed and misshapen trees; the Arctic-Alpine is entirely treeless and marked by its low, hardy, and often mat-forming vegetation.

Descriptive terms. The descriptive terms used in Chapters IV and V are to be interpreted with the meanings

assigned to them in Gray's Lessons in Botany, Revised.[6]

Listing specimens examined. In Chapter V, following the description and discussion of each species, is a list of specimens examined. These have been arranged according to the counties in which they were found, and the counties are listed alphabetically. Each county name is followed by a colon. The location, collector, specimen number, and herbarium wherein deposited have been given for each specimen whenever such information has been available. The herbarium in which a given specimen is to be found has been indicated as follows:

NM. University of New Mexico, Albuquerque.
A. University of Arizona, Tucson.
St. Saint Michael's College, Santa Fe
S. New Mexico State College, State College.
F. Forest Service Regional Office, Albuquerque.
CI. Carnegie Institution of Washington, Stanford University.
R. Rocky Mountain Herbarium, University of Wyoming.

When other herbaria have been mentioned, the names have been written out in full.

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[6]Asa Gray, Gray's Lessons in Botany (revised edition; New York: American Book Company, 1887), pp. 193-226.

III. CHAPTER ORGANIZATION

Chapter II contains a brief review of collection and identification of New Mexican penstemons and a short discussion of the available keys.

Chapter III consists of a statement of the sources of material studied and the methods used in carrying on the study.

Chapter IV is a key to the species of Penstemon found in New Mexico.

Chapter V contains a description of each species, a discussion of its validity and relationships, its variations, blooming period, habitat, range, and distribution in New Mexico. It also contains lists of material examined and a distribution map for each species.

Chapter VI contains a discussion of those penstemons found in Wooton and Standley's key but excluded from the present study.

Chapter VII consists of summary and conclusions.

CHAPTER II

REVIEW OF COLLECTION AND IDENTIFICATION OF PENSTEMONS IN NEW MEXICO AND A BRIEF DISCUSSION OF AVAILABLE KEYS

I. REVIEW OF COLLECTION AND IDENTIFICATION OF PENSTEMONS IN NEW MEXICO

Early collections. Major Stephen H. Long commanded an expedition from Pittsburg, Pa., to the Rocky Mountains in 1820. William James was a botanist and geologist on this expedition and collected the species, Penstemon jamesii Benth.[7] that was named for him. The exact locality where this species was first collected is not definitely known, but it may have been in Union County, New Mexico, as the party crossed this northeastern section of the state before proceeding into Texas. The species is very common in northeastern New Mexico.

August Fendler made the first important plant collections around Santa Fe in 1847; these collections formed the basis for Asa Gray's Plantae Fendlerianae[8]. No penstemons

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[7] David D. Keck, "Studies in Penstemon VI. The Section Aurator," Bulletin of the Torrey Botanical Club, 65:240, April, 1938.

[8] Asa Gray, "Plantae Fendleriane Novi-Mexicanae," Memoirs of the American Academy of Arts and Sciences, 4: 1-116, 1849.

are described in this important work, but specimens of penstemons collected by Fendler are among the earliest collected in the state.

Charles Wright visited New Mexico in 1849 and again in 1851-52. Most of his collecting in the state was done in the Organ Mountains and in the region around Santa Rita, Grant County. A number of the earliest collections of penstemons from New Mexico were made by Wright.

Emory's Report of the United States and Mexican Boundary Survey,[9] 1850-53, contains descriptions of several new species of Penstemon and records of a number of collections made in New Mexico. The botanical report was presented by John Torrey and the specimens identified or described by Asa Gray. Botanists on this survey included Dr. John M. Bigelow, Dr. George Thurber, Dr. C. C. Parry, and Charles Wright. New species occuring in New Mexico that were described in this report were P. linarioides A. Gray,[10] collected by Parry in the Organ Mountains and by Bigelow and Thurber near Santa Rita; P. virgatus A. Gray[11], found by Thurber and Wright near

[9] John Torrey, "Botany of the Boundary", Report on the United States and Mexican Boundary Survey, Vol. II, 1859, pp. 27-270.

[10] Ibid., p. 112.

[11] Ibid., p. 113.

Santa Rita; and P. dasyphyllus A. Gray[12], collected at Cook's Spring in Luna County by Wright. Important early New Mexican collections of a number of other species were made on this expedition.

The original description of P. fendleri A. Gray[13] is found in the Botany Report of the Report of the Whipple Survey for a Mississippi Pacific Railroad in 1853. The species was collected "on the Pecos and Llano Estacado,"[14] of eastern New Mexico. Some authorities believe the original collection was made in Texas. Dr. J. M. Bigelow, botanist for this expedition, also collected extensively in the Sandia Mountains where he secured the type specimen of P. whippleanus A. Gray in October, 1853.[15]

Park's Expedition came into New Mexico in 1854 by way of Santa Rita; again the purpose was to find a route between the central states and the west. The plants were collected

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12 Ibid., p. 112.

13 John Torrey and Asa Gray, "Botany Report", Reports of Explorations and Surveys from the Mississippi River to the Pacific Ocean, Vol. II, 1859, p. 168.

14 Loc. cit.

15 Asa Gray, "Synopsis of the Genus Penstemon", Proceedings of the American Academy of Arts and Sciences, 6: 73, 1866.

by Dr. Thomas Antisell who found the type of P. thurberi Torr. in the Burro Mountains southwest of Silver City.[16]

More recent collections. In 1897 A. A. Heller collected in the regions surrounding Santa Fe. At Barranca, southwestern Taos County, he made the type collection of P. caudatus Heller[17] that is now regarded as a subspecies of P. angustifolius Nutt.[18]

The contributions of E. O. Wooton and Paul C. Standley to the study of New Mexican taxonomy are of inestimable value. Dr. Wooton was connected with the New Mexico College of Agriculture for twenty years. Later he was associated with the United States Department of Agriculture. Mr. Standley was for many years assistant curator of the United States National Herbarium. He spent over three years in botanical work at the New Mexico Agriculture College. Both Wooton and Standley made extensive collecting trips over New Mexico, and Wooton also collected in Arizona. Among the many species

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[16] Paul C. Standley, "The Type Localities of Plants First Described from New Mexico," Contributions from the United States National Herbarium, Vol. XIII, (Bulletin of the U. S. National Museum. Washington: Government Printing Office, 1910), pp. 151 and 214.

[17] Ibid., p. 168.

[18] Thomas H. Kearney and Robert H. Peebles, "Arizona Plants: New species, varieties, and combinations," Journal of the Washington Academy of Sciences, 29: 474-92, November, 1939.

first described by Wooton and Standley are six species of Penstemon: P. cardinalis, P. crassulus, P. oliganthus, P. neomexicanus, P. spinulosus, and P. metcalfei. Of these the first four have been considered in Chapter V, and the last two have been discussed in Chapter VI.

O. B. Metcalfe collected extensively in the Silver City area. Dr. Aven Nelson has made collecting trips which took him through New Mexico, and he has described many new species of Penstemon from the Rocky Mountain regions. Bro. Arsene and Bro. Benedict of Saint Michael's College, Santa Fe, were indefatigable collectors as the number of their specimens, which run into many thousands, show. A number of their specimens of Penstemon have been examined for this s tudy. F. S. Earle and C. F. Baker have collected in northwestern New Mexico, although the most of their work has been done in Colorado. Many others have contributed a share of the material now available for study. It would be impossible to discuss here all of those whose contributions to the study of Penstemon in New Mexico have been of value.

II. A BRIEF DISCUSSION OF AVAILABLE KEYS

Flora of New Mexico.[19] Wooton and Standley's key has

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19 E. O. Wooton and Paul C. Standley, Flora of New Mexico, Contributions from the United States National Herbarium, Vol. XIX, (Bulletin of the U. S. National Museum. Washington: Government Printing Office, 1915), pp. 579-86.

been, and still is, the standby of New Mexican botanists. Since it has long been out of print, it is no longer available for general use. Most colleges and universities of the Southwest have copies in their libraries, but few individuals are fortunate enough to possess one. As has been stated before, this key is difficult for beginners to use; five of the species of Penstemon given are now limited to areas outside of New Mexico; a number of species not in this key are now known to occur in the state. These species have been discussed in Chapters V and VI.

A Flora of Arizona and New Mexico.[20] Tidestrom's key has the advantage of being in print. In the preface of this book he says, "The concept of species is held in a conservative vein. For that reason it has been necessary to refer many of the later described species to synonomy."[21] Yet he allows P. crassulus Woot. and Standl. to stand as a distinct species when it is distinguished from P. cardinalis Woot. and Standl. by very minor and inconstant characteristics. He regards P. comarrhenus Gray as a synonym of P. strictus Benth. but gives P. strictiformis Ryd. as a distinct species. Rydberg in describing this species wrote, "This is closely relat-

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[20] Ivar Tidestrom and Sister Teresita Kittell, A Flora of Arizona and New Mexico (Washington, D. C.: The Catholic University of America Press, 1941), pp. 602-10.

[21] Ibid., p. iii

ed to P. strictus, but differs mainly in the long-acuminate sepals."[22] P. strictiformis is much more closely related to P. strictus than is P. comarrhenus. Tidestrom has omitted P. oliganthus Woot. and Standl. from his key, although it is a good species and common in all the central and west central mountains of the state.

Keys that may be used in northern New Mexico. Coulter and Nelson's New Manual of Botany of the Central Rocky Mountains,[23] Rydberg's Flora of the Rocky Mountains,[24] and Pennell's Scrophulariaceae of the Central Rocky Mountain States[25] are applicable only for the northern part of the state, although some of the more widely spread species can be found in one or more of these keys. The last named is particularly useful in the study of northern New Mexican penstemons.

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22 Alex Rydberg, "Studies on the Rocky Mountain Flora No. XIII," Bulletin of the Torrey Botanical Club 31: 631-655, 1904.

23 John M. Coulter and Aven Nelson, New Manual of Botany of the Central Rocky Mountains (New York: American Book Company, 1909), pp. 439-49.

24 P. A. Rydberg, Flora of the Rocky Mountains and Adjacent Plains (New York: Published by the Author, 1917), pp. 763-77.

25 Francis W. Pennell, "Scrophulariaceae of the Central Rocky Mountain States," Contributions from the United States National Herbarium, Vol. XX, Part 9. (Bulletin of the U. S. National Museum. Washington: Government Printing Office, 1920), pp.311-81.

The Scrophulariaceae of Eastern Temperate North America.[26] Pennell's Monograph is exceedingly well done. Although only a very few of the species included in his key reach eastern New Mexico, the general information on the genus Penstemon is of great interest to anyone studying this group.

Studies in Penstemon by Keck. Studies in Penstemon IV. The Section Ericopsis,[27] Studies in Penstemon V. The Section Peltanthera,[28] Studies in Penstemon VI. The Section Aurator[29] contain excellent and adequate treatment of most of the New Mexican species that fall in these sections. The other Studies in Penstemon written by Keck do not apply to New Mexico.

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[26] Francis W. Pennell, The Scrophulariaceae of Eastern Temperate North America, The Academy of Natural Sciences of Philadelphia, Monograph I, 1935, 650 pp.

[27] David D. Keck, "Studies in Penstemon IV. The Section Ericopsis," Bulletin of the Torrey Botanical Club, 64: 357-381, June, 1937.

[28] David D. Keck, "Studies in Penstemon V. The Section Peltanthera," The American Midland Naturalist, 18: 790-829, September, 1937.

[29] David D. Keck, "Studies in Penstemon VI. The Section Aurator," Bulletin of the Torrey Botanical Club, 65: 233-255, April, 1938.

CHAPTER III

MATERIALS USED AND METHODS OF PROCEDURE

Materials used. This study has been based principally on material in the herbaria of New Mexico and on specimens collected by the investigator and co-workers. The penstemons in the herbaria of the following institutions have been studied: University of New Mexico, New Mexico State College, Highlands University, Saint Michael's College, the United States Forest Service Office at Albuquerque, and the University of Arizona. Also specimens have been studied that were loaned to this investigator from the Carnegie Institution at Washington, Stanford University; the Rocky Mountain Herbarium, University of Wyoming; and the Sull Ross Teachers College, Alpine, Texas.

Methods of Procedure. Since it has been impossible for this investigator to visit the large and nationally known herbaria to study specimens of penstemons, particularly the type specimens, other methods of becoming thoroughly familiar with each species have had to be taken. These methods have consisted of careful study of (1) original descriptions, (2) descriptions contained in all available keys, (3) herbarium specimens verified by recognized authorities, (4) fresh specimens collected and identified by the investigator and later verified by an accepted authority on the genus Penstemon.

Field work has been carried on at every opportunity all through the study, for thorough and systematic field work must be the basis of any satisfactory study in taxonomy. Field work gives the taxonomist a type of familiarity with plants that cannot be gained in the herbarium. Photographs, sketches, careful notes as to color, shape, and size of corolla, and as to the ecological setting are valuable aids in carrying the field impressions into the herbarium. Careful field work has been done to check for intergrades between closely related species; however, considerable work remains to be done along this line.

In order to study the distribution of penstemons in New Mexico, maps have been prepared of the state that show the life zones as discussed in Chapter I. The location of the collection of each specimen studied has been indicated on a map for that species (except where collections were close together or the locations were duplicated by different collectors). Thus the range of each species can be readily seen both as to area covered and as to the type of habitat preferred. Every effort has been made to ascertain the exact locations where specimens have been collected and to indicate them accurately on the maps. Subspecies have been included on the same map with the typical species whenever both occur in New Mexico. This has been done to facilitate the study of the distributional relationships of such species and subspecies.

Many specimens were carefully studied, many measurements taken, and many comparisons made in preparation for writing the descriptions of the species and arranging the key. The key has been made quite full with the idea that it might be used without the descriptions contained in Chapter V. Generally two or more contrasting characteristics have been used to distinguish between species or groups of species. The descriptions have been drawn almost entirely from New Mexican specimens for the express purpose of simplifying the identification of New Mexican material. The key, the descriptions, and all other data given, unless otherwise stated, applies to the species as found in New Mexico. Blooming period has been ascertained for each species by making records of the collection date of all specimens examined and by direct field observation whenever possible. These dates vary from year to year, depending largely on the amount and temporal distribution of rainfall.

Pennell says, "Working taxonomists have characteristically a better 'feeling for' or unconscious ability to recognize species, than words in which to define that elusive entity."[30] This is particularly true of the field worker or the person who has not delved deeply into the subject of genetics.

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[30] Francis W. Pennell, The Scrophulariaceae of Eastern Temperate North America, Academy of Natural Sciences of Philadelphia, Monograph I, 1935, p. 4.

The following generally accepted statements as to what constitutes a species, a subspecies, and a variety, have been applied in this study.

Species are the smallest populations that are permanently separated from one another by genetic barriers. Distinct species may intergrade, but the hybrids are either sterile or, if fertile, their offspring are so lacking in vigor that they are soon eliminated under natural conditions. Subspecies are completely interfertile and are kept separate through isolation by geographic or ecologic factors. They intergrade freely where they meet. Varieties are more or less distinct populations that are not isolated from the rest of the members of that species and which differ in only one or very few characteristics. They are completely interfertile with each other and the species. In distinguishing between species and subspecies not only the number but the degree of the morphological differences must be taken into consideration.

CHAPTER IV

KEY TO THE PENSTEMONS OF NEW MEXICO

A. Corolla scarlet, carmine, pink to rose, carnival (bright) red, crimson, or purple red.

B. Stems suffrutescent well above the base; leaves filiform, 20 mm. long or less . . . . . 1. *P. pinifolius*

BB. Stems herbaceous or woody at base only; leaves various, more than 20 mm. long.

C. Stem leaves connate-perfoliate, serrate; corolla pink to rose . . . . . 2. *P. pseudospectabilis* subsp. *connatifolius*

CC. Stem leaves sessile, clasping, or cordate, entire; corolla scarlet, carmine, carnival red, crimson, or purple red.

D. Corolla constricted at the orifice, crimson or purple red.

E. Leaves moderately thin, cauline ones 3-10 cm. long, broadly lanceolate, oblong, or lance-ovate; calyx-lobes 3 mm. long . . . . . 3. *P. cardinalis*

EE. Leaves moderately thick, cauline ones 2.5-6 cm. long, ovate or sub-cordate; calyx-lobes, 4-5 mm. long . . . . . 4. *P. cardinalis* subsp. *regalis*

DD. Corolla not constricted at the orifice, scarlet, carmine, or carnival red.

E. Anther-sacs only partially dehiscent by a short confluent slit which leaves the lower portion of each cell closed . . . . . 5. P. bridgesii

EE. Anther-sacs completely dehiscent or only partially dehiscent from the free tips, the lower portions always open.

F. Anther-sacs peltately explanate, as broad as long.

G. Foliage strongly glaucous; stem leaves broadly ovate; staminode short-bearded . . . . . 6. P. superbus

GG. Foliage green or slightly glaucous; stem leaves lanceolate; staminode glabrous . . . . . 7. P. alamosensis

FF. Anther-sacs not peltately explanate, narrow.

G. Calyx-lobes and pedicels glandular-pubescent . . . . . 8. P. lanceolatus

GG. Calyx-lobes and pedicels glabrous.

H. Corolla obscurely bilabiate, the lips about equally erect or spreading; anther-sacs somewhat divergent but not opposite . . . . . 9. P. eatonii

HH. Corolla strongly bilabiate, the upper lip projecting, the lower one reflexed; anther-sacs opposite.

I. Corolla bearded at the base of the lower lobes

with yellow hairs . . . . . .

. . . . . 10. *P. barbatus*

II. Corolla glabrous at the base of the lower lobes or with a few whitish hairs.

J. Anthers bearded . . . . . .

. . . . . 11. *P. barbatus* subsp. *trichander*

JJ. Anthers glabrous . . . . . .

. . . . . 12. *P. barbatus* subsp. *torreyi*

AA. Corolla blue, violet, lavender, purple, white or occasionally pink with a lavender or violet cast.

B. Foliage glaucous.

C. Basal leaves noticeably narrower than the stem leaves; most of the bracts prominent, ovate with acuminate or caudate tips; inflorescence many flowered, not secund.

D. Corolla pale lavender, lower Pecos Valley . . . . . .

. . . . . 13. *P. buckleyi*

DD. Corolla sky blue, pale violet blue, or violet-pink; northern New Mexico.

E. Foliage moderately glaucous and blackening in drying; bracts not prominently venose on either side; northeastern New Mexico . . . . . .

. . . . . 14. *P. angustifolius* subsp. *caudatus*

EE. Foliage slightly glaucous and not blackening in drying; bracts prominently venose on both sides; northwestern New Mexico . . . . . .

. . . . . 15. P. angustifolius subsp. venosus

CC. Basal leaves (most of them) as wide as the stem leaves; only the lower bracts at all prominent, lanceolate or broadly ovate with a short and abruptly pointed tip; inflorescence moderately flowered and secund or few-flowered and open.

D. Cauline leaves and bracts lanceolate, erect; corolla throat moderately inflated, bearded at the base of the lower lobes . . . . . 16. P. secundiflorus

DD. Cauline leaves lanceolate to ovate, erect or spreading; bracts broadly ovate with a short and abruptly pointed tip; corolla throat very slightly inflated, glabrous at the base of the lower lobes . . . . . 17. P. fendleri

BB. Foliage glabrous or puberulent.

C. Plants shrubby or suffrutescent above the base (sometimes almost herbaceous in P. linarioides.)

D. Staminode glabrous.

E. Corolla 15-25 mm. long, pink externally, white within, the limb set obliquely on the narrow curved throat.

F. Stems and leaves puberulent . . . . .18. P. ambiguus

FF. Stems and leaves glabrous . . . . . 19. P. ambiguus subsp. laevissimus

EE. Corolla 10-12 mm. long, blue-purple, limb scarcely oblique, throat funnel-form . . . . . .

. . . . . 20. P. thurberi

DD. Staminode bearded.

E. Stems several to many, in small tufts; leaves cinereous-puberulent with flat scale-like hairs; leaves of the inflorescence reduced; calyx-lobes ovate, acute to short acuminate, scarious-margined almost to the tip.

F. Stems several, 2-5 dm. tall; corolla strongly bearded at the orifice; staminode well bearded for most of its length with bright yellow hairs, often longer and tufted at the tip.

G. Leaves principally linear . . . 21. P. linarioides

GG. Leaves principally oblanceolate . . . . . 22. P. linarioides subsp. maguirei

FF. Stems many, 1.5-3 dm. tall; corolla lightly bearded at the orifice; staminode strongly bearded at the tip with bright yellow hairs and behind the apical tuft with sparse whitish or yellowish hairs . . . . . 23. P. linarioides subsp. coloradoensis

EE. Stems many, tufted forming small mats; leaves glabrous or puberulent with fine erect or retrosely spreading hairs; leaves of the inflorescence not reduced; calyx-lobes attenuate, scarious-margined only on the ovate base.

F. Leaves glabrous or nearly so above the petiole . .

. . . . . 24. P. crandallii subsp. glabrescens

FF. Leaves puberulent with fine erect or retrosely spreading hairs . . . . . 25. P. crandallii subsp. glabrescens var. taosensis

CC. Plants herbaceous or somewhat suffrutescent at base only.

D. Inflorescence glandular pubescent.

E. Corolla dull dark purple, lower lobes projecting. . . . . 26. P. whippleanus

EE. Corolla white, blue, violet-blue, lavender, or occasionally pink with a lavender cast, lower lobes spreading or reflexed.

F. Anther-sacs broad, peltately explanate.

G. Leaves sharply serrate, fascicles of small leaves in the axil of each larger leaf . . . . . 27. P. pulchellus

GG. Leaves undulately serrate, obscurely toothed, or entire, no fascicled leaves.

H. Corolla much or moderately inflated, the lower lip glandular within.

I. Lower lip without bearding; corolla white to lavender, leaves scabrous . . . . 28. P. albidus

II. Lower lip villose; corolla pale violet to violet blue; leaves puberulent to glabrous.

J. Corolla 25-35 mm. long, 10-15 mm. wide . . . .

. . . . . 29. P. jamesii

JJ. Corolla 17-22 mm. long, 7-10 mm. wide . . . .

. . . . . .30. P. jamesii subsp. ophianthus

HH. Corolla scarcely inflated, the lower lip without glands within . . . . . .

. . . . . 31. P. jamesii subsp. breviculus

FF. Anther-sacs narrow, not peltately explanate.

G. Staminode glabrous; corolla 25-32 mm. long . . . .

. . . . . 32. P. dasyphyllus

GG. Staminode bearded; corolla 15-25 mm. long.

H. Leaves finely but sharply serrate . . . . . .

. . . . . .33. P. gracilis

HH. Leaves entire or practically so.

I. Stem leaves mostly shorter than the internodes; bracts much reduced; calyx-lobes elliptic-oblong, 4-5 mm. long . . . . . .

. . . . . 34. P. oliganthus

II. Stem leaves mostly longer than the internodes; bracts leaf-like; calyx-lobes linear-lanceolate, 7-9 mm. long . . . . . .

. . . . . 35. P. auriberbis

DD. Inflorescence glabrous or puberulent.

E. Inflorescence interrupted, the verticillasters many-flowered and the lowest pair usually remote; corolla 10-14 mm. long . . . . . 36. P. rydbergii

EE. Inflorescence more or less continuous, the verticillasters moderately or few flowered; corolla 15-40 mm. long.

F. Leaves oblong or lance-ovate, to 45 mm. wide; inflorescence broad and usually compact; corollas 30-40 mm. long . . . . . 37. P. brandegeei

FF. Leaves linear or lanceolate, to 18 mm. wide; inflorescence narrow and usually elongated; corollas 15-30 mm. long.

G. Fertile anthers villose.

H. Calyx-lobes 3-6 mm. long; anther-sacs less strongly villose, staminode slightly dilated, glabrous or with a few short hairs at the tip . . . . . 38. P. strictus

HH. Calyx-lobes 8-10 mm. long; anther-sacs more strongly villose, staminode strongly dilated, bearded for about one-half its length with long hairs . . . 39. P. strictus subsp. strictiformis

GG. Fertile anthers glabrous.

H. Corolla 15-25 mm. long, 7-10 mm. wide, white to blue-violet; glabrous or lightly bearded at base of lower lobes; inflorescence usually with short internodes and many flowers . . . . . 40. P. virgatus

HH. Corolla 20-30 mm. long, 10-13 mm. wide, blue or

blue-violet, strongly bearded at base of lower lobes; inflorescence usually with longer internodes and few flowers . . . . . 41. *P. virgatus* subsp. *neomexicanus*

CHAPTER V

DESCRIPTIONS, DISCUSSIONS, AND DISTRIBUTION MAPS

1. PENSTEMON PINIFOLIUS Greene

(Fig. 1)

Penstemon pinifolius Greene, Bot. Gaz. 6:218. 1881. "Summits of the San Francisco Range, back of Clifton, in southeastern Arizona." Type was collected by E. L. Greene in 1880.

Stems 1.5 to 3 dm. high, numerous, forming small mats, woody well above the base, puberulent; leaves 1 mm. wide, 20 mm. long or less, filiform, apiculate, widened at the clasping base, crowded on the lower part of the stems, scattered on the upper part, glabrous; inflorescence secund, the solitary axillary peduncles bearing one or occasionally two blossoms; calyx 4-5 mm. long, glandular pubescent, the lobes lanceolate, scarious-margined; corolla 25-30 mm. long, scarlet, strongly bilabiate, glandular-pubescent externally, throat narrow, very slightly inflated, pubescent with yellow hairs at the base of the lower lobes; anther-sacs exserted, explanate, longer than broad; staminode included, not dilated, bearded for most of its length with short bright yellow hairs.

This interesting and attractive species blooms in late June and through July in the Transition and Canadian zones. Evidently not common, it prefers the rocky summits at higher

FIGURE 1

DISTRIBUTION OF *PENSTEMON PINIFOLIUS* GREENE

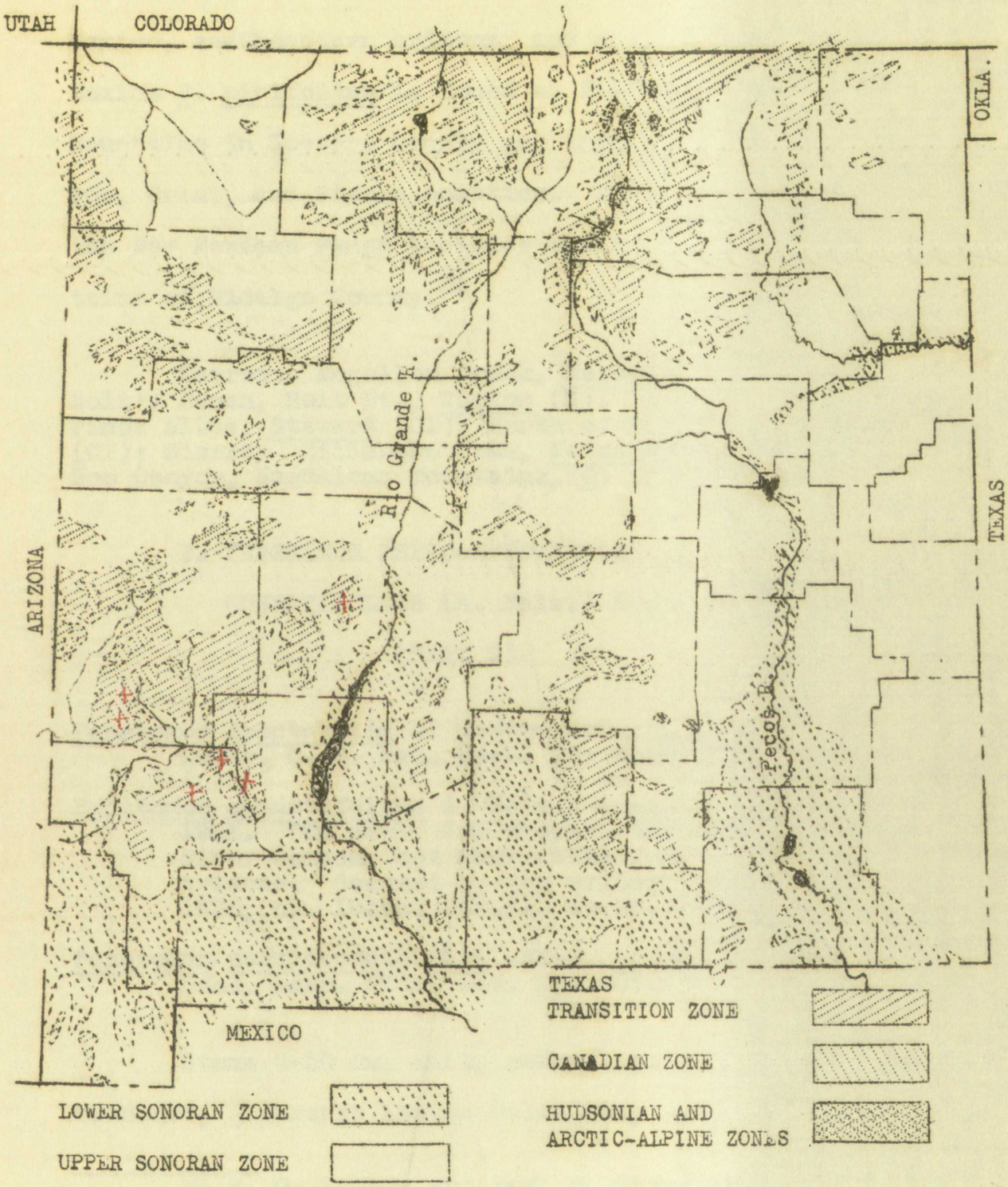
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 1

UTAH
COLORADO
NEW MEXICO
ARIZONA
TEXAS
MEXICO
TRANSITION ZONE
LOWER SONORAN ZONE
UPPER SONORAN ZONE

elevations. It occurs in the mountains of southwestern New Mexico, southeastern Arizona, and adjacent Mexico. In New Mexico P. pinifolius is found as far north as the Magdalena Mountains in Socorro County and through the mountains of Catron, Grant, and Sierra counties. Wooton and Standley state the New Mexican range includes the Animas and San Luis mountains of Hidalgo County.[31]

Catron: Mogollon Creek, Metcalf 2401 (A); East of Holt's Ranch, Holt Mt., Wooton (S). Grant: Mountains near Pinos Altos, Stewart (CI); North of Pinos Altos, Ownbey 1637 (CI); Sierra: Hillsboro Peak, Metcalfe 1163 (S). Socorro: Hop Canyon, Magdalena Mountains, G. Nisbet 749 (NM,CI).

2. PENSTEMON PSEUDOSPECTABILIS subsp.

CONNATIFOLIUS (A. Nels.) Keck

(Fig. 2)

Penstemon spectabilis of Wooton and Standley not of Thurb., Contr. U. S. Nat. Herb. 19: 583. 1915.

Penstemon connatifolius A. Nels., Amer. Jour. Bot. 18: 437. 1931. "On sandy dry slopes, 'Apache Trail', Salt River Canyon, not many miles from the Roosevelt Dam, Arizona. Secured by the writer Aven Nelson , May 3, 1925, no. 10314. (Type, R. Mt.)"

Penstemon pseudospectabilis subsp. connatifolius (A. Nels.) Keck, Amer. Midl. Nat. 18: 807. 1937.

Stems 6-10 dm. tall, several to many, often much branched, glabrous; leaves relatively thin, glaucescent to

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[31] E. O. Wooton and Paul C. Standley, Flora of New Mexico, Contributions from the United States National Herbarium, Vol. XIX, (Bulletin of the U. S. National Museum. Washington: Government Printing Office, 1915), p. 582.

FIGURE 2

DISTRIBUTION OF *PENSTEMON PSEUDOSPECTABILIS* SUBSP. *CONNATIFOLIUS* (A. NELS.) KECK

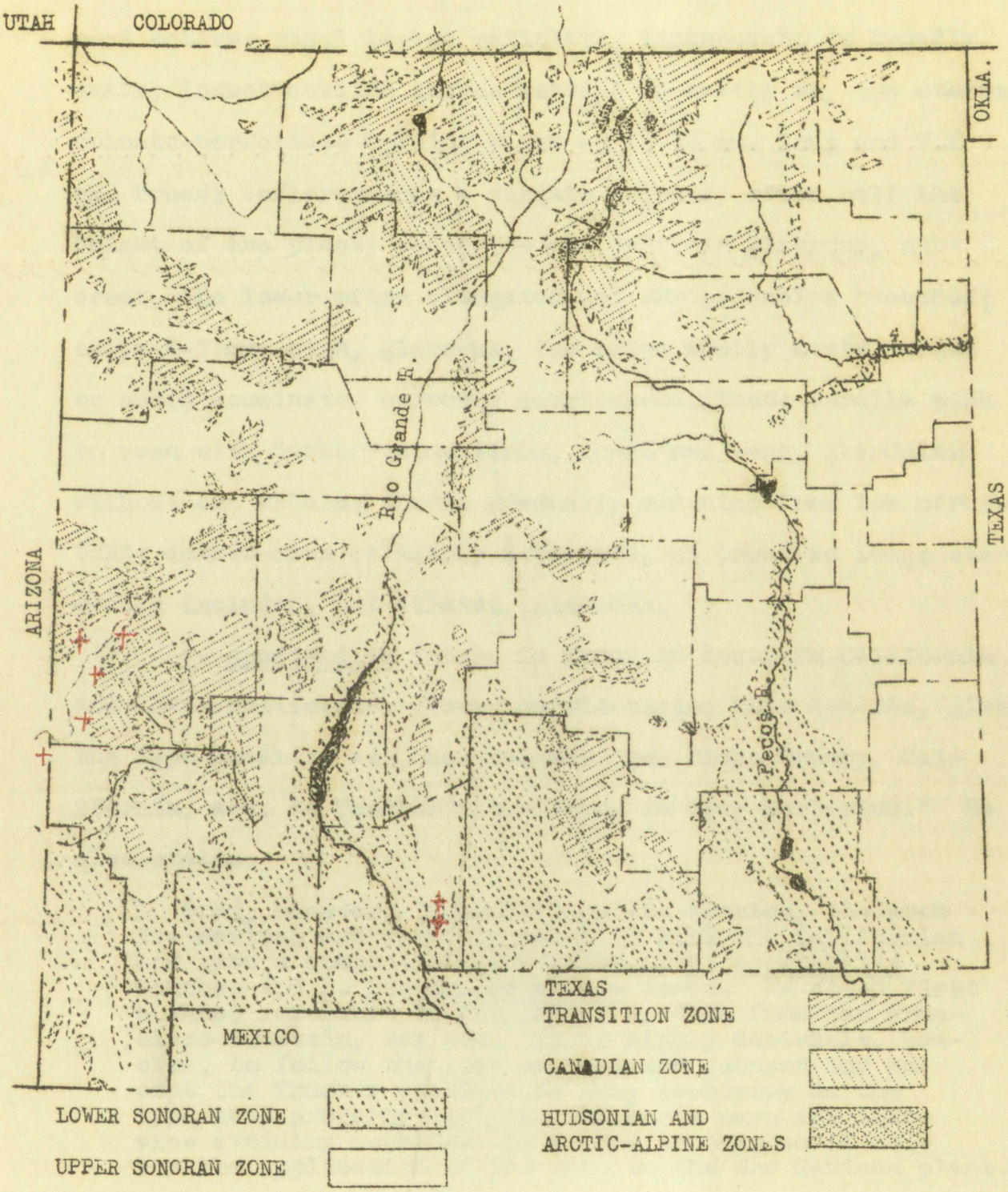
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 2

UTAH
COLORADO
NEW MEXICO
ARIZONA
MEXICO
LOWER SONORAN ZONE
UPPER SONORAN ZONE

bright green, serrate-dentate with fine pungent teeth to almost entire; basal leaves petiolate, lance-ovate to broadly ovate; lowest cauline leaves sessile or nearly so, the others connate-perfoliate forming disks up to 18 cm. long and 7.5 cm. broad; inflorescence a virgate thyrsus, often half the height of the plant; peduncles and pedicels glabrous, suberect, the lower often elongated and the peduncles branched; calyx 4-7 mm. high, glabrous, the lobes mostly ovate, acute or short acuminate, narrowly scarious-margined; corolla pink to rose with darker guide lines, 22-25 mm. long, glandular without and within; throat gradually widening from the narrow tube; anther-sacs peltately explanate, as broad as long; staminode included, not dilated, glabrous.

P. spectabilis Thurb. is found in southern California and Lower California. Keck, in discussing this species, gives the type locality as, "San Pasqual, San Diego County, California, acc. to Thurber's specimens in Gray Herbarium." He also states:

> Gray, however, in describing the species, included New Mexican and Arizonan material with the Californian and gave a composite description of P. spectabilis Thurber and P. pseudospectabilis Jones. He cited first a sheet referable to the latter species from San Francisco Mountain, New Mex. It is highly desirable, however, to follow the lead of Munz and Johnson and accept the Thurber specimen at Gray Herbarium as the type thus properly applying Thurber's name and likewise avoiding considerable confusion that would follow the application of the name to the New Mexican plant.[32]

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[32] David D. Keck, "Studies in Penstemon V. The Section Peltanthera," The American Midland Naturalist, 18:817, September, 1937.

P. pseudospectabilis Jones occurs from southeastern California to southwestern New Mexico. The eastern subspecies, to which the New Mexican plants belong, is distinguished from the western subspecies by the lack of glands on the pedicels and calyces and the greener and thinner leaves. However, plants from near Reserve, Catron County, have thicker leaves than do the typical specimens of this subspecies.

This is indeed a beautiful species of Penstemon. It blooms in April and May at lower altitudes and into June at higher elevations. This species is usually found growing in rocky washes or on gravely slopes of the Upper Sonoran and Transition zones. Its range extends from westcentral Arizona, southeastward across central and southeastern Arizona to southwestern New Mexico. In New Mexico P. pseudospectabilis subsp. connatifolius has been reported from Catron, Grant, and Dona Ana counties.

Catron: White Water Creek, near Glenwood, G. Nisbet 48 (NM,CI); Reserve, Hershey (S); Datil Forest, north of Glenwood, 48233 (F); 18-20 miles south of Luna, S. Turner and G. Nisbet 808,809 (NM). Dona Ana: Organ Mts., Hershey (S); Dripping Springs, Hershey (S). Grant: Mule Creek Pass (Specimens collected about 2 miles west of Arizona-New Mexico line), S. Turner and G. Nisbet 813 (NM).

3. PENSTEMON CARDINALIS Woot. and Standl.

(Fig. 3)

Penstemon cardinalis Woot. and Standl., Contr. U. S. Nat.

FIGURE 3

DISTRIBUTION OF *PENSTEMON CARDINALIS* WOOT. & STAND. (+)
AND *PENSTEMON CARDINALIS* SUBSP. *REGALIS*
(A. NELS.) COMB. NOV. (⊙)

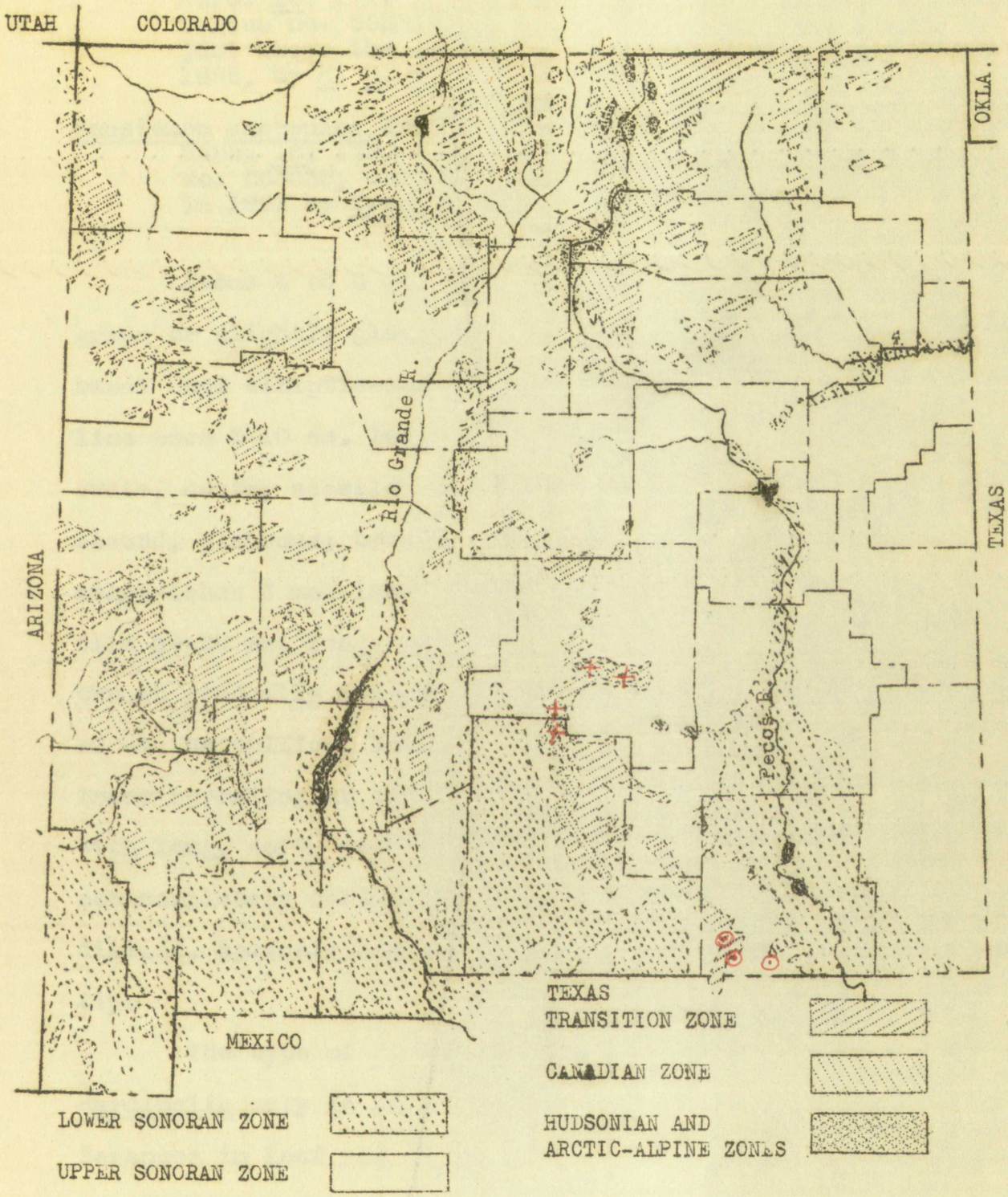
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 3

UTAH
COLORADO
NEW MEXICO
ARIZONA
MEXICO
LOWER SONORAN ZONE
UPPER SONORAN ZONE

Herb. 16: 171. 1913. "Type in U. S. National Herbarium no. 563916, collected on White Mountain Peak just above the forks of the Ruidoso Creek, July 6, 1895, by E. O. Wooton. Altitude about 2,400 meters."

Penstemon crassulus Woot. and Standl., Contr. U. S. Nat. Herb. 16: 172. 1913. "Type in U. S. National Herb. No. 563032, collected in the Lincoln National Forest in 1903 by Fred G. Plummer."

Stems 4 to 6 dm. tall, few to many, slender, glabrous, green or slightly glaucous; leaves moderately thin, glabrous, basal ones elliptic-spatulate, petiolate, mostly obtuse, cauline ones 3-10 cm. long, broadly lanceolate, oblong, or lance-ovate, acute, sessile; inflorescence narrow, more or less secund, glabrous; bracts, except the lowest pair, very small; calyx-lobes 3 mm. long, ovate, acute, scarious-margined; corolla 22-28 mm. long, purplish-red or crimson, tube short, throat gradually and moderately inflated, somewhat contracted at the orifice, lobes 2-3 mm. long, upper ones erect, lower spreading or reflexed and strongly bearded at the base with long, soft, yellow hairs; stamens included, anther-sacs not completely dehiscent, ciliate-denticulate; staminode not dilated, sparsely bearded with yellow hairs below, near the tip.

The type of P. crassulus differs from the type of P. cardinalis only in minor characteristics. The slight differences in leaf and calyx characters are not constant over any definite area and constitute only a variation of the species.

P. cardinalis blooms from the last of June through July. It grows on rocky ridges associated with pine or fir and spruce in the Transition or Canadian zones. As yet this species has been found only in the White and Capitan mountains of Lincoln and Otero counties. Although it may occur to the southward in the Sacramento Mountains, it has not been reported from there.

Lincoln: Pierce Canyon, Capitan Mts., Hendricks 36103 (F); White Mountain Peak, just above the forks of the Ruidoso, Wooton (S); Capitan Pass, C. Nisbet 747 (CI,NM).
Otero: Sierra Blanca Peak, Wolf 2871 (CI).

4. PENSTEMON CARDINALIS subsp. REGALIS

(A. Nels.) comb. nov.

(Fig. 3)

Penstemon regalis A. Nels., Amer. Jour. Bot. 21:578, 1934. "Near Carlsbad Caverns by Mrs. Gladys Convis, May, 1930. Her number 75 is the type in the Rocky Mountain Herbarium."

Penstemon cardinalis subsp. regalis comb. nov.

Similar to P. cardinalis but distinguished by the different foliage and calyx-lobes. Leaves moderately thick, firm, cauline ones 2.5-6 cm. long, ovate or sub-cordate, usually obtuse, the lowest often elliptic; calyx-lobes 4-5 mm. long, acute to short acuminate.

P. regalis has not been retained as a species because of the slight morphological differences between it and P.

cardinalis. In fact, the above stated differences are somewhat obscure in some specimens. Neither species has been reported from the Sacramento Mountains, which lie between the White and Guadalupe mountains. So it would seem that their ranges do not overlap. However, this investigator feels that this gap in distribution is more apparent than real, and that it is due to lack of collecting in the Sacramento Mountains. P. cardinalis and P. cardinalis subsp. regalis show their relationship with P. havardi A. Gray in the peculiar shape of the corollas. P. havardi occurs to the south in the mountains of Texas. P. havardi and P. cardinalis subsp. regalis are closely associated geographically, but P. havardi differs from the New Mexican species in having a glandular-pubescent inflorescence, corollas nearly scarlet, lobes 5 mm. long, orifice glabrous, staminode glabrous, and anther-sacs peltately explanate.

P. cardinalis subsp. regalis blooms in May and June in rocky canyons in the Upper Sonoran Zone. It is found in the Guadalupe Mountains of Otero and Eddy counties and probably southward into Texas.

Eddy: Near Carlsbad Caverns, Convis 75 (R); Dark Canyon, Hershey (CI,S); Guadalupe Mts., Hershey (S,MN).

5. PENSTEMON BRIDGESII A. Gray

Penstemon bridgesii A. Gray, Proc. Amer. Acad. 7: 379. 1868. "No. 218 in Californian collection of the late Thomas Bridges. Yosemite Valley, very scarce, Bolander."

Stems 3-6 dm. tall, herbaceous or often slightly woody near the base, glabrous below the inflorescence; lower leaves linear-oblanceolate, upper ones linear, not crowded; inflorescence narrow, glandular-pubescent, peduncles 2-5 flowered; calyx-lobes 5 mm. long, ovate or lanceolate, acuminate; corolla 22-25 mm. long, scarlet, strongly bilabiate, throat only slightly inflated, glabrous within, posterior lobes projecting, anterior ones strongly descending-recurved; anther-sacs partially dehiscent by a short confluent slit that leaves the lower portion of each cell closed, edges minutely ciliate-denticulate; staminode glabrous.

P. bridgesii is easily distinguished from P. barbatus by its peculiar anthers that are closed at the free tips like tiny sacs. The anthers of P. barbatus are open at the free tips.

This species blooms from the middle of June to late August. It is found in low mountains in the Upper Sonoran and Transition zones where it is associated with the piñons and yellow pines. Its range extends from California to westernmost New Mexico and from southern Utah and Nevada to southern Arizona. Although this species has a fairly wide range, the plants are few and scattered. P. bridgesii seems to be rare in the mountains of western Catron County. It was collected in the San Francisco Mountains in 1900, but it has not been reported since. Since only one specimen

from New Mexico has been examined, no distribution map for this species has been included.

Catron: Trujillo's Ranch on the Frisco River [San Francisco River], Wooton (S).

6. PENSTEMON SUPERBUS A. Nels.

(Fig. 4)

Penstemon puniceus A. Gray, in Torr., Bot. Mex. Bound. 113. 1859. Not P. puniceus Lilja, 1843. "In the Guadalupe cañon, Sonora, June, 1851; Thurber and Captain E. K. Smith."

Penstemon superbus A. Nels., Proc. Biol. Soc. Wash. 17: 100. 1904.

Stems 3-10 dm. tall, one to several; stems and leaves strongly glaucous, blackening in drying (occasionally not darkening much); basal leaves obovate or spatulate with margined petioles; cauline leaves coriaceous, broadly ovate to oblong-ovate, clasping, cordate, or slightly connate-perfoliate; inflorescence narrow, many flowered, often one-half the height of the plant; peduncles and pedicels short, slightly glandular-pubescent; calyx 3-5 mm. high, with scattered stalked glands, the lobes ovate to narrowly ovate, acute with narrow, pinkish, scarious margins; corolla 17-22 mm. long, scarlet, with stalked glands internally and externally, throat narrowly funnel-form, lobes flaring; anther-sacs peltately explanate, as broad as long; staminode included, not dilated, short bearded near the tip.

FIGURE 4

DISTRIBUTION OF *PENSTEMON SUPERBUS* A. NELS.

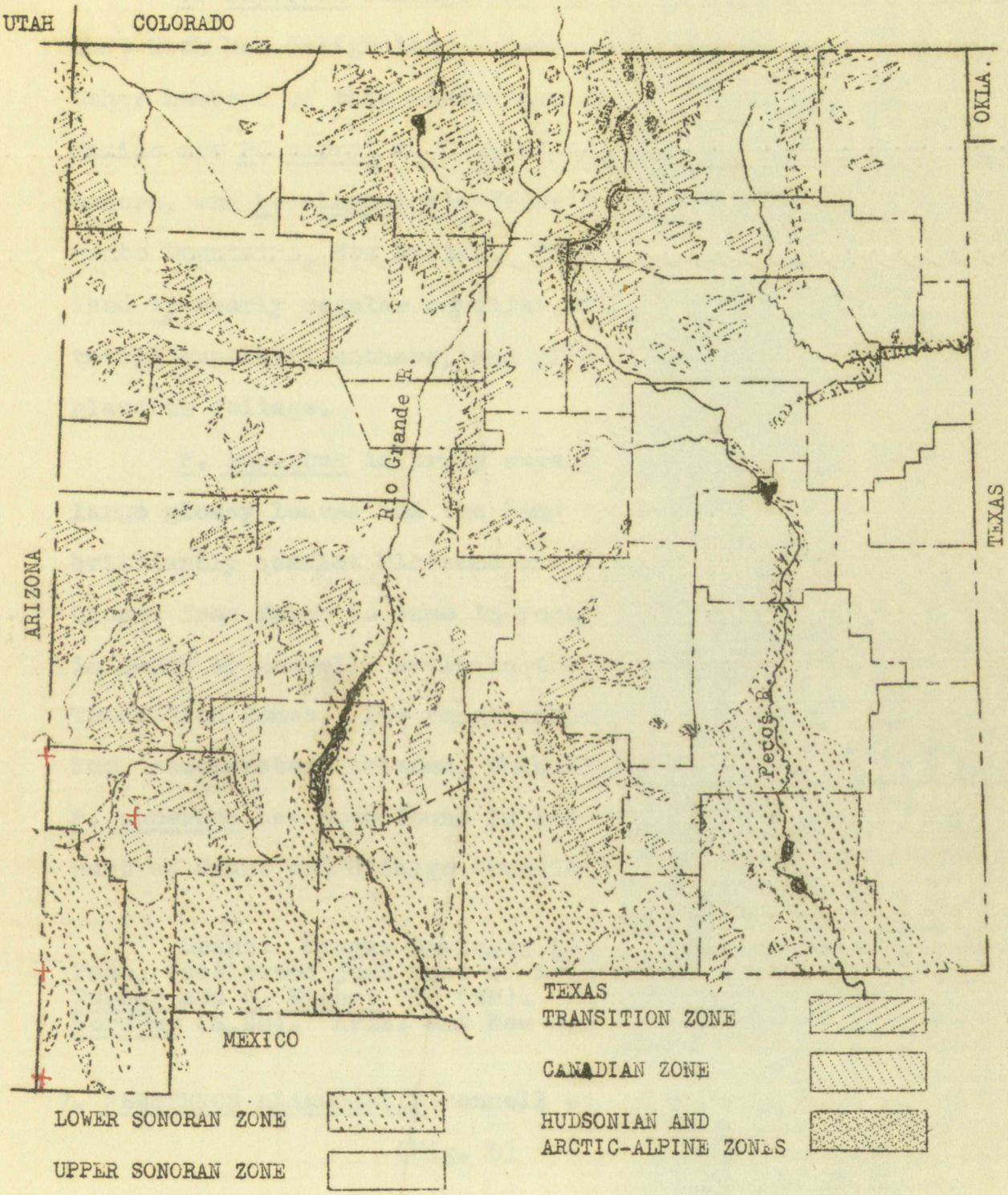
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 4

UTAH
COLORADO
NEW MEXICO
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

P. superbus belongs to a group of related species that Keck has designated as Subsection Centranthifolii.[33] Other members of this subsection that occur in or near New Mexico are P. parryi A. Gray of southcentral Arizona and Sonora, and P. alamosensis Pennell et Nisbet of the Sacramento Mountains, New Mexico. These species are characterized by nearly regular corollas with flaring lobes, peltately explanate anthers, and glabrous and more or less glaucous foliage.

P. superbus is truly superb. The tall plants with large glossy leaves and the long inflorescences with many brilliantly scarlet blossoms are very attractive. It blooms from March to June in rocky canyons and along washes in sandy or gravelly soils in the Upper Sonora and lower Transition zones. Its range includes southwestern New Mexico, southeastern Arizona, Chihuahua, and Sonora. As yet P. superbus has been found in New Mexico only in the western part of Grant and Hidalgo counties.

Grant: Mangas Springs, Metcalfe 68 (S); Mule Creek Pass, (collected just west of Ariz. and New Mex. line) S. Turner and G. Nisbet 675 (NM). Hidalgo: Guadalupe Canyon, Hershey (S,NM). Ariz. and New Mex. line, Hershey (S).

7. PENSTEMON ALAMOSENSIS Pennell et Nisbet, sp. nov.

(Fig. 5)

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[33] Ibid., pp. 791, 793, and 821.

FIGURE 5

DISTRIBUTION OF *PENSTEMON ALAMOSENSIS* PENNELL & NISBET

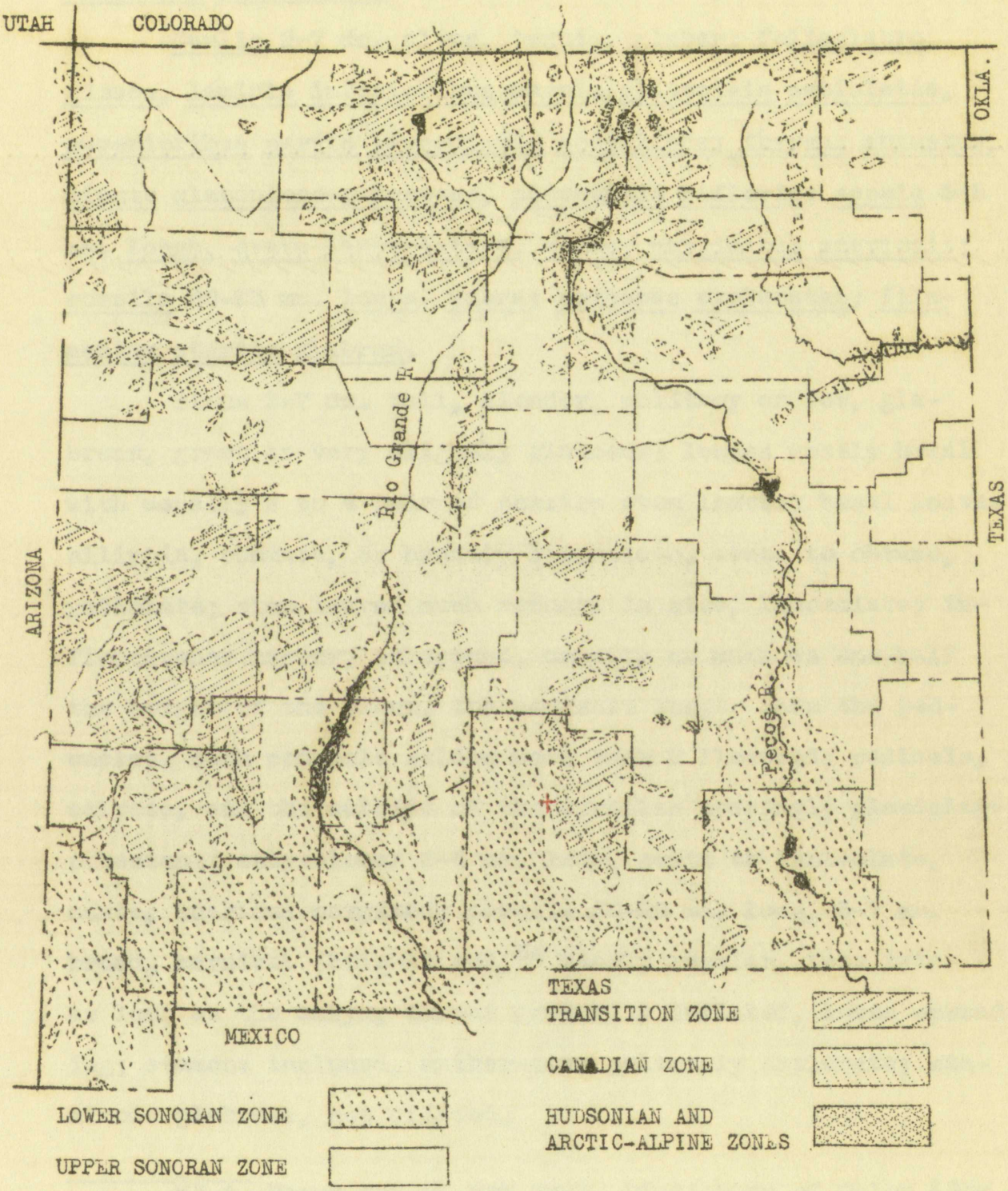
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 5

UTAH
COLORADO
NEW MEXICO
TEXAS
ARIZONA
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

Penstemon alamosensis Pennell et Nisbet, sp. nov.

Caulis 3-7 dm. altus, tenuis, glaber; foliaglabra, glauca, laminis inferioribus magnis ellipticis petiolatis, superioribus parvis lanceolatis sessilibus; thyrsus angustus, minute glanduloso-pubescens, pedunculis bifloris; sepala 3-5 mm. longa, ovata lanceolatave, acuta, marginibus scariosis; corolla 20-25 mm. longa, rubra; antherae explanatae; filamentum sterile glabrum.

Stems 3-7 dm. tall, slender, solitary or few, glabrous, green or very slightly glaucous; leaves mostly basal with usually 2 to 4 pair of sessile stem leaves; basal leaves elliptic, obovate, or broadly lanceolate, acute to obtuse, petiolate; stem leaves much reduced in size, lanceolate; inflorescence narrow, subsecund, usually as much as one-half the height of the plant, the pedicels longer than the peduncles, each peduncle seldom more than 2 flowered; pedicels, calyces, and the outside of the corollas sparingly glandular-pubescent; calyx-lobes 3-5 mm. long, ovate to lanceolate, acute, scarious-margined; corolla 20-25 mm. long, 5-7 mm. broad, carnival (bright) red,[34] nearly regular, tube twice as long as the calyx, throat gradually inflated, lobes spreading; stamens included, anther-sacs peltately explanate; staminode glabrous, not dilated.

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[34] A. Maerz and M. Rea Paul, Dictionary of Color (New York: McGraw Hill Book Company, Inc., 1930), Plate 3, J6; Plate 3, L7.

The type was collected by G. Nisbet and Cleon Mankin, June 10, 1941, in a limestone crevice of a dry, rocky wash in Alamo Canyon on the west slope of the Sacramento Mountains about five miles southeast of Alamogordo, Otero County, New Mexico. The type specimen is G. Nisbet's 817 in the herbarium of the Academy of Natural Sciences of Philadelphia. Isotypes have been placed in CI and NM.

As has been stated previously, P. alamosensis, P. wrightii Hook., P. superbus A. Nels., and P. parryi A. Gray are closely related species. P. wrightii occurs about one hundred seventy-five miles to the southeast of Alamogordo in the Jeff Davis Mountains of Texas. P. superbus is found some two hundred miles to the west and P. parryi still farther west. P. alamosensis is apparently an endemic restricted to the west slope of the Sacramento Mountains east of Alamogordo. P. alamosensis is distinguished from P. superbus by the characteristics given in the key and in the descriptions of the two species. P. alamosensis may be distinguished from P. wrightii by the following:

P. alamosensis	P. wrightii
Leaves mostly basal; stem leaves much reduced in size, 2-4 pair, mostly lanceolate and acute, .5-2 cm. wide, green or slightly glaucous;	Stem leaves not reduced 4-6 pair, ovate or oblong, mostly obtuse, 3-4 cm. wide, moderately glaucous;

lower peduncles seldom more than two-flowered; corolla bright red, 20-25 mm. long, tube twice as long as the calyx, throat gradually expanded; staminode glabrous.	lower peduncles usually 4 or 5 flowered; corolla rose, 15-20 mm. long, tube no longer than the calyx, throat abruptly expanded; staminode retrosely bearded along outer half.

Since P. parryi is still farther removed geographically and morphologically from P. alamosensis than P. superbus and P. wrightii, there has seemed no need to discuss it here. An interesting variation of P. superbus from Black Rock Wash about fifteen miles south-southwest of Fort Thomas, Graham County, Arizona, (S. Turner and C. Nisbet, No. 699 in NM) has corollas of much the same shape, size, and color as P. alamosensis; however, its foliage and the bearded staminode resemble P. superbus. This variation emphasizes the close relationship of these species and leads one to speculate on the possible discoveries when more field work is done and more specimens available for study.

P. alamosensis blooms in May and early June. It grows only on north or northeast facing slopes on rocky limestone ridges, in crevices of the limestone in dry washes, or at the foot of limestone cliffs. The plants are fairly abundant, but quite scattered. As yet no specimens of the species have been discovered in the upper part of the canyons but only in

the lower part associated with ocotillo, cacti, allthorn, century plant, and other semi-desert plants. Specimens of P. alamosensis have been collected in Alamo and Dry canyons. Dry Canyon lies slightly to the northeast of Alamogordo. The occurrence or absence of this species in other canyons on the west slope of the Sacramento Mountains has not yet been determined.

Otero: Alamo Canyon, Misbet and Mankin 816 (CI,NM); Dry Canyon, Rehn and Viereck (CI).

8. PENSTEMON LANCEOLATUS Benth.

(Fig. 6)

Penstemon lanceolatus Benth., Pl. Hartw. 22, 1839. "Mexico; 184 Hartweg; 57 and probably 441, Gregg."[35]

Penstemon pauciflorus Greene, Bot. Gaz. 6: 218. 1881. "On a bluff of the Gila River in the extreme southwestern part of New Mexico near the border of Arizona, in flower August 30, 1880."

Stems 4-6 dm. tall, usually densely puberulent but sometimes lightly so; leaves linear-attentuate, puberulent; inflorescence narrow, densely glandular-pubescent; calyx-lobes ovate with narrow scarious margins on the basal half or not at all scarious; corolla dark scarlet, tube short, throat moderately ampliate; anther-sacs not explanate but dehiscent from apex to base, minutely denticulate along the edges; staminode glabrous.

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[35] Asa Gray, "Synopsis of the Genus Penstemon," Proceedings of the American Academy of Arts and Sciences, 6: 65, 1866.

FIGURE 6

DISTRIBUTION OF PENSTEMON LANCEOLATUS BENTH.

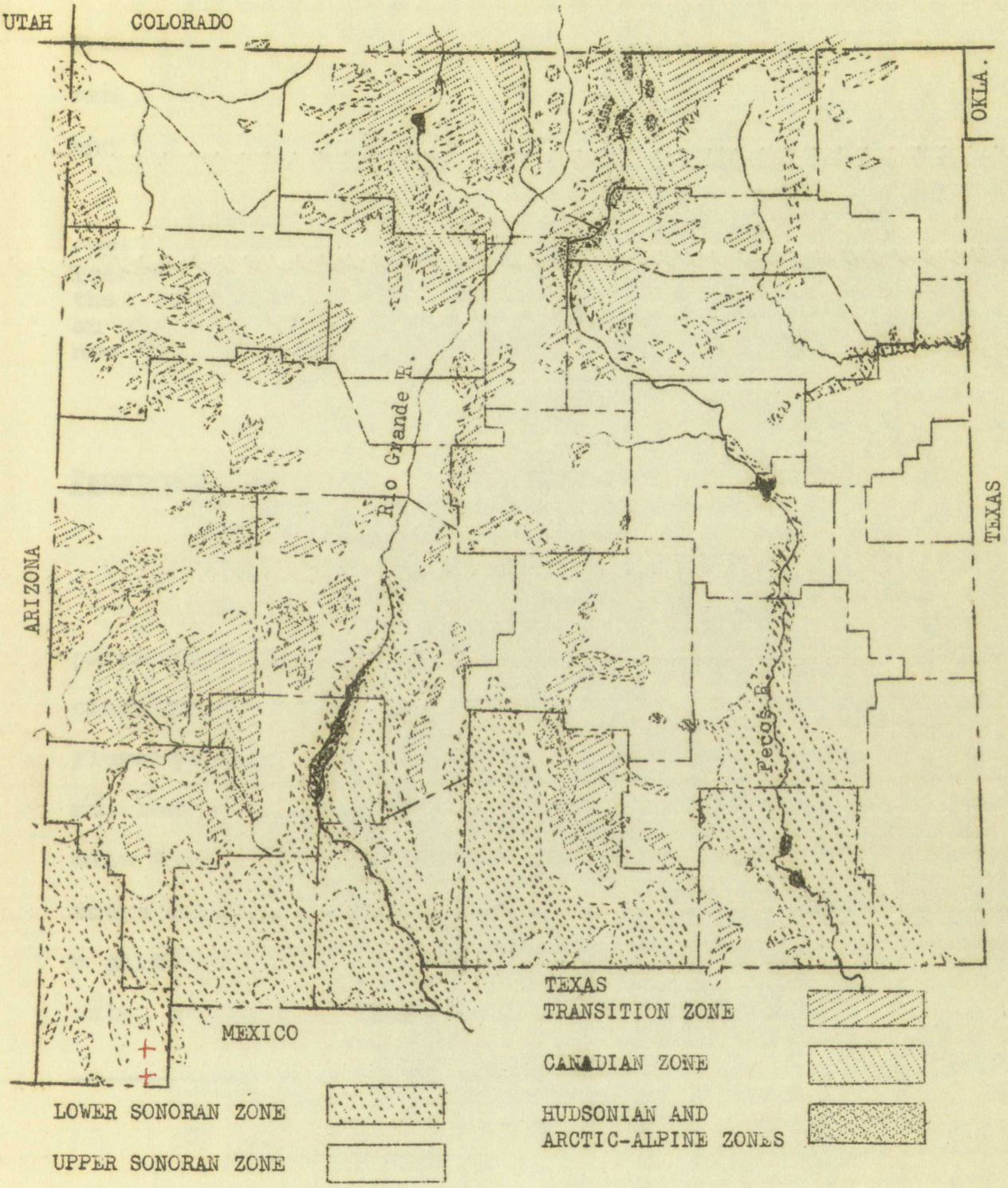
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 6

UTAH
COLORADO
NEVADA
ARIZONA
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

This species, blooming in May and June, occurs infrequently in rocky canyons of the Upper Sonoran Zone. Its range includes southwestern New Mexico, southeastern Arizona, and the neighboring states of northern Mexico.

Hidalgo: Alamo Hueco Mts., Woods Div. of Grazing (NM); Dog Springs, Mearns 102,2553,[36] (Wooton & Standley locate Dog Springs in southeastern Grant Co.,[37] but at that time Grant County extended to the Mexican Border. On an old map, Dog Springs was found to be located in what is now the southeast corner of Hidalgo County.)

9. PENSTEMON EATONII A. Gray

Penstemon eatonii A. Gray, Proc. Amer. Acad. 8: 395. 1872. "Mr. Watson *** in company with Professor Eaton, found it abundantly in Provo Canyon, Wasatch Mountains," Utah.

Stems 3-6 dm. tall, solitary to few, glabrous to puberulent, not at all glaucous; stem leaves broadened and clasping at the base, acuminate; inflorescence strict, many flowered, the peduncles and pedicels short; calyx-lobes 3-5 mm. long, ovate, acute to acuminate, scarious-margined; corolla 22-30 mm. long, scarlet, obscurely bilabiate, the lobes about equally erect or spreading; anther-sacs dehiscent only a part of their length from the free tips, somewhat divaricate, edges minutely denticulate; staminode glabrous.

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[36] Wooton and Standley, op. cit. p. 582.

[37] Ibid., p. 759.

This species blooms from April to July or in southern Arizona as early as March. It is found on mesas and mountain sides, in the open and among the trees in the Upper Sonoran and Transition zones. Its range includes southern Utah, the San Juan Valley of southwestern Colorado, much of Arizona, and extreme northwestern New Mexico. Wooton and Standley state P. eatonii was collected in the Carrizo Mountains. No recent collections have been made in New Mexico; therefore no distribution map has been included for this species.

San Juan: Carrizo Mts., west of Shiprock, Standley 7315.[38]

10. PENSTEMON BARBATUS (Cav.) Roth.

(Fig. 7)

Chelone barbata Cav., Icones 3: 22, Pl. 242. 1794. "Habitat in Imperio Mexicano."

Penstemon barbatus (Cav.) Roth, Catal. Bot. 3:49. 1806.

Penstemon barbatus var. puberulus A. Gray in Torr. Bot. U. S. & Mex. Bound. Rpt. 114, 1859. "Guadalupe Canyon, May, 1851; Thurber."

Stems 3-18 dm. high, solitary to several, glabrous or puberulent; basal leaves petiolate, lanceolate, spatulate, or ovate, glabrous or puberulent; stem leaves 5-14 cm. long, narrowly linear to broadly lanceolate; calyx 6-10 mm. high,

[38] Wooton and Standley, op. cit., p. 583.

FIGURE 7

DISTRIBUTION OF PENSTEMON BARBATUS (CAV.) ROTH. (⊕), PENSTEMON BARBATUS SUBSP. TORREYI (BENTH.) KECK (○), PENSTEMON BARBATUS SUBSP. TRICHANDER (A. GRAY) KECK (●), AND INTERGRADING SHOWN BY (⊕) OR (⊙)

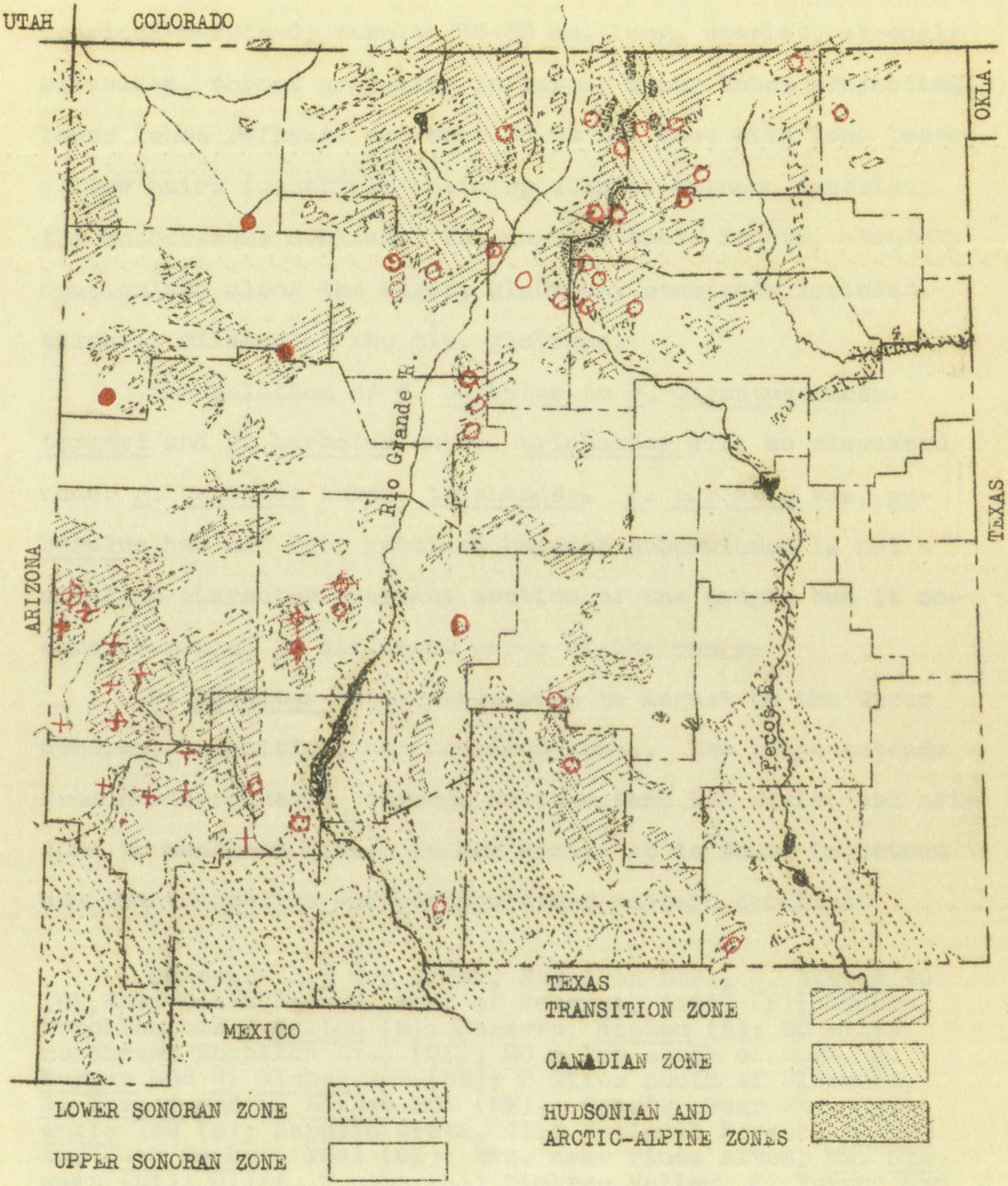
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 7

UTAH
COLORADO
ARIZONA
MEXICO
TEXAS
TRANSITION ZONE
LOWER SONORAN ZONE
UPPER SONORAN ZONE

lobes lanceolate or ovate and short acuminate, glabrous, scarious-margined; corolla 28-38 mm. long, scarlet, strongly bilabiate, throat gradually inflated, upper lobes projecting, lower lobes reflexed and bearded at the base with long loose yellow hairs (sometimes bearding scant); anthers exserted, the anther-sacs dehiscent for most of their length, minutely denticulate along the edges, glabrous; staminode included, slightly dilated at the tip, glabrous.

The relation of P. barbatus to P. barbatus subsp. torreyi and P. barbatus subsp. trichander will be discussed under P. barbatus subsp. trichander. P. barbatus var. puberulus has not been retained because puberulence is not a constant character over any section of the range, but it occurs at random in different parts of the range.

P. barbatus blooms from June to August in the Upper Sonoran, Transition, and Canadian zones. The range extends from northern Mexico through southwestern New Mexico and Arizona to southern Utah. In New Mexico it is found in Catron and Grant counties and perhaps other western counties.

Catron: Big Dry Creek, Mogollon Mts., G. Nisbet 46 (CI,NM); Datil Forest, west of Reserve, 41947 (F); Graham, Mogollon Mts., Wooton (S); Reserve, Wooton (S); 20 miles northeast Mogollon Mt., (CI); 20 miles south of Luna, S. Turner and G. Nisbet 789 (NM); 2 miles south of Glenwood, S. Turner and G. Nisbet 805 (NM). Grant: Bear Mt., Metcalfe 169 (S); Sapello Creek, Gila National Forest, Marion and Ruth Ownbey, 1641 (CI); Mts. near Pinos Altos, Wm. Stewart (CI); Cliff, Wooton (S); Mimbres Valley, S. Turner and G. Nisbet 788 (NM).

11. PENSTEMON BARBATUS subsp. TORREYI (Benth.) Keck

(Fig. 7)

Penstemon torreyi Benth. in DC. Prodr. 10:324. 1846. "Versus montes Scopulosos."

Penstemon barbatus var. torreyi A. Gray, Proc. Amer. Acad. 6: 59. 1862.

Penstemon barbatus subsp. torreyi (Benth.) Keck, Jour. Wash. Acad. Sci. 29:491. 1939.

Very similar to typical P. barbatus but the foliage usually less ample, most of the leaves linear; calyx-lobes only 3-5 mm. long; lower lip of the corolla glabrous or with a few whitish hairs.

This pretty penstemon blooms from June to August in rocky soil of the Transition and Canadian zones. It is found principally from central Colorado southward through New Mexico on both continental slopes. It occasionally occurs in eastern Arizona, but the common form in Arizona is the typical P. barbatus. P. barbatus subsp. torreyi is very common in the Sangre de Cristo, Jemez, Sandia, and Manzano mountains and less common in the mountains of southern New Mexico.

Bernalillo: Sandia Loop Road, Castetter 234 (NM); Cedro Canyon, G. Nisbet 752 (NM); El Cedro, Herrick (S). Catron: San Francisco Mts. near Luna, 78440 (F); Colfax: Johnson's Mesa, G. Nisbet 665 (NM); Cimarron Canyon, G. Nisbet 784 (NM); Heck Canyon, G. Nisbet 666 (NM). Dona Ana: Dripping Springs, Organ Mts., Hershey (S,NM). Eddy: Queen, Guadalupe Mts., Hershey (S,NM); Guadalupe Mts., Carson Seep, 38705 (F).

Grant: Bear Mt. near Silver City (A); Cherry Creek Springs, Hershey (S). Lincoln: Apache Fire Cabin, White Mts., Worth 717 (NM). Mora: Near Ocate, G. Nisbet 666 (NM); Holman Hill G. Nisbet 47 (NM). Otero: Cloudcroft, Hershey (S,NM). Rio Arriba: Near Vallicitos, Martin 241 (CI). Santa Fe: Santa Fe, Bro. Arsene & Bro. Benedict 16086 (St); Glorietta, G. Nisbet 668 (NM); Santa Clare Canyon, near Espanola (Personal coll.) San Miguel: Elk Mt. G. Nisbet 670. (Personal coll.) Romeroville, Bro. Arsene and Bro. Benedict, 16086 (St); Pecos, Mrs. Florence Bartlett (S); Grass Mt., head of Pecos R., Standley (S). Sandoval: Jemez Springs, Hershey (S); Battleship Rock, Jemez Mt., Castetter 438 (NM). Sierra: Tierra Blanca Canyon, Mimbres Mts., 21811 (F); Black Range, Hershey (S). Socorro: Magdalena Mts. Herrick (S); East of Bingham, G. Nisbet 761 (NM); Hop Canyon, Magdalena Mts., G. Nisbet 875 (NM); Monica Canyon, San Mateo Mts., G. Nisbet 769 (NM). Taos: Tres Ritos Canyon, G. Nisbet 668 (NM); Red River Canyon, G. Nisbet 667 (NM); Taos Canyon, T. Williams 1697 (NM).

12. PENSTEMON BARBATUS subsp. TRICHANDER (A. Gray) Keck

(Fig. 7)

Penstemon barbatus var. trichander A. Gray, Proc. Amer. Acad. 11:94. 1876. "S. W. Colorado, T. S. Brandegee, in Hayden's Exploration, 1875."

Penstemon trichander Ryd., Bull. Torrey Club 33:151. 1906.

Penstemon barbatus subsp. trichander (A. Gray) Keck, Jour. Wash. Acad. Sci. 29:491. 1939.

Similar to P. barbatus and P. barbatus subsp. torreyi, but distinguished by villose anthers.

This investigator has followed Dr. Keck in not retaining P. trichander and P. torreyi as distinct species. This step has been taken because of the relatively small amount of morphological difference between them and the frequent evidences of intergradation. This intergradation is most frequent in the Magdalena and San Mateo mountains of Socorro

County and the Mogollon Mountains of Catron County. Specimens from these regions vary in the amount of bearding in the throat, from glabrous to moderately bearded with yellow or yellowish white hairs; and the sepals are generally intermediate in length, averaging about 5-6 mm. in contrast with the 3 mm. sepals of specimens of typical P. torreyi and the 8-10 mm. sepals of specimens of typical P. barbatus. Some typical P. torreyi and some typical P. barbatus occur in this region but the majority of the specimens are intermediate in character and might be referred to either species with equal propriety. Occasionally specimens from the Magdalena, San Mateo, and Jemez mountains show some bearding on the anthers. Of three specimens found at the Santa Monica Ranger Station, San Mateo Mountains, all three have calyx-lobes 4-5 mm. long, two specimens have a light bearding of yellowish hairs in the throat, and the third, while glabrous in the throat, has sparse bearding on the anthers.

P. barbatus subsp. trichander is similar in blooming period and in habitat to P. barbatus subsp. torreyi. It is found in northwestern New Mexico, southwestern Colorado, southern Utah, and northeastern Arizona in the drainage of the Dolores and San Juan rivers. In New Mexico this subspecies is found in San Juan, McKinley, and Valencia counties; in Sandoval County, as has been stated above, it intergrades to some extent with P. barbatus subsp. torreyi.

McKinley: Zuni, Hershey (S). San Juan: Chaco Canyon, Castetter 830 (NM); Chaco Canyon, Aztec Ruins Natn. Moun. No. 45. Sandoval: Jemez, Hershey (S). Valencia: San Mateo, Aven Nelson 1773 (NM).

13. PENSTEMON BUCKLEYI Pennell

(Fig. 8)

Penstemon amplexicaulis Buckley in Proc. Acad. Nat. Sci. Phila. 13:461. 1862. "About 60 miles N. E. of Camp Colorado [Texas, S. B. Buckley], June [1861] . Not P. amplexicaulis Moench, Meth. Hort. Bot. Marburg. 442. 1794."[39]

Penstemon buckleyi Pennell, Proc. Acad. Nat. Sci. Phila., 73:486. 1921.

Stems 3-4 dm. tall, solitary or few, stout, glabrous, glaucous, not blackening in drying; leaves moderately thick, glabrous and glaucous, oblong to lanceolate; inflorescence narrow, not secund; bracts prominent, widened at the base and with an acuminate tip, in fruit conspicuously reticulate ridged; calyx-lobes attentuate, with scarious and erose margins; corolla pale lavender, throat slightly inflated, lobes short, spreading; staminode sparsely bearded at the tip with yellowish hairs.

P. buckleyi is similar in appearance and closely related to P. angustifolius subsp. caudatus of northeastern New Mexico from which it can be distinguished by its paler

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[39] Francis W. Pennell, The Scrophulariaceae of Eastern Temperate North America, The Academy of Natural Sciences of Philadelphia, Monograph 1, 1935, p. 267.

FIGURE 8

DISTRIBUTION OF *PENSTEMON BUCKLEYI* PENNELL (●), *PENSTEMON ANGUSTIFOLIUS* SUBSP. *CAUDATUS* (HELLER) KECK (+), AND *PENSTEMON ANGUSTIFOLIUS* SUBSP. *VENOSUS* KECK (○)

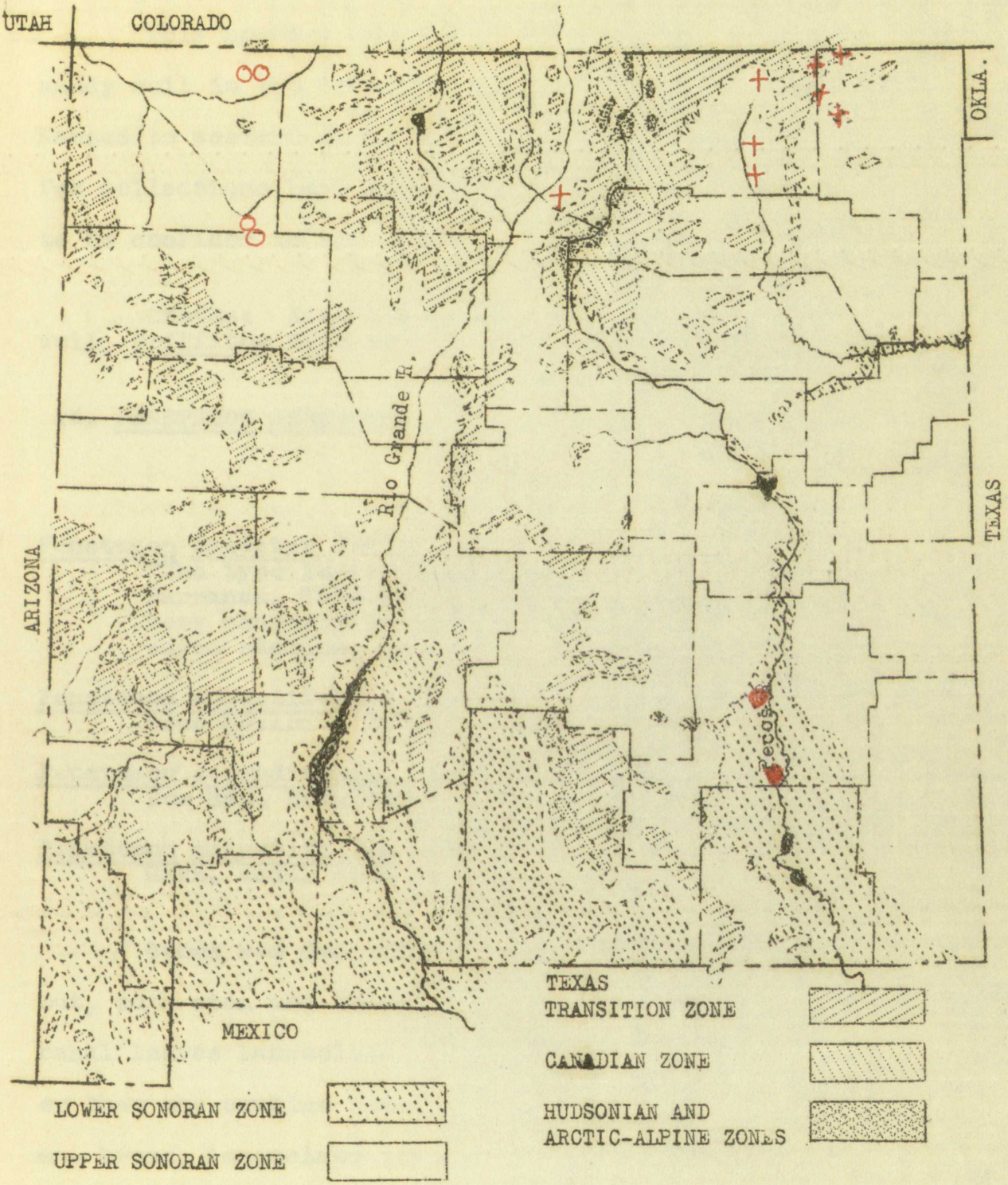
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 8

UTAH
COLORADO
NEW MEXICO
ARIZONA
MEXICO
Gila R.
Colorado R.
LOWER SONORAN ZONE
UPPER SONORAN ZONE

flowers and sparsely bearded staminode.

This species blooms in April and May. It grows in sandy soil in the Lower and Upper Sonoran zones from western Kansas to western Texas and southeastern New Mexico. Very few collections have been made in New Mexico, where it seems to be confined to the lower Pecos Valley.

Chaves: Near Lake Arthur, Grazing Survey (NM); Roswell, Griffiths 4263 at the U. S. Nat. Herb.[40]

14. PENSTEMON ANGUSTIFOLIUS subsp. CAUDATUS (Heller) Keck

(Fig. 8)

Penstemon caudatus Heller, Minn. Bot. Stud. 2:34. 1898.
"The type is our No. 3581, collected May 26, 1897, at Barranca, Taos County, altitude 6,900 feet. It is very abundant in open grassy sandy soil, about Barranca station, growing in large patches."

Penstemon angustifolius var. caudatus Rydb., Bull. Torrey Club 33:151. 1906.

Penstemon secundiflorus caudatus A. Nels., in Coult. & Nels., New Man. Bot. 444. 1909.

Penstemon angustifolius subsp. caudatus (Heller) Keck, Jour. Wash. Acad. Sci. 29:490. 1939.

Stems 2-5 dm. tall, one to several, glabrous throughout, both stem and leaves blackening more or less in drying; basal leaves lanceolate or spatulate, short petiolate, narrower than the cauline leaves; cauline leaves 5-10 cm. long, 5-25 mm. broad, lanceolate to narrowly ovate, acuminate; inflor-

[40] Pennell, loc. cit.

escence not secund, many flowered, often with short internodes that combined with the short pedicels and peduncles form a compact spike-like mass of flowers; lower bracts usually large, lance-ovate or ovate with an acuminate or caudate tip; calyx 5-7 mm. high, lobes lanceolate, acute, broadly scarious-margined on the lower half; corolla 17-22 mm. long, sky blue, pale violet-blue, or violet-pink, throat gradually and moderately expanded, lobes spreading; anther sacs narrow, confluent but not explanate; staminode bearded with short, deep yellow hairs on and near the dilated tip.

P. angustifolius Nutt. is a variable species that occurs in the typical form from North Dakota and eastern Wyoming southward to eastern Colorado. In southeastern Colorado, northeastern New Mexico, and western Kansas, P. angustifolius subsp. caudatus replaces the typical form. Rydberg considered it a variety and said, "P. caudatus Heller is in my opinion the southern more luxuriant and broad leaved form of P. angustifolius. The two grade absolutely into each other in Colorado."[41] Pennell disagrees and regards this form as a distinct species. Typical P. angustifolius has smaller corollas, usually narrower leaves and more gradually acuminate bracts than P. angustifolius subsp. caudatus. Intermediate forms occasionally are found in northern New Mexico. This

[41] Alex Rydberg, "Studies on the Rocky Mountain Flora," Bulletin of the Torrey Botanical Club 33:151, March, 1906.

investigator agrees with Dr. Keck that this form should be considered as a subspecies rather than a variety. A western form of P. angustifolius occurs in northwestern New Mexico, northeastern Arizona, southern Utah, and southwestern Colorado. This form, P. angustifolius subsp. venosus is very closely allied with the eastern subspecies.

P. angustifolius subsp. caudatus is a beautiful early blooming (May and early June) species well worth bringing into the gardens. It is found only in sandy soil in the foothills and on the plains of the Upper Sonoran Zone. It occurs in southeastern Colorado, western Kansas, and northeastern New Mexico west to Taos County. It is very common in eastern Colfax and northwestern Union counties.

Colfax: Springer, C. Nisbet 30 (NM,CI); 5 miles east of Maxwell, Nisbet 658 (NM); east end of Johnson's Mesa, Nisbet 739 (NM,CI); 14 miles south of Raton, Nisbet 741 (NM). Taos: Barranca, Heller 3851 (Herb. of U. of Minn. and others). Union: Emory Gap, Nisbet 737 (NM); Sierra Grande, Nisbet 777 (NM,CI); 3 miles north of Capulin, Nisbet 742 (NM).

15. PENSTEMON ANGUSTIFOLIUS subsp. VENOSUS Keck

(Fig. 8)

Penstemon angustifolius subsp. venosus Keck, Jour. Wash. Acad. Sci. 29:490. 1939. "Type: R. H. Peebles & H. J. Fulton 11877, from 12 miles northeast of Tuba City, Coconino County, Ariz., at 5,300 feet elevation, June 3, 1935 (United States National Herbarium)."

Very similar to P. angustifolius subsp. caudatus but the herbage paler, less glaucous, and not blackening in dry-

ing; bracts prominently venose on both sides; corollas 15-20 mm. long, often pinkish.

Of this form Keck says:

> This subspecies is a rather constant plant of sand dunes. It grades over by fine steps into subsp. caudatus in western New Mexico, but it may usually be distinguished by the smaller, often pinkish flowers and the more venose bracts, which do not turn blackish in drying.[42]

The pinkish flower is not a good characteristic by which to distinguish this subspecies, because P. angustifolius subsp. caudatus also often has pinkish flowers.

This subspecies blooms in May and June in northern Arizona, southern Utah, southwestern Colorado, and northwestern New Mexico. This investigator has been told by residents of Farmington that a"blue penstemon" is common in spring along the highway south of Shiprock and also along the highway leading from New Mexico to Mesa Verde National Park, Colorado. Although this "blue penstemon" is probably the subspecies here being considered, it has not been confirmed or specimens collected. In the eastern part of its range this subspecies is difficult to distinguish from P. angustifolius subsp. caudatus.

San Juan: Chaco Canyon, Herb. of Aztec Ruins Nat. Mon. 42; Aztec, Herb. of Aztec Ruins Nat. Mon.; 10 miles south of Chaco Canyon, Thomas F. Martin 133 (CI) (Probably would be in McKinley Co.).

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[42] Thomas H. Kearney and Robert H. Peebles, "Arizona Plants: New species, varieties, and combinations," Journal of the Washington Academy of Sciences, 29:490, November, 1939.

16. PENSTEMON SECUNDIFLORUS Benth.

(Fig. 9)

Penstemon secundiflorus Benth. in DC. Prodr. 10:325. 1846.
"In montibus Scopulosis."

Stems 1.5-4 dm. high, one to several, glabrous and glaucous; leaves firm, thick, glabrous, glaucous, basal ones spatulate with margined petioles, cauline ones 2-6 cm. long, 5-15 mm. wide, lanceolate to oblong, obtuse or acute, erect (not at all spreading); inflorescence narrow, secund; bracts lanceolate, erect, not prominent; calyx 4-7 mm. high, lobes lanceolate to ovate, acute, with wide scarious and erose margins which are often pinkish or purplish; corolla 18-25 mm. long, dark blue or sometimes strongly shaded with violet, throat gradually expanded, lower lip more or less bearded; anther-sacs narrow, opposite, not explanate; staminode dilated and heavily bearded on the upper side with yellow hairs.

The exact type locality for this species is not known. Pennell says:

> Type . . . lacks satisfactorily opened flowers, but leaves and young flowers indicate the plant here considered. The specimen is labeled 'Fremont-2nd Exped.,' 'named by Bentham'; unfortunately the number of collection is lost, but Fremont upon his second expedition was in eastern Colorado.[43]

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[43] Francis W. Pennell, "Scrophulariaceae of the Central Rocky Mountain States," Contributions from the United States National Herbarium, Vol. XX, Part 9, (Bulletin of the U. S. National Museum. Washington: Government Printing Office, 1920), p. 357.

FIGURE 9

DISTRIBUTION OF PENSTEMON SECUNDIFLORUS BENTH.

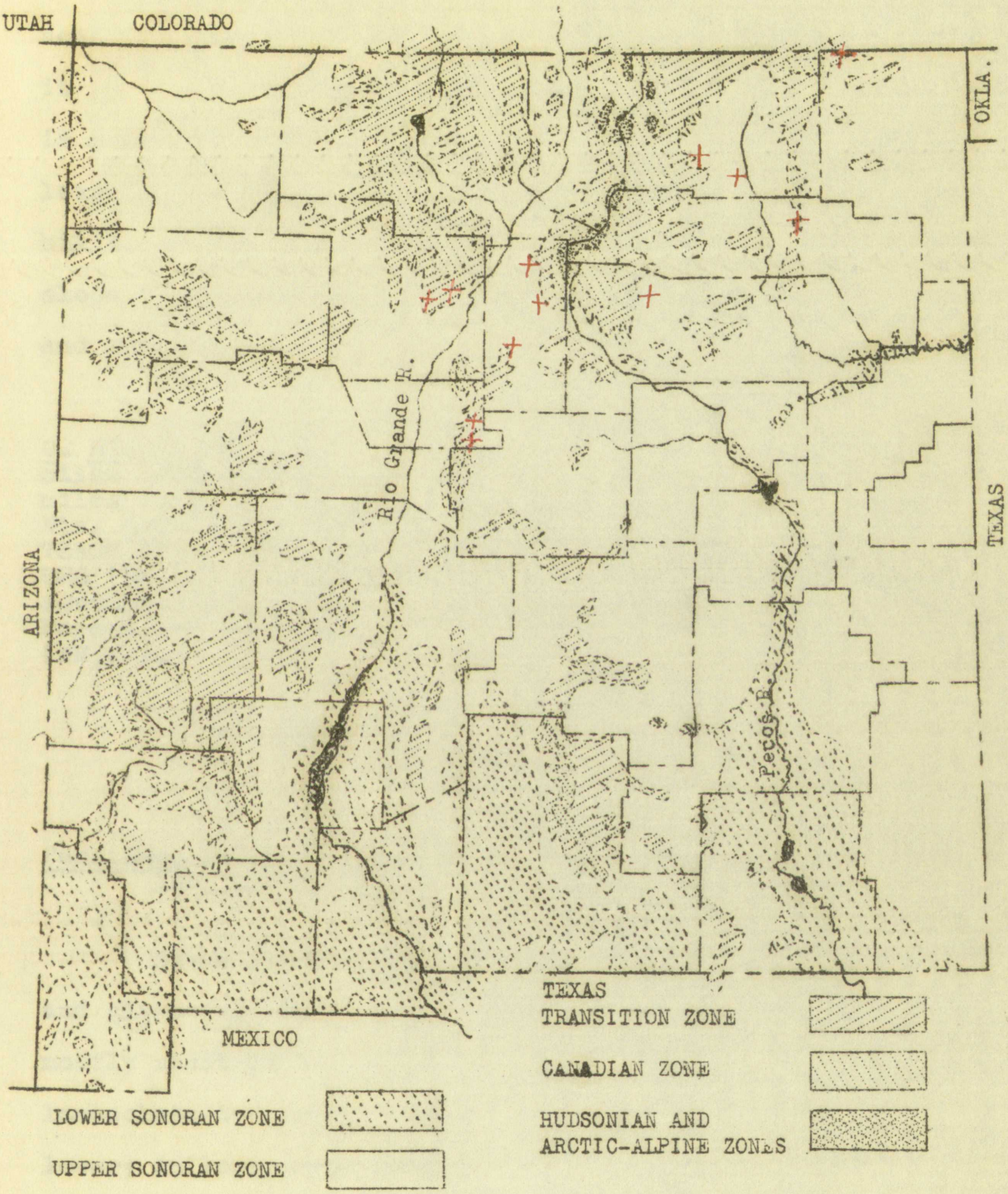
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 9

UTAH
COLORADO
NEW MEXICO
ARIZONA
TEXAS
MEXICO
LOWER SONORAN ZONE
UPPER SONORAN ZONE

P. secundiflorus blooms in late May and June in rocky soil of the foothill country of the Upper Sonoran Zone, where it is associated with junipers, piñons, and scrub oak. It is sometimes found in the Transition Zone and also on treeless rocky ridges running out into the plains from the foot hills. In New Mexico it occurs on the eastern continental slope from Bernalillo County northward, thence into Colorado and Wyoming.

Bernalillo: Cedro Canyon, Nisbet 848 (NM); Escobosa, G. Nisbet 726 (NM). Colfax: Springer, G. Nisbet 119; 4-5 miles south of Cimarron, Nisbet 26 (NM,CI). Harding: 10 miles north of Mills, Nisbet 27 (NM,CI). Sandoval: Jemez Mts. Bro. Arsene and Bro. Benedict 15962 (St); Bear Springs, 78408 (F). San Miguel: 12 miles north of Las Vegas, Nisbet 826 (NM,CI). Santa Fe: Cerrillos, A. Nelson 1156 (NM); southeast of Santa Fe, Nisbet 28 (NM); North of Santa Fe, Forest Service 24591 (F). Union: Emory Gap, Nisbet 720 (NM,CI).

17. PENSTEMON FENDLERI Torr. and Gray

(Fig. 10)

Penstemon fendleri Torr. and Gray, Pacif. Rail. Rep. 2. 4: 168, pl. 5. 1855. "On the Pecos and Llano Estacado."

Stems 2-5 dm. high, solitary or few, stout, glabrous and glaucous; leaves thick, glabrous and glaucous, basal ones mostly short-petiolate, spatulate, obtuse; cauline leaves lanceolate to ovate, the upper shorter and broader than the lower; inflorescence narrow, not secund, appearing open because of long internodes and few flowers, peduncles and pe-

FIGURE 10

DISTRIBUTION OF *PENSTEMON FENDLERI* TORR. & GRAY

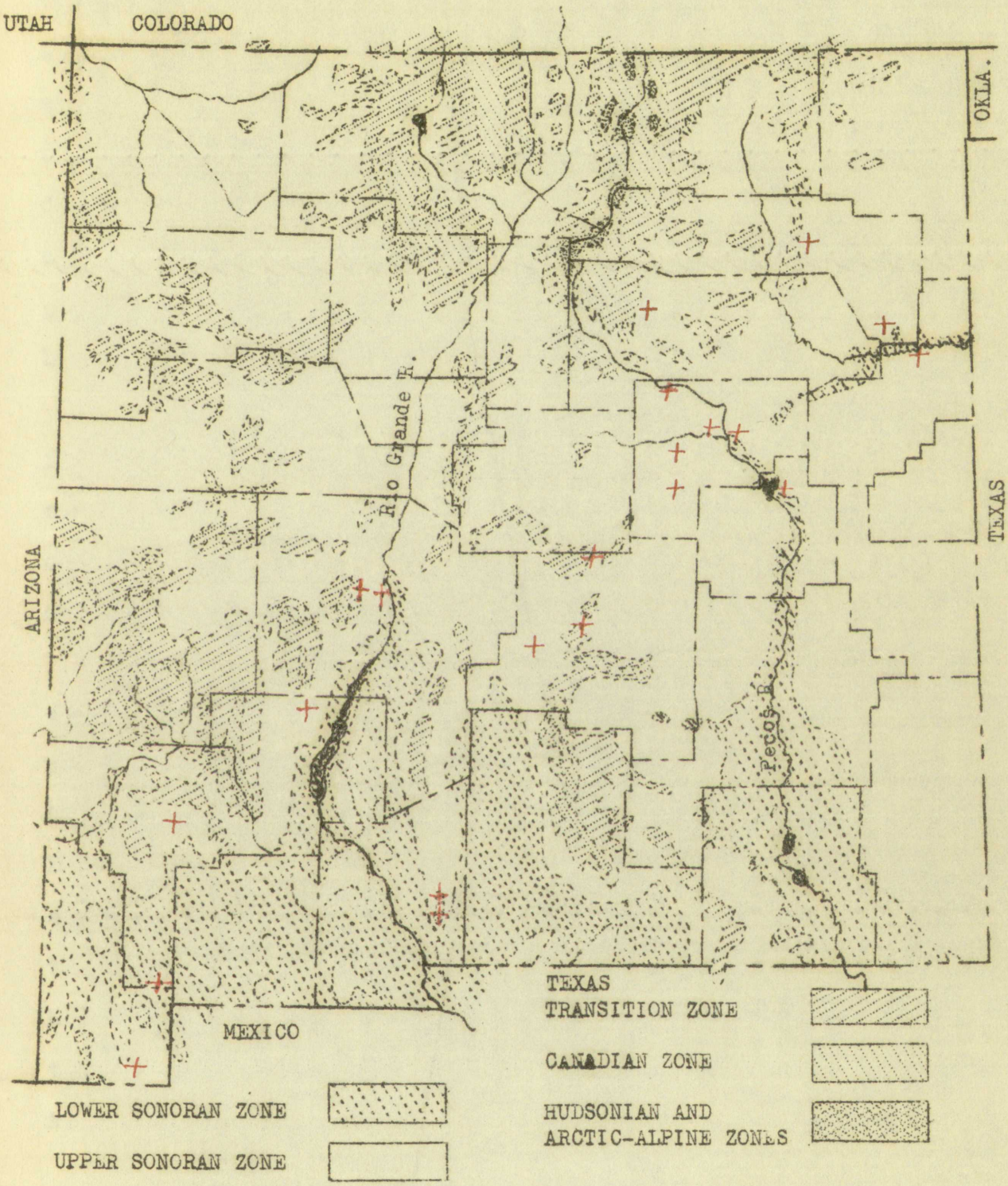
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 10

UTAH
COLORADO
NEW MEXICO
ARIZONA
TEXAS
MEXICO
Colorado R.
Rio Grande R.
TRANSITION ZONE
OAKDALIAN ZONE
HUDSONIAN AND ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

dicels short and erect; bracts mostly broader than long, with an abruptly pointed tip; calyx 4-5 mm. high, lobes ovate, acute to acuminate, scarious-margined; corolla 15-25 mm. long, usually violet but sometimes blue, with strongly defined deep violet guide lines, the narrow throat somewhat dilated at the orifice, lobes spreading; anther-sacs narrow, completely dehiscent, not explanate; staminode dilated, densely bearded with short yellow hairs on and near the tip.

The exact type locality, "On the Pecos and Llano Estacado," is not known. It is thought by some to be in western Texas, by others in eastern New Mexico. P. fendleri is common in the Panhandle of Texas and in the drainage of the Canadian and Pecos Rivers in eastern New Mexico.

This is a spring blooming species, coming out as early as April in the southern part of the state, but not until May and June in the northern part. It is found on the plains and in the lower foothills in the Upper Sonoran Zone, where it prefers sandy or gravelly soils. The range extends from western Oklahoma and Texas across New Mexico to southeastern Arizona and northern Chihuahua. In New Mexico P. fendleri is found in most of the counties east of the Rio Grande, and from Socorro County southwestward to Arizona.

De Baca: Ft. Sumner, Nisbet 830 (NM); Dona Ana; Organ Mts., Hershey (S); Ash Canyon, Hershey (S); Augustine

Pass, A. Nelson 2130 (NM); Filmore Canyon, Wooton (S). Grant: Silver City, G. Nisbet 659 (NM); 10 miles south of Hachita, Hershey (S). Guadalupe: East of Vaughn, Div. of Grazing (NM); Dilia, Nisbet 820 (NM); Santa Rosa, Nisbet 821 (NM); Pastura, Nisbet 846 (NM). Harding: 4 miles north of Roy, Nisbet 32 (NM,CI); David Hill, Nisbet 33 (NM). Hidalgo: Hatchet Valley, Div. of Grazing (NM). Lincoln: Jack's Peak Jicarilla Mts. (F); 3 miles north of Carrizozo, Nisbet 836 (NM); Corona, Nisbet 839 (NM). Quay: Logan, Nisbet 24 (NM). San Miguel: South of Romeroville, Nisbet 822 (NM). Sierra, south of Monticello, Div. of Grazing (NM). Socorro: south of San Antonio, A. Nelson 2114 (NM); west of San Antonio, Wooton 3874 (S).

18. PENSTEMON AMBIGUUS Torr.

(Fig. 11)

Penstemon ambiguus Torr., Ann. Lyc. Nat. His. N. Y. 2:228. 1828. "Hab. Near the Rocky Mountains."

Leiostemen ambiguus Greene, Leaflets 1:223. 1906.

Stems 2-6 dm. tall, profusely branched, decidedly suffrutescent, puberulent; leaves 6-30 mm. long, linear, mucronate, glabrous, the edges ciliolate and usually inrolled; inflorescence paniculate, the opposite peduncles 1-2 flowered; bracts resembling the leaves or more subulate; calyx 2-3 mm. high, lobes ovate, acute, scarious margined; corolla 14-24 mm. long, pink externally, the face of the lobes white, lobes set obliquely on the narrow curved throat which is densely puberulent on all sides at the orifice; stamens included, anther-sacs very small, explanate; staminode included, not dilated, glabrous.

This species is commonly called the Bush Penstemon.

FIGURE 11

DISTRIBUTION OF *PENSTEMON AMBIGUUS* TORR. (+),
PENSTEMON AMBIGUUS SUBSP. *LAEVISSIMUS* KECK (●),
PENSTEMON THURBERI TORR. (○),
AND INTERGRADING SHOWN BY (⊕)

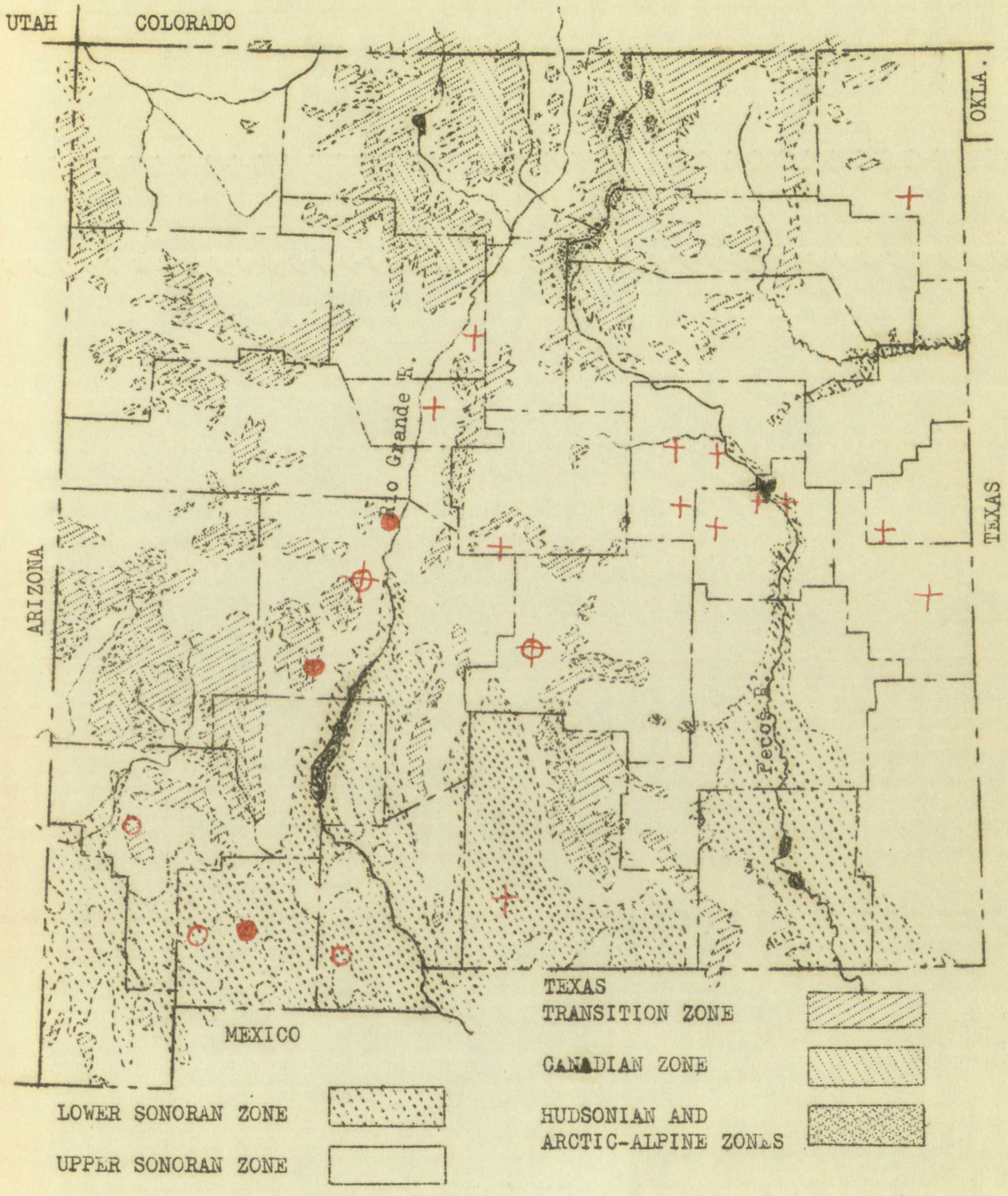
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 11

UTAH
COLORADO
NEW MEXICO
ARIZONA
MEXICO
TEXAS
TRANSITION ZONE
OAKS-JUAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

The many branches, each with its several to many blossoms, present an almost solid mass of flowers. The white of the face of the lobes has a glistening sheen uncommon among penstemons. Bushes two feet in diameter are not uncommon.

P. ambiguus blooms from late May to August, but is most common in June. It is found on the sandy plains and mesas of the Upper Sonoran Zone in Colorado, Texas, Oklahoma, and eastern New Mexico.

Bernalillo: Albuquerque, G. Nisbet 41 (NM). Curry: South of Melrose, Wooton (S). De Baca: Ft. Sumner, Nisbet 40 (NM); Buchanan, Wooton (S). Guadalupe: Puerta de Luna, Bro. Arsene & Bro. Benedict 16648 (St); between Vaughn and Buchanan, Div. of Grazing, Smith (NM); between Santa Rosa and Pastura, Nisbet, 844 (NM). Otero: Jarilla, Cockerell (S). Roosevelt: Pep, Hershey (S). Sandoval: 30 miles southwest Santa Fe, Nisbet 664 (NM). Torrance: 5 miles east of Gran Quivera, Nisbet 750 (NM). Union: 25 miles southwest of Clayton, Nisbet 663 (NM); Clayton, Bartlett 237 (S).

19. PENSTEMON AMBIGUUS subsp. LAEVISSIMUS Keck

(Fig. 11)

Penstemon ambiguus subsp. laevissimus Keck, Jour. Wash. Acad. Sci. 29:491. 1939.

Differs from typical P. ambiguus only in being glabrous.

This species is found in southern New Mexico, east to Texas, and west to Arizona and Nevada. From Socorro County north and east, the typical form with puberulent stems is common, but from Socorro County south and west, P. ambiguus subsp. laevissimus with glabrous stems is more often found.

Luna: Deming, Hershey (S). Socorro: West of Rosedale, Division of Grazing (NM); Abeyas, Nisbet 756 (NM).

20. PENSTEMON THURBERI Torr.

(Fig. 11)

Penstemon thurberi Torr., U. S. Rep. Expl. Miss. Pacif. 7: 15. 1856.

Leiostemon thurberi Greene, Leaflets 1:223. 1906.

Stems 2-4 dm. high, branched, suffrutescent, glabrous; leaves 5-25 mm. long, linear, mucronate, glabrous, the edges usually inrolled but not ciliate; inflorescence paniculate, the opposite penduncles usually one-flowered; bracts resembling the leaves; calyx 2 mm. high, lobes ovate, acute, scarious-margined; corolla 10-12 mm. long, blue-purple throughout, lobes scarcely oblique, throat not curved but ventricose, pubescent at the base of lower lobes; anther-sacs very small, explanate; staminode glabrous, filiform.

Although P. thurberi and P. ambiguus are usually quite distinct, they definitely do intergrade in Socorro and Lincoln counties. A colony of such intergrades was found by this investigator about seventeen miles west of Socorro along the highway leading to Magdalena. These specimens (Nisbet 42, 43, 44 in NM,CI) show all gradations between the two extremes. Another colony was found three miles north of Carrizozo, Lincoln County, that contained many specimens (Nisbet 834 in NM,CI) which are intermediate between the two species.

Nevertheless, it has been thought best to retain P. ambiguus and P. thurberi as distinct species while this situation is being investigated further. Apparently hybridization between the two forms is infrequent and they are separated by a considerable number of morphological differences, as can be seen from the key and the descriptions above. Dr. Keck has suggested to this investigator that the two species are probably pollinated by different agencies, P. ambiguus by lepidoptera and P. thurberi hymenoptera. Since this is a matter that can be investigated and answered in the field, the answer must await further field work.

P. thurberi blooms from April to July, sometimes August, in the Upper and Lower Sonoran zones of southwestern New Mexico, Arizona, southern California, and northern Mexico.

Dona Ana: Aden, Wooton (S). Grant: Burro Mts., Antisell. Luna: Gage, Hershey (S).

21. PENSTEMON LINARIOIDES A. Gray

(Fig. 12)

Penstemon linarioides A. Gray in Torr., Bot. Mex. Bound. 112, 1859. "Organ mountains; Parry. Copper mines and Los Animos, New Mexico; Wright (1472), Thurber, (331, 1115), Bigelow. Sierra San Luis, Chihuahua and Sonora: Schott."

Stems 2-5 dm. tall, several, erect or ascending from a woody caudex, stems and leaves cinereous-puberulent with flattened scale-like hairs; leaves linear, mucronate, crowd-

ed on the bases of flowering stems and on the short sterile shoots, scattered on flowering stems above the base, reduced to subulate bracts in the inflorescence; inflorescence narrow, secund, usually one but occasionally two peduncles at a node, pedicels and calyces glandular-pubescent; calyx-lobes 4-5 mm. long, ovate, acute to short acuminate, widely scarious-margined, entire or erose; corolla 16-20 mm. long, bright blue with purplish or violet tube and deep purple guide-lines in the two-ridged throat, tube slender, throat abruptly and widely expanded, strongly bearded at base of lower lobes; anther-sacs oblong, opposite, dehiscent across the connective, not explanate, minutely denticulate on the edges; staminode not dilated, bearded for most of its length with bright yellow hairs which are often longer and tufted at the tip.

P. linarioides is a very variable species. Several more or less distinct forms occur in Arizona, but only the typical species and two subspecies are found in New Mexico. Typical P. linarioides is found in southwestern New Mexico and southeastern Arizona. A subspecies, P. linarioides subsp. maguirei, which is distinguished from the typical form by its oblanceolate leaves, occurs in the Gila Valley of New Mexico and Arizona. P. linarioides subsp. coloradoensis is found in the northwestern corner of the state.

P. linarioides blooms from June to August in canyons and foothills of the Upper Sonoran and Transition zones. In

New Mexico it is found south of San Juan County and west of the Rio Grande River, except in Dona Ana County where it is common east of the Rio Grande in the Organ Mountains.

Catron: 22 miles south of Luna, Turner & Nisbet 806 (NM). Dona Ana: Organ Mts. Hershey (S). Grant: Near Silver City, Turner & Nisbet 786, 787 (NM); 5 miles west of Silver City, Wooton (S). McKinley: North of Ramah, Wooton (S). Sierra: South Percha Canyon, Mimbres Mts. (F). Valencia: Mt. Taylor, E. F. Parker 1771 (S).

22. PENSTEMON LINARIOIDES subsp.

MAGUIRSI Keck

(Fig. 12)

Penstemon linarioides maguirei Keck, Bull. Torr. Club 64:378. 1937. "Type: Maguire, Richards & Moeller No. 11797 (Utah State Agriculture College Herbarium, No. 18872), collected on limestone cliff sides 1 mi. w. of Metcalf, Greenlee County, Arizona, June 5, 1935."

Similar to typical P. linarioides but the leaves oblanceolate, the lower 2.5-5 mm. wide, obtuse, acuminate to the base.[43]

This subspecies is known only from the Gila Valley of southeastern Arizona and southwestern New Mexico.

Grant: Gila Valley, Nov. 1880, Greene (Pomona College, Claremont, Calif.)[44]

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[43] David D. Keck, "Studies in Penstemon IV. The Section Ericopsis," Bulletin of the Torrey Botanical Club 64: 378, June, 1937.

[44] Loc. cit.

23. PENSTEMON LINARIOIDES subsp. COLORADOENSIS (A. Nels.) Keck

(Fig. 12)

Penstemon coloradoensis A. Nels., Bull. Torr. Club 26:355. 1899. "Of this species I have before me specimens from two collections made near Mancos, Colo., by Messrs. Baker, Earle, and Tracy, 1898 and distributed as P. caespitosus Nutt."

Penstemon linarioides subsp. coloradoensis (A. Nels.) Keck, Bull. Torr. Bot. Club 64:375. 1937.

Stems 1.5-3 dm. tall, numerous, tufted from a woody caudex; corolla 15-18 mm. long, lightly bearded at the base of the lower lobes; staminode bearded at the tip with bright yellow hairs and behind the apical tuft with sparse whitish or yellowish hairs.

This subspecies is frequently accorded specific status. It was reduced to synonomy in the Coulter-Nelson Manual[45] under P. linarioides. It was retained as a species by Pennell in Scrophulariacae of the Central Rocky Mountain States[46] and by Rydberg in Flora of the Rocky Mountains and Adjacent Plains.[47]

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[45] John M. Coulter and Aven Nelson, New Manual of Botany of the Central Rocky Mountains (New York: American Book Company, 1909), p. 446.

[46] Francis W. Pennell, "Scrophulariaceae of the Central Rocky Mountain States," Contributions from the United States National Herbarium, Vol. XX, Part 9, (Bulletin of the U. S. National Museum. Washington: Government Printing Office, 1920), p. 363.

[47] P. A. Rydberg, Flora of the Rocky Mountain and Adjacent Plains (New York: Published by the Author, 1917), p. 775.

FIGURE 12

DISTRIBUTION OF PENSTEMON LINARIOIDES A. GRAY (+), PENSTEMON LINARIOIDES SUBSP. MAGUIREI KECK (●), AND PENSTEMON LINARIOIDES SUBSP. COLORADOENSIS (A. NELS.) KECK (⊙)

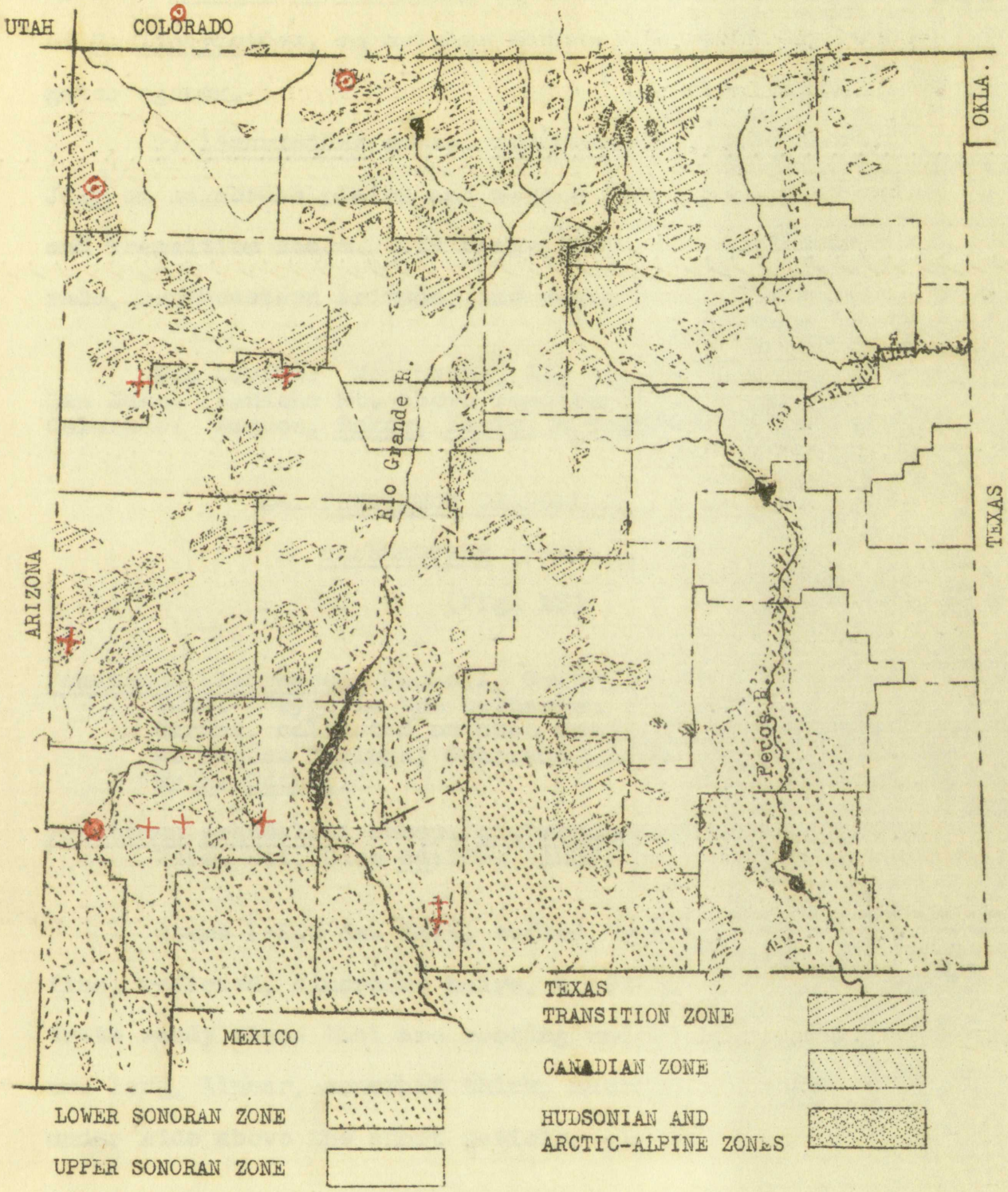
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 12

UTAH
COLORADO
NEW MEXICO
ARIZONA
TEXAS
OKLA.
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

Keck in Studies in Penstemon IV[48] considered it a subspecies of P. linarioides, an opinion with which the present investigator agrees.

P. linarioides subsp. coloradoensis blooms in June and July on sagebrush plains and wooded slopes of the Upper Sonoran and Transition zones. Its range includes southwestern Colorado, northeastern Arizona, and northwestern New Mexico.

Rio Arriba: Mountains, Rio Arriba Co., Baker (RM).
San Juan: Tunicha Mt. above Toadlena, McKelvey 4617 (CI).
Colorado: Mancos, Baker, Earle, & Tracy (S).

24. PENSTEMON CRANDALLII subsp. GLABRESCENS (Pennell) Keck

(Fig. 13)

Penstemon glabrescens Pennell, Contr. U. S. Nat. Herb. 20:375. 1920. "Type in the herbarium of the New York Botanical Garden, collected on open mesas and gravelly hillsides at Pagosa Springs, Colorado, in flower, July 2, 1917, by E. Bethel."

Penstemon crandallii subsp. glabrescens (Pennell) Keck, Bull. Torr. Bot. Club 64:369. 1937.

Stems 1-2.5 dm. tall, tufted, branched, pubescent with fine, reflexed, cinereous hairs, erect or ascending from prostrate woody stems that are rooting underneath; leaves 8-18 mm. long, linear, somewhat thick, mucronate, glabrous on the under side above the short petiole, glabrous or lightly puber-

[48] Keck, op. cit., pp. 375-76.

ulent on the upper side; inflorescence narrow, leafy, usually secund, glandular-pubescent; calyx-lobes 5-7 mm. long, broadly scarious-margined on the ovate base, the tips acuminate to caudate; corolla 15-20 mm. long, blue or violet-blue with darker guide lines, glandular-pubescent externally, throat moderately inflated, flattened and two-ridged ventrally, lower lip exceeding the upper and lightly bearded at the base; anther-sacs ovate, opposite, completely dehiscent, not explanate; staminode linear, bearded dorsally for most of its length with golden hairs which are longer and more dense at the tip.

This subspecies is distinguished from typical P. crandallii by its narrower and more crowded leaves, more prominently scarious-margined sepals, and slightly smaller corollas. In Colorado where they meet the distinctions are not sharply drawn. It is distinguished from P. linarioides subsp. coloradoensis by its leafy inflorescence, glabrous leaves, longer and more acuminate calyx-lobes, and narrower corollas.

P. crandallii subsp. glabrescens blooms in June, July, and early August on open rocky slopes in the Transition and Canadian zones. It is found in northcentral New Mexico and southern Colorado. In New Mexico this subspecies occurs in Colfax, Taos, and Rio Arriba counties.

Colfax: Moreno Valley, G. Nisbet 36, 862, (NM,CI).

Rio Arriba: East of Regina, Cleon Mankin 854 (NM); Near El Vado Lake, Cleon Mankin 850 (NM,CI); Coyote, Hershey (S). Taos: Top of U. S. Hill, G. Nisbet 37 (NM,CI); 2 mi. N. of San Cristobal, G. Nisbet 662 (NM,CI); Red River Box Canyon, G. Nisbet 661 (NM); Near Penasco, Hershey (S); Near Tres Piedras, Martin 245 (CI); Taos Canyon, G. Nisbet 859 (NM).

25. PENSTEMON CRANDALLII subsp. GLABRESCENS var. TAOSENSIS (Keck) comb. nov.

(Fig. 13)

Penstemon linarioides subsp. taosensis Keck, Bull. Torr. Bot. Club 64:373. 1937. "Type: Aven Nelson and Ruth A. Nelson No. 158 (University of California, No. 800219), collected between Questa and Taos, Taos County, New Mexico, July 30, 1932."

Penstemon crandallii subsp. glabrescens var. taosensis (Keck) Nisbet, comb. nov.

Similar to P. crandallii subsp. glabrescens but the leaves puberulent with fine erect or retrosely spreading hairs.

After considerable study this investigator has decided that, except for the puberulence on the leaves, this variety is identical with P. crandallii subsp. glabrescens with which it grows. Although the quadrinomial is awkward, it has been thought best to express it thus; it is evidently most closely related to P. crandallii subsp. glabrescens and not to typical P. crandallii or P. linarioides.

This variety has been found in Taos County only, where it is associated with P. crandallii subsp. glabrescens.

FIGURE 13

DISTRIBUTION OF *PENSTEMON CRANDALLII* SUBSP. *GLABRESCENS* (PENNELL) KECK (+) AND *PENSTEMON CRANDALLII* SUBSP. *GLABRESCENS* VAR. *TAOSENSIS* (KECK) COMB. NOV. (⊙)

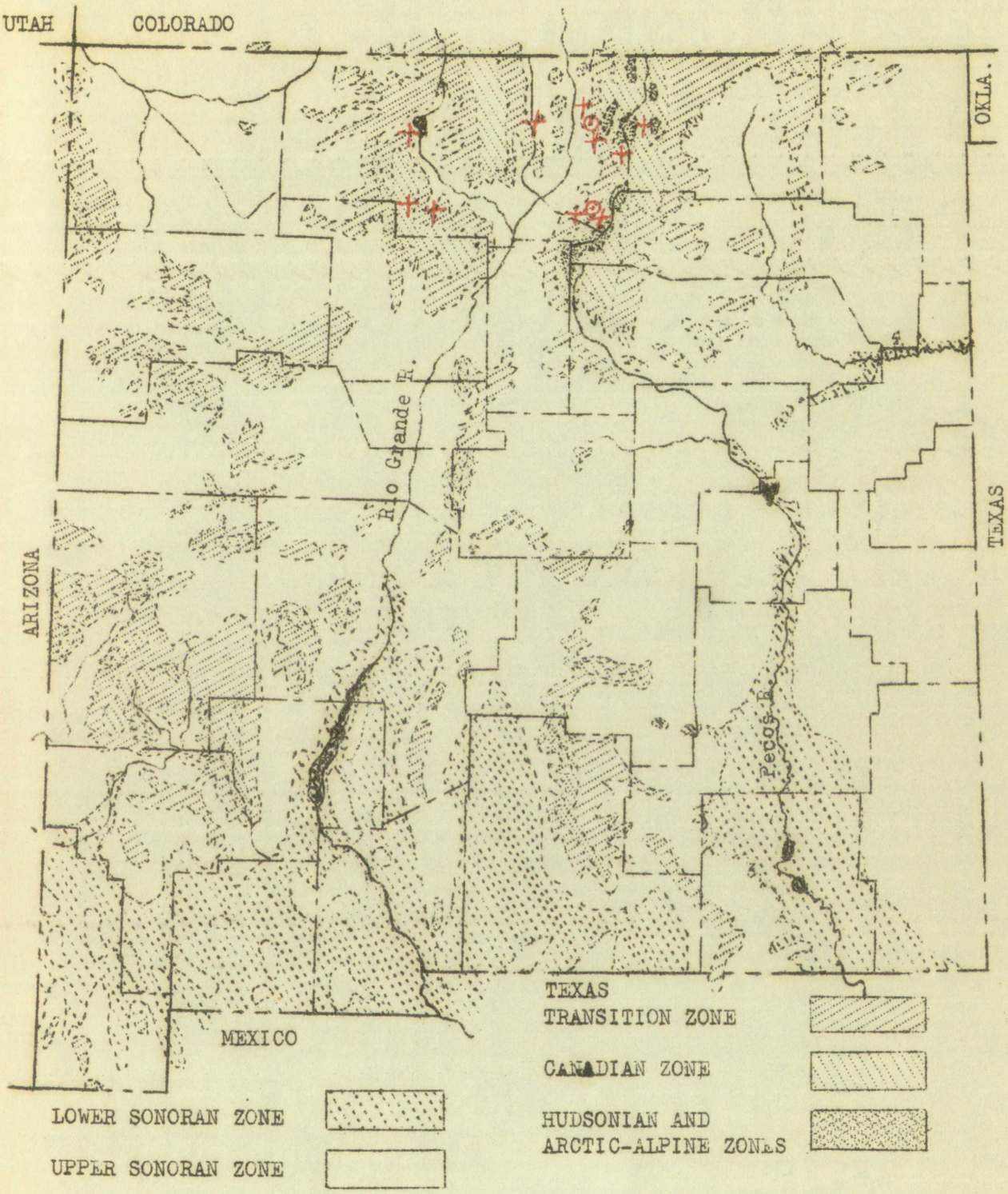
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 13

UTAH
COLORADO
NEVADA
ARIZONA
MEXICO
TEXAS
TRANSITION ZONE
OAKLEIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

Taos: North of San Cristobal, Nisbet 38 (NM,CI); U. S. Hill, Nisbet 36 (NM,CI).

26. PENSTEMON WHIPPLEANUS A. Gray

(Fig. 14)

Penstemon glaucus stenosepalus A. Gray, Proc. Amer. Acad. 6: 70. 1862. "Rocky Mountains, about Pikes Peak, Clear Creek, etc., Dr. James in herb. Torr., Dr. Parry, 261, 262, and coll. 1862, distributed by Hall and Harbour, 399."

Penstemon whippleanus A. Gray, Proc. Amer. Acad. 6:73. 1862. "Arroyos in the Sandia Mountains, New Mexico, east of the Rio Grande, Dr. J. M. Bigelow, in Whipple's Expedition, Oct. 1853."

Penstemon stenosepalus Howell, Fl. Northw. Amer. 1:514. 1901.

Penstemon metcalfei Woot. & Standl., Torreya 9:145. 1909. "On sandy slopes at the Lookout Mine, Sierra County, New Mexico. Type collected by Metcalfe No. 1605."

Stems 2-6 dm. tall, few or several, slender, ascending to erect from woody horizontal rootstocks, puberulent or glabrous; leaves entire or obscurely denticulate, thin, glabrous; basal leaves ovate, spatulate, or lance-ovate, with long petioles; cauline leaves 3-9 cm. long, 6-20 mm. wide, lanceolate (sometimes lance-oblong); inflorescence glandular-pubescent, composed of 2-5 verticillasters which are usually widely separated by the long internodes, the lowest peduncles often elongated; bracts leaf-like but reduced upward; calyx-lobes 7-12 mm. long, lanceolate to attentuate, glandular-pubescent, very narrowly scarious-margined near the base; corolla 22-30 mm. long, dull red-purple or blue-purple,

glandular-pubescent exteriorly, throat rather abruptly dilated, the villose lower lip projecting and longer than the upper lip; anther-sacs confluent, explanate, longer than broad; staminode somewhat dilated at the apex, glabrous or with a few short yellowish-white hairs at the tip.

This species has been given a number of names in different localities probably due to certain variations that occur. The staminode may be glabrous or lightly bearded in material from the same locality. Type material has glabrous staminodes which resulted in some confusion. The stems are glabrous or puberulent and the corolla varies in color. Pennell writes of P. whippleanus thus:

> Occurs in several apparently distinct color forms, separable only by field observation. Through Colorado and Utah mountains red-violet is prevalent, but high on some mountains -- e.g., Pikes Peak -- a very pale greenish brown form occurs. In the Wasatch Mountains I have seen the color lavender, but Watson says that this is not the prevalent form. In the Teton Mountains, Wyoming, (Nelson 100) a blue form exists.[49]

In Arizona and New Mexico the purplish form is found. So far no form has been found distinct or consistent enough to be set off as a subspecies.

P. whippleanus blooms usually from June to August, although the type material was collected in October. It is found on wooded or grassy slopes from the Transition to the Hudsonian zones in Wyoming, Idaho, Colorado, Utah, Arizona,

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[49] Pennell, op. cit., p. 377.

FIGURE 14

DISTRIBUTION OF *PENSTEMON WHIPPLEANUS* A. GRAY

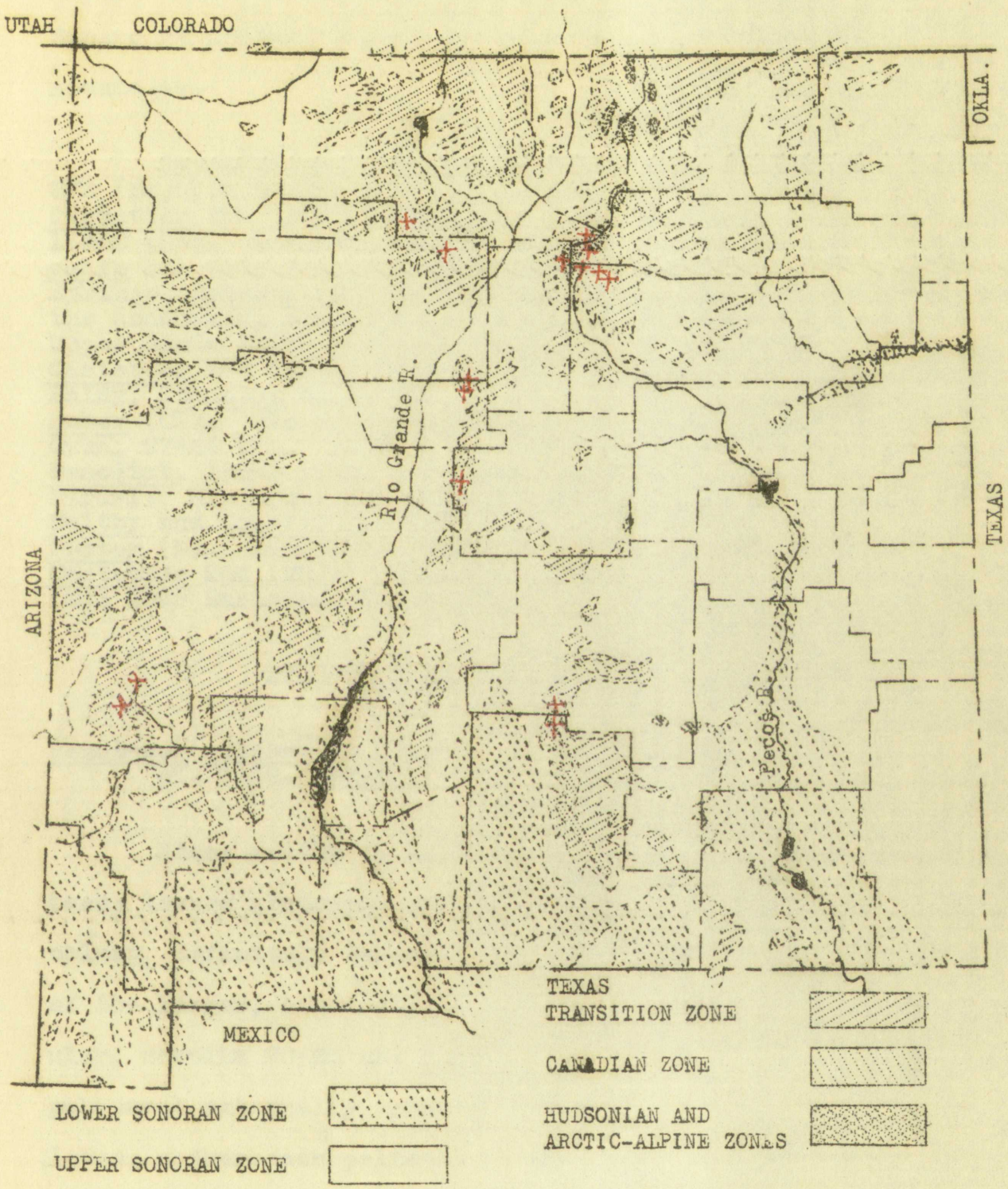
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 14

UTAH
COLORADO
NEW MEXICO
ARIZONA
TEXAS
TRANSITION ZONE
UPPER SONORAN ZONE
LOWER SONORAN ZONE

and New Mexico. In New Mexico this species is found in the Sangre de Cristo, Jemez, Sandia, Manzano, White, and Mogollon mountains.

Bernalillo: Cienega Canyon, Sandia Mts., Nisbet 23, 873 (NM,CI); Sandia Rim Road, G. Nisbet 24, A. Nelson 434, Castetter 853 (NM); Sandia Mts., Bro. Arsene & Bro. Benedict 16340 (St). Catron: West Fork of Gila, Mogollon Mts., Metcalfe 541 (S); Mogollon Road, Wooton (S). Lincoln: Cold Springs, Hershey (S); White Mt. Peak, Worth (NM); Head of the Rodamaker, 50842 (F); White Mt. Peak, Wooton (S). Mora: Upper Santa Barbara Canyon, Nisbet 25 (NM); Pecos Baldy, Castetter 799 (NM); Truchas Peak, Standley 4785 (S); Pecos Baldy, Standley 4310 (S). Otero: Summit of Sierra Blanca, Huber (CI). Rio Arriba: Rio Palomas watershed, east of Cuba, 27484 (F). Santa Fe: Lake Peak, Bro. Arsene and Bro. Benedict, 15583 (St); Lake Peak, Castetter 1642 (NM). San Miguel: Elk Mountain, Standley 4595 (S); Upper Pecos River, Maltby and Coghill 194 (S); Beulah (Northwest San Miguel Co.) Porter (S). Sandoval: Jemez, Hershey (S); Redondo Peak, Castetter 244 (NM). Torrance: Manzano Mts., Castetter 782 (S); Near Eastview, Manzano Mts., Wooton (S).

27. PENSTEMON PULCHELLUS Lindl.

Penstemon pulchellus Lindl., in Edwards' Bot. Reg. 14: pl. 1138. 1528.

Stems medium in height, pubescent, somewhat woody at base; leaves glabrous, of two sorts, the larger lanceolate or oblong, definitely serrate, the smaller fascicled in the axis of the larger, obscurely toothed; inflorescence loose, glandular, corolla 20-25 mm. long, inflated, slightly glandular pubescent externally, somewhat pubescent at base of lower lobes; anther-sacs peltately explanate; staminode dilated and bearded at the tip with a tuft of short yellow hairs.

The above description is incomplete, because this investigator has had no opportunity to study specimens of this species. Specimens of P. campanulatus (Cav.) Willd., a closely allied species with maroon-red corollas from the highlands of central Mexico, have been seen and studied. The following extract from a letter from Dr. D. D. Keck to the present investigator helps clear this situation.

> The more northern plant which enters southern New Mexico is P. pulchellus Lindl., differing from P. campanulatus in 'its corolla being paler, more inflated, and destitute of glands, which abound on the corolla of P. campanulatus. The leaves of this plant are also less finely toothed, not so acuminate, and of a more oblong figure.' (Quotation from Lindley.) His plate shows a whitish corolla veined with pink, with somewhat glandular sepals and presumably somewhat glandular corolla, ... The sheets in this herbarium show no difference in glands between northern and southern material. All have some glands on the exterior of the corolla. The material here of pulchellus in which the color was noted state: corolla violet above, pale beneath.[50]

The corollas of P. campanulatus are maroon-red in color and gradually and moderately inflated; the leaves are sharply serrate, lanceolate and acuminate. Lindley's quotation above cites the differences of P. pulchellus.

This species probably comes into extreme southwestern New Mexico in the mountains. No recent collections have been made, but Wooton and Standley state that it was collected in the San Luis Mountains by Mearns.[51] No distribution map is

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[50] Personal Correspondence of Author, letter from Dr. D. D. Keck, Carnegie Institution of Washington, Stanford University, California, September 12, 1940.

[51] Wooton and Standley, op. cit., p. 585.

included.

28. PENSTEMON ALBIDUS Nutt.

(Fig. 15)

Penstemon albidus Nutt., Gen. Pl. N. Amer. 2:53. 1818. "On the plains of the Missouri, common, from the confluence of the river Platte to the mountains."

Stems 2-4 dm. tall, few or several, erect, puberulent; leaves scabrous-puberulent, entire or obscurely toothed, blades of the cauline leaves lanceolate, those of the basal rosette petiolate and tapered to both ends; inflorescence glandular-pubescent, narrow, leafy-bracted, verticillasters many-flowered, peduncles and pedicels very short; calyx-lobes lanceolate, 7-10 mm. long, densely glandular-pubescent; corolla 12-22 mm. long, white or sometimes shaded with violet especially on the lobes, glandular pubescent without and within, throat gradually expanding, moderately inflated, lobes spreading; anther-sacs glabrous, peltately explanate; staminode bearded with flattened yellow hairs at and near the tip, not dilated.

P. albidus is easily distinguished from the related species of northwestern New Mexico thus: from P. auriberbis by its peltately explanate anthers, from P. jamesii by the gradually expanding throat and absence of bearding at the base of the lower lobes.

This species is in flower from early May to early July, depending on latitude and altitude. In New Mexico the bloom-

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NEW MEXICO LIBRARY
ALBUQUERQUE, N.M.

FIGURE 15

DISTRIBUTION OF PENSTEMON ALBIDUS NUTT.

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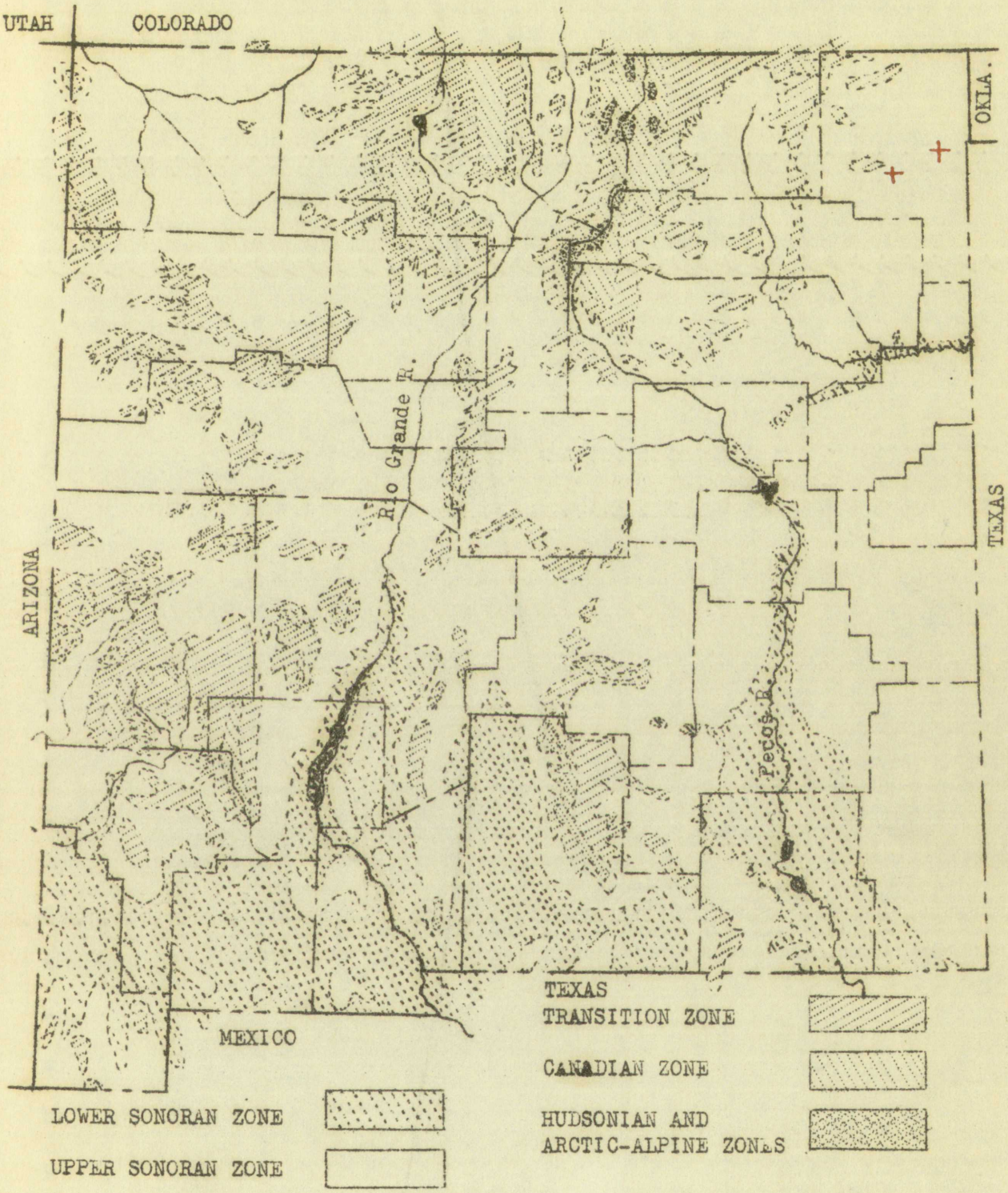
ALBUQUERQUE, N.M.


UTAH
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Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 15

UTAH
COLORADO
NEVADA
ARIZONA
NEW MEXICO
TEXAS
Colorado

ing period is from late May to early June. This is an unusually widespread species that occurs on the prairies and plains from southern Manitoba, Saskatchewan, and Alberta southward to Oklahoma, Texas, and northeastern New Mexico.

Union: 32 miles west of Clayton, Mankin 855 (NM,CI); 2 miles west of Clayton, Mankin 856 (NM,CI).

29. PENSTEMON JAMESII Benth.

(Fig. 16)

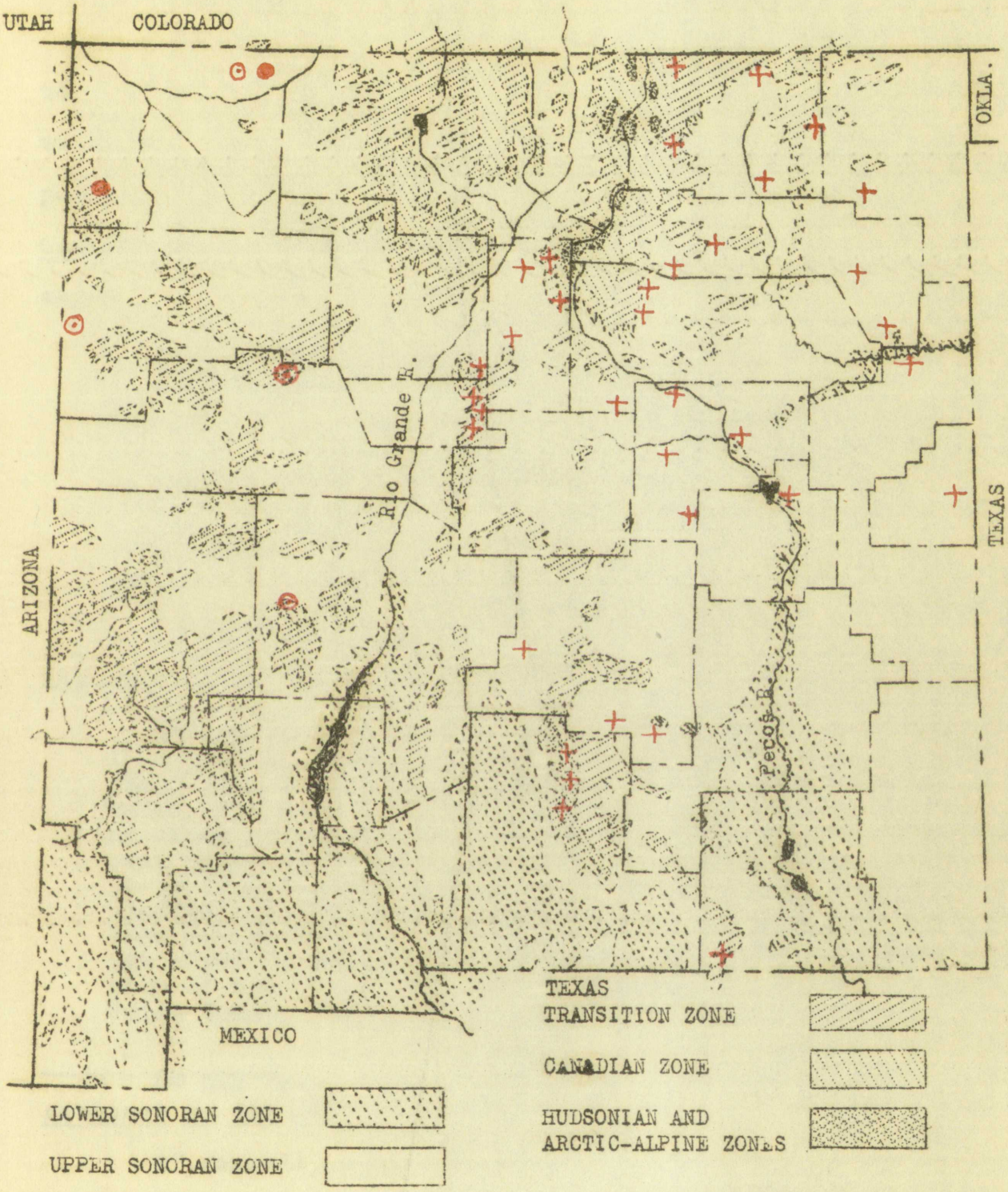
Penstemon jamesii Benth., in D.C., Prod. 10:325. 1846. "In Montibus Scopulosis (James in Itinere Longii)"

Penstemon similis A. Nels., Bull. Torrey Club. 25:548. 1898.

Stems 1-4.5 dm. tall, sometimes solitary but usually several, glabrate or puberulent; leaves linear to lanceolate, 2-12 cm. long, 2-20 mm. wide, entire or undulately serrate, glabrous or puberulent; inflorescence narrow, secund, glandular-pubescent; calyx-lobes narrowly to broadly lanceolate, acuminate, entirely herbaceous or narrowly scarious-margined, corolla 25-35 mm. long, 10-15 mm. wide, pale lavender to blue-violet, with prominent guide lines, throat broadly ampliate and ventricose, upper lip projecting, lower lip somewhat reflexed, glandular-pubescent within and prominently bearded with long whitish hairs at the orifice; anther-sacs peltately-explanate, as broad as long; staminode exserted, with a tuft of long yellowish-white hairs at the tip and

FIGURE 16

DISTRIBUTION OF PENSTEMON JAMESII BENTH. (+), PENSTEMON JAMESII SUBSP. OPHIANTHUS (PENNELL) KECK (⊙) AND PENSTEMON JAMESII SUBSP. BREVICULUS KECK (●)


UTAH
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MEXICO
Rio Grande R.
Pecos R.
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 16

UTAH
COLORADO
NEVADA
ARIZONA
MEXICO
LOWER SONORAN ZONE
UPPER SONORAN ZONE

shorter reflexed yellow hairs to below the middle.

Asa Gray, in Synopsis of the Genus Penstemon, gives the range of P. jamesii as "Eastern side Rocky Mts. and vicinity, to New Mexico (575, 579, Fendler) and the adjacent parts of Texas."[52] Pennell in Scrophulariaceae of the Central Rocky Mountain States in discussing P. auriberbis says:

> This species [P. auriberbis] has been identified as P. jamesii Benth., but examination of the type of that species, in Torrey's herbarium (Columbia University Herbarium) at the New York Botanical Garden, shows that his name [P. jamesii] should replace P. similis A. Nels. P. similis occurs on the Staked Plains of eastern New Mexico and northwestern Texas, and it was doubtless on these or in nearby western Oklahoma, while on the return route of Long's expedition, that Doctor James collected his plant.[53]

In Studies in Penstemon VI. The Section Aurator, Keck has this to say on the same subject:

> Nelson redescribed this New Mexican species under this name [P. similis], believing that P. jamesii was the plant of the Red Desert of southwestern Wyoming, which, instead is P. cleburnei Jones. The first number he cites is Fendler 575, which was probably collected near Santa Fe . . . . The route followed by James' party from the Arkansas River in Colorado near the vicinity of what is now La Junta, was straight south into New Mexico veering easterly to strike the Canadian River in western Texas. Apparently the only portion of New Mexico traversed by the party lies now in Union County and we suspect the type came from there.[54]

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[52] Asa Gray, "Synopsis of the Genus Penstemon," Proceedings of the American Academy of Arts and Sciences 6:67,1866.

[53] Pennell, op. cit., p. 340.

[54] David D. Keck, "Studies in Penstemon VI. The Section Aurator," Bulletin of the Torrey Botanical Club, 65:239-40, April, 1938.

P. jamesii is a very variable species as to height of plant, puberulence of stems and leaves, width and length of leaves, amount of serration of leaves, length of sepals, length of internodes of stem and inflorescence, and even the length and amount of inflation of the corollas. On the other hand, the inflorescence is always glandular-pubescent, the lower lip is always villose (except in P. jamesii subsp. breviculus), and the staminode is exserted and has the characteristic bearding. None of the above stated variations in specimens from east of the continental divide has been found to be constant over any particular area so as to warrant setting off any form as a subspecies. For instance, specimens from Lincoln and Otero counties are generally 3-4.5 dm. tall with long internodes and linear, practically glabrous leaves; but plants answering this description can also be found in Santa Fe County. However, specimens from west of the continental divide have consistently smaller corollas, thus dividing the species into eastern and western sections; the western members forming the subspecies P. ophianthus.

P. jamesii blooms in May and June on the plains and in the foothills of the Upper Sonoran Zone, also occasionally in open meadows in the Transition Zone. This species is the most common and plentiful penstemon found in New Mexico east of the Rio Grande River. Its range also includes western Texas.

Bernalillo: Sandia Mts., foothills on the east, Nisbet 650 (NM); Forest Park, A. Nelson 1265 (NM); 1-5 miles south of Tierras, Cedro Canyon, Nisbet 724 (NM). Colfax: Springer, Nisbet 671, 126 (NM,CI); southwest of Capulin, Nisbet 649 (NM); Ute Park, Nisbet 652 (NM,CI); Vermejo, Gooding 18 (CI); Raton, Susan McKelvey 4861 (CI). Curry: North of Clovis, Nisbet (NM). De Baca: 5 miles north Ft. Sumner, Nisbet 829 (NM); Eddy: Guadalupe Mts. Hershey (S). Guadalupe: Dilia, Nisbet 819 (NM); Pastura, Nisbet 845 (NM); 15 miles southeast Vaughn, Nisbet 847 (NM). Harding: David Hill, Nisbet 65 (NM); Mosquero, Nisbet 647 (NM). Lincoln: Bonnell's Ranch, Glencoe, Worth (NM); San Patricio, Nisbet 833 (NM,CI); 3 miles north of Carrizozo, Nisbet 840 (NM). Mora: Coyote Creek, Nisbet 3 (NM); Between Wagon Mound and Las Vegas, McKelvey 4909 (CI). Otero: Head of Alamo Canyon, Nisbet & Mankin 837 (NM); High Rolls, Nisbet & Mankin 838 (NM,CI); Mescalero, Nisbet and Mankin 841 (NM). Quay: Logan, Nisbet 648 (NM). Sandoval: southwest of Golden, Nisbet 722 (NM). San Miguel: south of Romeroville, Nisbet 823 (NM); Las Vegas, Emerson (Herb. of Highlands U.). Santa Fe: Glorietta, Nisbet 5 (NM,CI); Santa Fe Hills, Bro. Benedict 15463 (St); Near Turquoise Mines, Nisbet 721 (NM); Near Tesuque, Hershey (S). Torrance: Gran Quivera, Nisbet 749 (NM). Union: East of Farley, Nisbet 4 (NM).

30. PENSTEMON JAMESII subsp. OPHIANTHUS

(Pennell) Keck

(Fig. 16)

Penstemon ophianthus Pennell, Contr. U. S. Nat. Herb. 20: 343. 1920. "Type in the U. S. National Herbarium No. 327015, collected at Thurber, Utah, altitude 2,100 meters, in flower and fruit, August 1, 1894, by M. E. Jones (No. 5708; distributed as P. moffatti Eastw.) Isotypes in herbaria of Missouri Botanical Garden and New York Botanical Garden."

Penstemon pilosigulatus A. Nels., Univ. Wyom. Pub. Bot. 1: 130. 1926. "This also was secured near Flagstaff, Arizona, and is reported by Mr. Hanson from 'the Canadian Zone and above.' His No. 554, June 6, 1923, is the type."

Penstemon jamesii subsp. ophianthus (Pennell) Keck, Bull.

Torr. Bot. Club. 65:240. 1938.

Distinguished from typical P. jamesii by the smaller corollas, 17-22 mm. long, 7-10 mm. wide.

This subspecies is found west of the continental divide in western Colorado, southern Utah, northern Arizona, and western New Mexico. In New Mexico it is also found east of the continental divide in Socorro and Valencia counties but west of the Rio Grande River.

McKinley: West of Gallup, McKelvey 4593 (CI). San Juan: 4 miles north of Aztec, Aztec Ruins Natl. Monu. Socorro: Santa Monica Ranger Station, Nisbet 762 (CI). Valencia: San Mateo, Mount Taylor, Castetter 1794 (RM).

31. PENSTEMON JAMESII subsp. BREVICULUS Keck

(Fig. 16)

Penstemon jamesii subsp. breviculus Keck, Bull. Torr. Bot. Club 65:241. 1938. "Type: Baker, Earle, & Tracy 410, collected on dry plains below Mancos, Montezuma County, Colorado, July 8, 1898. Pomona College Herbarium, Number 7232."

Distinguished from typical P. jamesii by the small, scarcely inflated corollas without glands within the limb or throat, corolla 14-16 mm. long, 5-6.5 mm. wide.

In his discussion of this subspecies Keck makes the following statements:

Possibly careful field study would demonstrate that

this unit is fully deserving of specific rank. On the present data, however, it appears to compose a natural subspecies, the small, scarcely inflated corollas, without glands within the limb or throat, being a constant characteristic of the collections cited and differing appreciably from all others in the species. Pennell cited the type collection under his P. ophianthus, but the two do not overlap in corolla-size. It is true that the type collection of P. ophianthus and Payson 347, from Naturita, Colorado, both from the periphery of the subspecies and not typical of the unit, have very few glands within the lower lip; but normally P. jamesii subsp. ophianthus is obviously glandular on the lower lip.[55]

This subspecies occurs in southwestern Colorado and northwestern New Mexico. It is spring blooming, as are the other closely related forms.

San Juan: Aztec, Baker 601 (S).

32. PENSTEMON DASYPHYLLUS A. Gray

(Fig. 17)

Penstemon dasyphyllus A. Gray in Torr., Bot. Mex. Bound. 112. 1859. "Stony hills of the Pecos, and Cook's Spring, New Mexico; Wright, (1478). Valley of the Santa Cruz River on mountain sides, and in the valley of the San Pedro, Sonora; Capt. E. K. Smith, Bigelow & Thurber. Also collected by Dr. Woodhouse in Sitgreave's Expedition."

Stems 2-5 dm. tall, few to many, covered with short, thick cinereus pubescence; leaves 4-10 cm. long, linear-attentuate, usually densely cinereus-pubescent but sometimes only lightly so; inflorescence densely glandular-pubescent,

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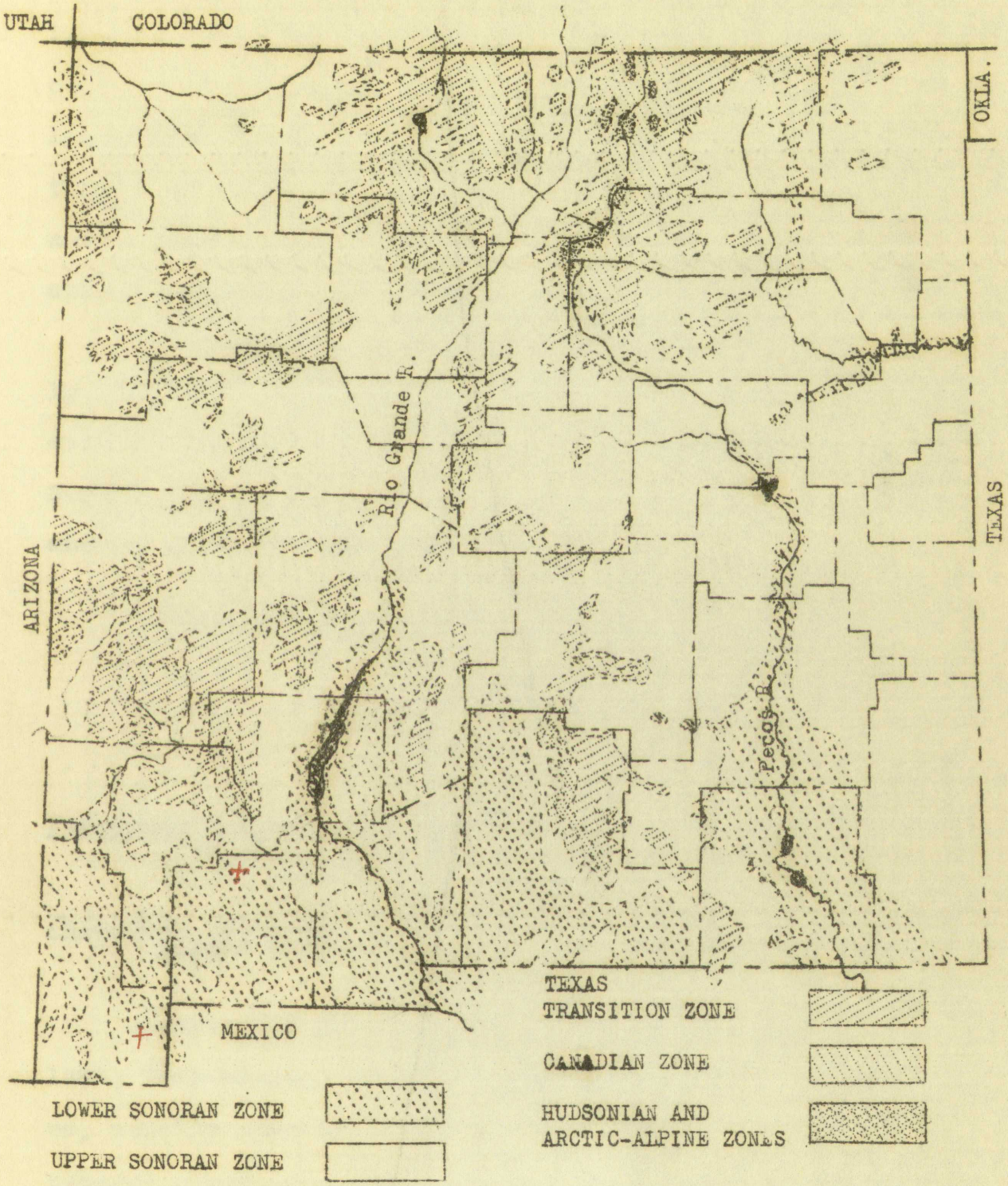
[55] Ibid., pp. 241-42.

FIGURE 17

DISTRIBUTION OF *PENSTEMON DASYPHYLLUS* A. GRAY


UTAH
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Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 17

UTAH
COLORADO
NEVADA
ARIZONA
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

strict, the mostly one-flowered peduncles erect; calyx-lobes narrowly ovate or oblong-lanceolate, entirely herbaceous or very narrowly scarious-margined; corolla 25-32 mm. long, blue, glandular-pubescent externally, tube short, throat much inflated, lower lobes longer than the upper; anther-sacs completely dehiscent, deep, not explanate, spinose-dentate on the edges; staminode not dilated, glabrous.

This species flowers in April and May on open gravelly slopes in the Upper and Lower Sonoran zones of southeastern Arizona, southwestern New Mexico, southwestern Texas, Sonora, and Chihuahua. Cook's Spring, New Mexico, mentioned above, is in northern Luna County.

Hidalgo: Hatchet Mts., Div. of Grazing, Woods (NM).

33. PENSTEMON GRACILIS Nutt.

(Fig. 18)

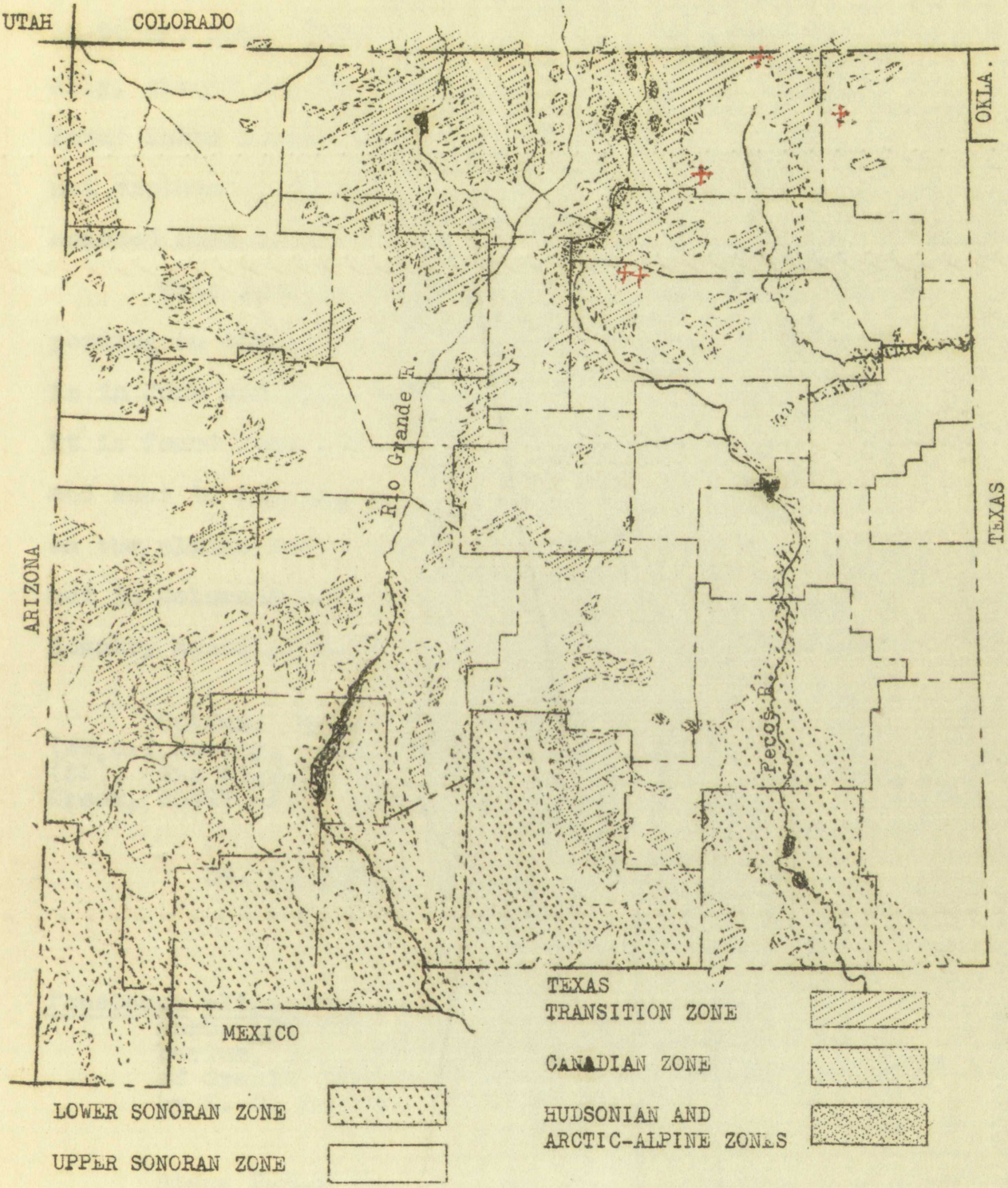
Penstemon gracilis Nutt., Gen. N. Amer. Pl. 2:52. 1818. "From the Arikarees [South Dakota] to Fort Mandan [North Dakota] in depressed soils."

Penstemon pubescens gracilis A. Gray, Proc. Amer. Acad. 6:69. 1862-63.

Stems 2-4 dm. tall, solitary or few, slender, puberulent; leaf-blades, except the uppermost, glabrous or nearly so, usually sharply serrate, linear to lanceolate; inflorescence glandular-pubescent, strict, peduncles erect; calyx-lobes 4-5 mm. long, ovate, acute, glandular-pubescent, very

FIGURE 18

DISTRIBUTION OF *PENSTEMON GRACILIS* NUTT.


UTAH
COLORADO
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Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 18

UTAH
COLORADO
NEVADA
ARIZONA
MEXICO
Colorado R.
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

slightly scarious-margined or entirely herbaceous; corolla 15-20 mm. long, pale violet-blue, glandular-pubescent externally, throat narrow, flattened and strongly ridged within, lower lobes longer than the upper ones; anther-sacs narrow, not explanate, denticulate on the edges; staminode narrow, bearded most of its length with deep yellow hairs.

This species blooms from late May to early August depending on the latitude; in New Mexico the blooming period is in June and July. P. gracilis has quite a large range as it is found from Alberta and Saskatchewan south to New Mexico and east to Wisconsin. It grows in sandy or gravelly soils on the plains and prairies in the northern part of its range, but in Colorado and New Mexico it is found in the foothill country associated with the western yellow pine.

Colfax: 30 miles west of Springer, G. Nisbet 18 (NM,CI) Morley, Colorado, to Raton, N. Mex., Mollins 1817 (CI). San Miguel: Beulah, Porter (S) San Miguel: Dailey Creek, 43397 (F). Union: Sierra Grande, Nisbet 776 (NM,CI).

34. PENSTEMON OLIGANTHUS Woot. & Standl.

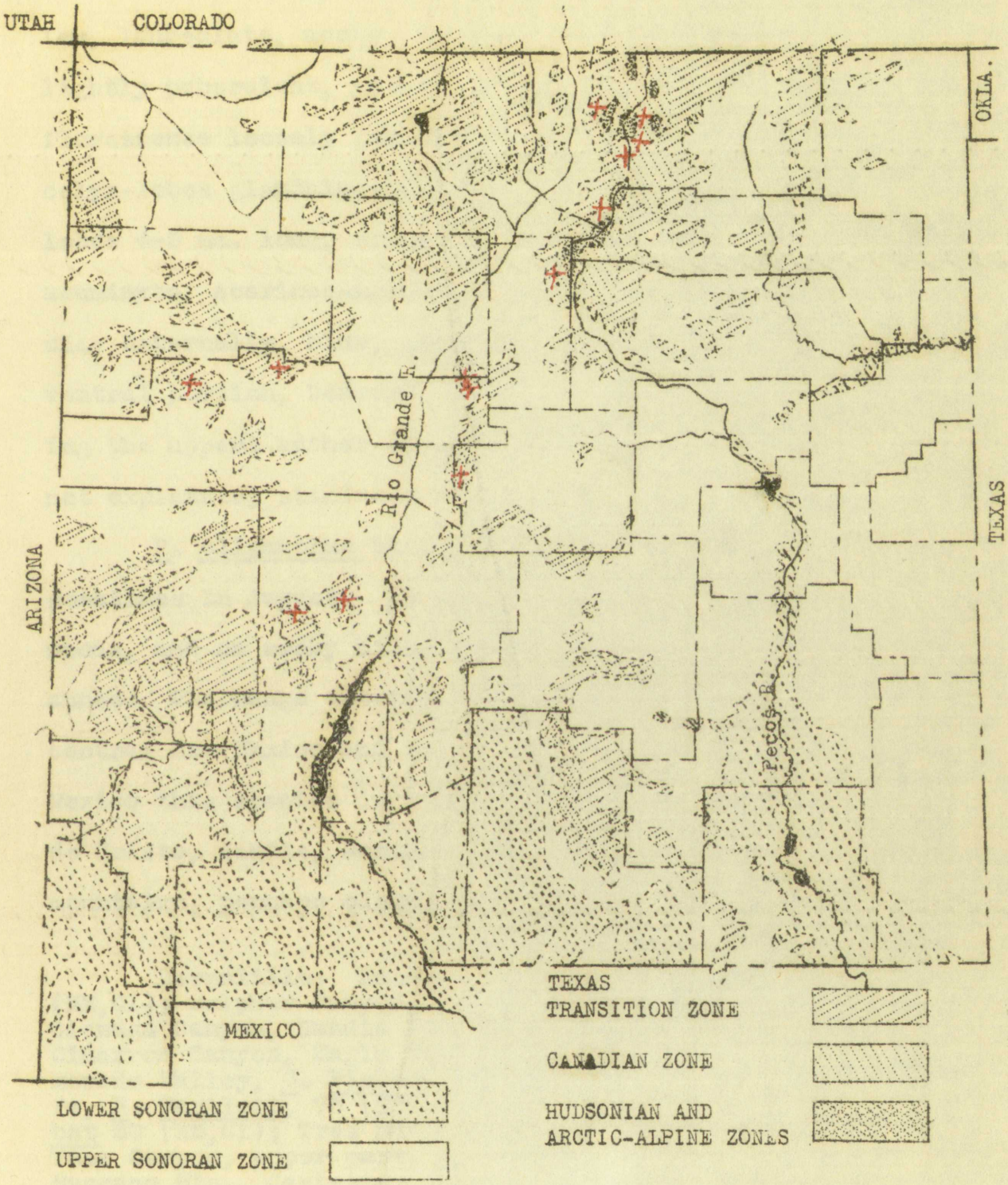
(Fig. 19)

Penstemon oliganthus Woot. and Standl., Contr. U. S. Nat. Herb. 16:172. 1913. "Type in U. S. National Herbarium, No. 259061, collected in the mountains west of Grants Station [Valencia County] August 1, 1892, by E. O. Wooton."

Stems 2-4.5 dm. high, solitary or few, from a small basal rosette, slender, erect, puberulent; basal leaves ovate

FIGURE 19

DISTRIBUTION OF PENSTEMON OLIGANTHUS WOOT. & STANDL.


UTAH
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Pecos R.
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TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 19

UTAH
COLORADO
NEVADA
CALIFORNIA
ARIZONA
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

to oblanceolate, obtuse or acute, petiolate; cauline leaves few, lanceolate, acute, erect, rather thick, glabrous to lightly puberulent, mostly shorter than the internodes; inflorescence loosely few-flowered, peduncles, pedicels, and calyx-lobes glandular-pubescent; bracts much reduced; calyx-lobes 4-5 mm. long, elliptic-oblong to lanceolate, acute to acuminate, scarious-margined; corolla 20-25 mm. long, glandular externally, blue, much paler on the strongly two-ridged ventral portion, bearded in the throat, the lower lip exceeding the upper; anther-sacs narrow, completely dehiscent but not explanate; staminode strongly bearded with yellow hairs.

P. oliganthus blooms from late June through July, sometimes in August. It grows in grassy meadows, open pine woods, and on rocky hillsides in the Transition and Canadian zones. The range extends from central Colorado south to central New Mexico and west to eastcentral Arizona. In New Mexico this species is found on Mount Taylor and in the Sangre de Cristo, Sandia, Manzano, Magdalena, San Mateo, and Zuni mountains, perhaps elsewhere.

Bernalillo: Sandia Rim, open meadows, G. Nisbet 22 (NM,CI); Sulphur Canyon, Sandia Mts., Castetter, 130 (NM); Cienaga Canyon, Sandia Mts. G. Nisbet 725 (NM). Colfax: Cimarron Canyon, Eagle Nest Pass, G. Nisbet 19 (NM,CI); Moreno Valley, G. Nisbet 866 (NM). Santa Fe: Near Santa Fe, F. Bartlett, 73 (S). Taos: 5 mi. below Questa, G. Nisbet 20 (NM,CI); Tres Ritos Canyon, G. Nisbet 21 (NM,CI); Taos Canyon, upper part, G. Nisbet 861 (NM). Torrance: Manzano Mts., Castetter 783 (NM). Socorro: Magdalena Mts., Hop Canyon; G. Nisbet 758 (NM,CI); Monica Canyon, San Mateo Mts., G. Nisbet 760 (NM,CI). Valencia: Lee's Horse Camp, Mt. Taylor, A. Nelson 1813 (NM); Mts. west of Grants Station, Wooton 327 (S).

35. PENSTEMON AURIBERBIS Pennell

Penstemon auriberbis Pennell, Contr. U. S. Nat. Herb. 20:339. 1920. "Type in the herbarium of the New York Botanical Garden, collected on a dry sandy sage brush slope, east of Fountain Creek, northeast of Pueblo, Pueblo County, Colorado, altitude about 1,400 meters, in flower, June 5, 1915, by F. W. Pennell (No. 5731)."

Stems 10-25 cm. tall, erect, solitary to several, cinereous-puberulent; basal leaves petiolate, 2-6 cm. long, narrow; cauline leaves linear to linear-lanceolate, 4-10 cm. long, 2-9 mm. wide, entire or nearly so, puberulent or sometimes almost glabrous; inflorescence narrow, strongly glandular-pubescent; bracts leaf-like, more or less glandular-pubescent; calyx-lobes 7-9 mm. long, linear-lanceolate, acuminate; corolla 18-25 mm. long, 7-8 mm. wide (pressed), pale lavender to purplish-blue, glandular without but not within, throat ampliate, lobes spreading, lower lip lightly bearded at the base; anther-sacs opposite, opening almost throughout, not explanate, the edges minutely denticulate; staminode more or less exserted, slightly dilated apically, densely bearded for its entire length with long, deep yellow hairs.

P. auriberbis is in flower in late May and June on sage brush slopes and in the foothills associated with scrub oak and juniper. It is found in the Upper Sonoran Zone in southern Colorado east of the Rio Grande and northeastern New Mexico close to the Colorado line. No distribution map has been included; collections have been made only at one

location in New Mexico.

Union: Emory Gap, northwestern corner of county, G. Nisbet 712 (NM,CI).

36. PENSTEMON RYDBERGII A. Nels.

(Fig. 20)

Penstemon rydbergii A. Nels., Bull. Torrey Club 25:281. 1898. "It was met with in abundance in an aspen grove in a draw in the Laramie Hills, July 1, 1897. Type specimen collected at Green Top, in Herb. University of Wyoming, A. Nelson No. 3214."

Penstemon erosus Rydb., Bull. Torrey Club 28:28. 1901. "Colorado: Indian Creek Pass, 1900, F. K. Vreeland, 615."

Penstemon lacrellus Greene, Leaflets 1:161. 1906. "At Sargents, southern Colorado, 5 July, 1901, C. F. Baker, N 352, 25 in U. S. Herb."

Stems 3-6 dm. high, of two kinds, long, slender flowering stems and short leafy shoots arising from horizontal rootstocks, glabrous or puberulent in lines; basal leaves and those on the sterile shoots oblong or oblanceolate, obtuse or acute, long petiolate, glabrous; stem leaves few, oblong to lanceolate, 3-11 cm. long, acute, glabrous; inflorescence interrupted, composed of two or more many-flowered verticillasters, the lower one usually distant and subtended by leaf-like bracts; calyx-lobes about 5 mm. long, linear, acuminate, glabrous, with conspicuously broad, scarious, and erose margins; corolla 10-14 mm. long, bright blue or deep violet-blue, glabrous externally, pubescent with yel-

FIGURE 20

DISTRIBUTION OF PENSTEMON RYDBERGII A. NELS.

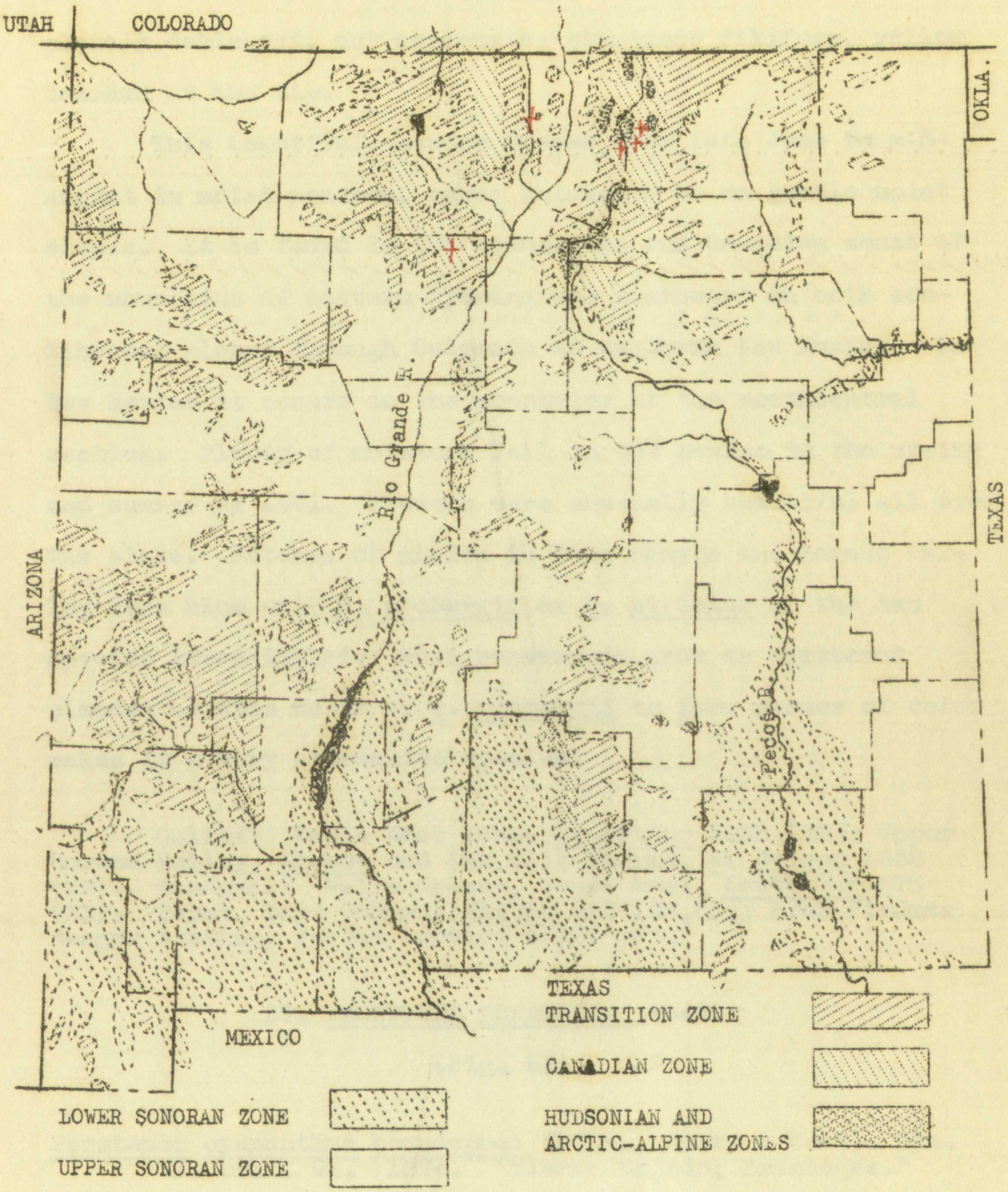
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 20

UTAH
COLORADO
NEVADA
ARIZONA
NEW MEXICO
MEXICO
TEXAS
TRANSITION ZONE
LOWER SONORAN ZONE
UPPER SONORAN ZONE

low hairs at base of lower lobes; anther-sacs opposite, completely dehiscent, not explanate; staminode filiform, yellow bearded at the tip.

This beautiful species blooms from late June to mid-August in moist meadows, aspen thickets, or on gentle moist slopes. It is found in the Transition and Canadian zones of the mountains of eastern Wyoming and southward on both continental slopes through Colorado to northern New Mexico. In New Mexico it occurs in the mountains of the northcentral section. Plenty of moisture fell in New Mexico in the spring and summer of 1941. Flowers were unusually beautiful all over the state. Patches of meadow in Taos Canyon and Moreno Valley were blue with P. rydbergii or P. strictus or the two species intermingled. Most penstemons grow as scattered plants; so this habit of P. rydbergii to form masses of color makes it a very attractive species.

Colfax: Eagle Nest Lake, Castetter 2035 (NM); Upper Moreno Valley, Nisbet 863 (NM,CI); Therma, A. Nelson 1558 (NM). Sandoval: Valle Grande, Jemez Mts., Castetter 675 (NM). Taos: Taos Canyon, Nisbet 860 (NM,CI); Tres Piedras Ranger Station, Forest Service 46421 (F).

37. PENSTEMON BRANDEGEEI Porter

(Fig. 21)

Penstemon cyananthus brandegeei Porter, Port. & Coult. Syn. Fl. Colo. 91. 1874. "Sierra Mojado, Brandegee."

Penstemon brandegeei Porter, Rydb. Mem. N. Y. Bot. Gard. 1:

FIGURE 21

DISTRIBUTION OF *PENSTEMON BRANDEGEEI* PORTER

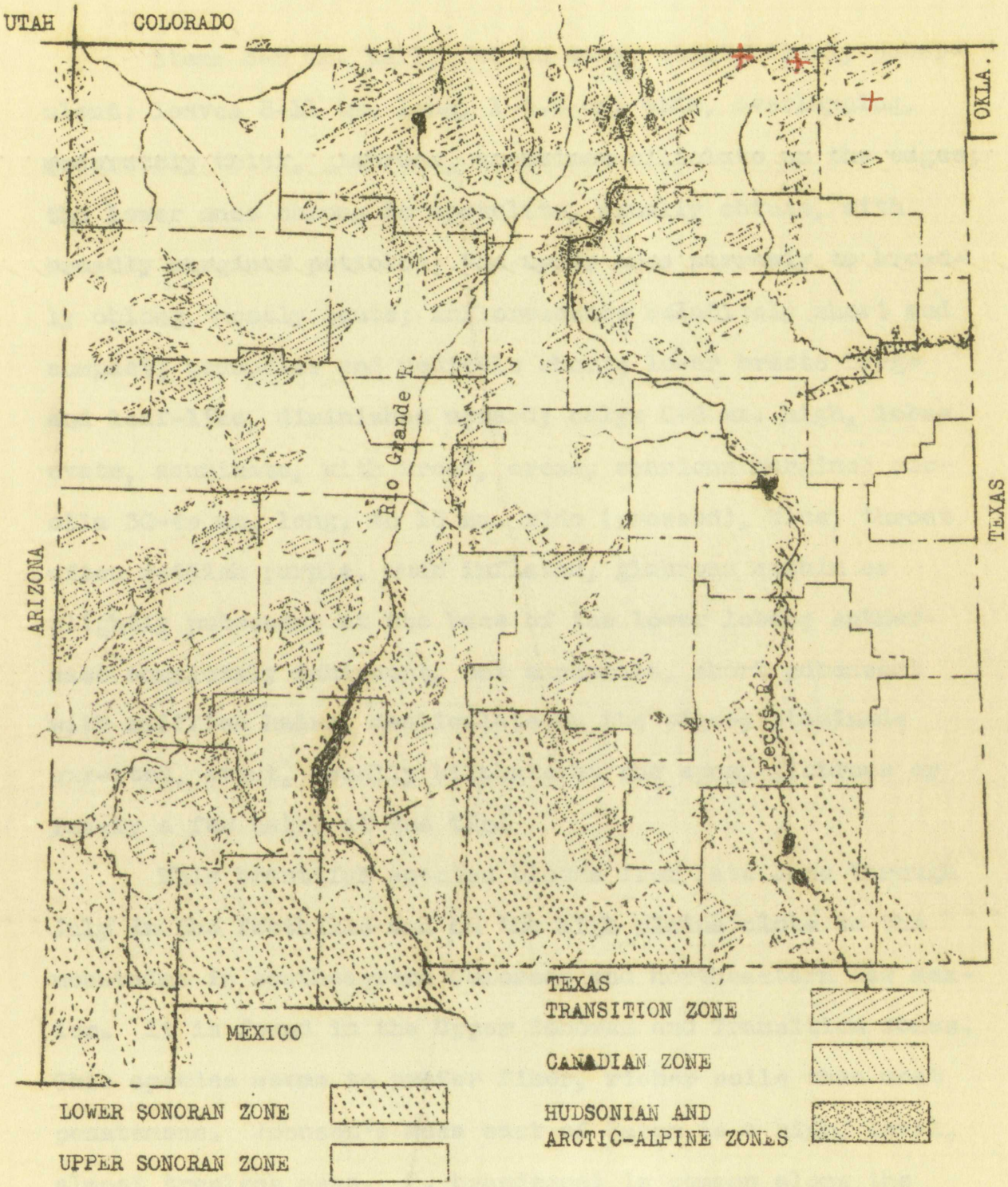
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 21

UTAH
COLORADO
NEVADA
ARIZONA
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

343. 1900.

Stems 3-6 dm. tall, few to many, stout, finely puberulent; leaves 5-11 cm. long, 1-4.5 cm. wide, overlapping, moderately thick, glabrous, sometimes ciliolate on the edges; the lower ones oblong to spatulate, usually obtuse, with broadly margined petioles; the upper ones narrowly to broadly oblong, mostly acute; inflorescence relatively short and compact; peduncles and pedicels short; lower bracts large and leaf-like, diminished upward; calyx 6-8 mm. high, lobes ovate, acuminate, with broad, erose, scarious margins; corolla 30-4o mm. long, to 15 mm. wide (pressed), blue, throat often reddish purple, much inflated, glabrous within or slightly pubescent at the base of the lower lobes; anther-sacs completely dehiscent, not explanate, short pubescent with stiffish hairs, denticulate on the edges; staminode exserted, stout, usually bilobate at the apex, glabrous or rarely a few hairs at the tip.

This beautiful species blooms from late June through July in the foothills and on the high plains close to the mountains in southeastern Colorado and northeastern New Mexico. It is found in the Upper Sonoran and Transition zones. This species seems to prefer finer, richer soils than most penstemons. Johnson's Mesa east of Raton is a high, level, almost treeless mesa. P. brandegeei is common along the

roads and in the meadows on top of the mesa; but it is not found in the rough broken country on the sides of the mesa. It also occurs on the high plains to the east and has been reported from Sierra Grande Mountain.

Colfax: Johnson's Mesa, G. Nisbet 17 (NM,CI). Union: Few miles west of Grenville, G. Nisbet 16 (NM,CI). Raton Pass, Emerson (Herbarium of Highlands Univ. Las Vegas).

38. PENSTEMON STRICTUS Benth.

(Fig. 22)

Penstemon strictus Benth. in DC. Prodr. 10:324. 1846. "In montibus scopulosis ad fontes fl. Sweetwater (Fremont)."

Stems 2-8 dm. high, one to several from a woody caudex, glabrous; basal leaves spatulate or lanceolate, long petiolate; cauline leaves 4-12 cm. long, linear to broadly lanceolate, glabrous; inflorescence strict, usually secund, peduncles and pedicels short; calyx 3-6 mm. long, lobes ovate to lanceolate, usually scarious-margined and only slightly erose but occasionally with wider and more erose margins; corolla 18-28 mm. long, blue or blue-violet, moderately ampliate, strongly bilabiate; anther-sacs villose on the sides, opposite, completely dehiscent; not explanate, denticulate along the edges; staminode glabrous or with a few short hairs on the somewhat dilated tip.

This is a variable species in the width of the leaves, the amount of bearding on the anthers and staminode, the

FIGURE 22

DISTRIBUTION OF *PENSTEMON STRICTUS* BENTH. (+)
AND *PENSTEMON STRICTUS* SUBSP. *STRICTIFORMIS*
(RYD.) KECK (⊙)

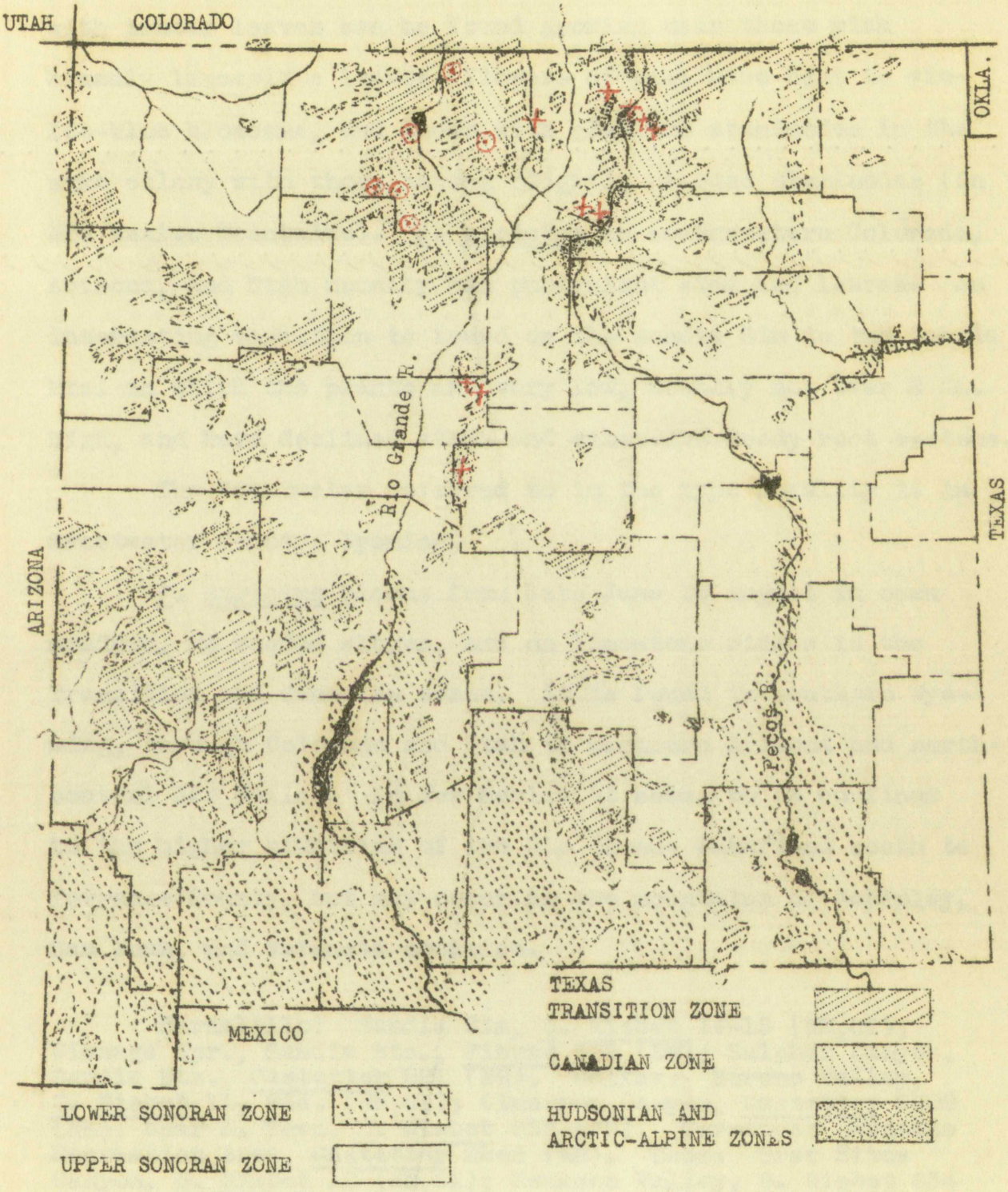
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 22

UTAH
COLORADO
NEW MEXICO
ARIZONA
MEXICO

length of the calyx-lobes, and the flower color. Plants with linear leaves can be found growing near those with broadly lanceolate leaves, flowers of pure blue next to violet-blue blossoms, and those with glabrous staminodes in the same colony with those having slightly bearded staminodes (in New Mexico Mountains). P. strictus in southwestern Colorado, Arizona, and Utah usually has puberulent stem and leaves. An interesting variation is found on the Sandia Rim in the Sandia Mts. in which the plants are very low, usually not over 2 dm. high, and have declined stems and extensive woody root systems.

The Sweetwater referred to in the type locality is in Sweetwater County, Wyoming.

P. strictus blooms from late June to August in open meadows, on wooded slopes, and on limestone ridges in the Transition and Canadian zones. It is found in southern Wyoming, through Colorado and Utah to northern Arizona and north-central New Mexico. In New Mexico it seems to be confined to the higher mountains of the Rio Grande watershed south to Torrance County, but may occur in the mountains of McKinley, San Juan, and Valencia counties.

Bernalillo: Sandia Rim, G. Nisbet 14-15 (NM,CI); Cienaga Spr., Sandia Mts., Pierce 655 (NM); Sulphur Canyon, Sandia Mts., Castetter 221 (NM). Colfax: Moreno Valley, G. Nisbet 11, 864. (NM,CI); Cimarron Canyon, Castetter 2008 (NM); Near E. Town, G. Nisbet 653 (NM). Torrance: Manzano Recreation Area, Castetter 2248 (NM). Taos: Tres Ritos Canyon, G. Nisbet 12 (NM,CI); Penasco Valley, G. Nisbet 634 (NM); Taos Canyon, Rollins & Chambers (CI). Red River Canyon, Nelson 1756 (NM). Tres Piedras Ranger Station, Barker (NM).

39. PENSTEMON STRICTUS subsp. STRICTIFORMIS (Ryd.) Keck

(Fig. 22)

Penstemon strictiformis Ryd., Bull. Torr. Bot. Club 31:642. 1905. "Colorado: Mancos, 1898, Baker, Earle & Tracy 76 (type)."

Penstemon strictus subsp. strictiformis (Ryd.) Keck, Jour. Wash. Acad. Sci. 29:491. 1939.

Similar to P. strictus but having longer and more acuminate calyx-lobes, 7-10 mm. long, which are usually more erose and have wider scarious margins; corollas more ampliate; anther-sacs more densely villose; staminode strongly dilated and bearded for about one-half its length with long hairs.

Of this form the author says, "This is closely related to P. strictus, but differs mainly in the long-acuminate sepals."[56] P. strictus and P. strictus subsp. strictiformis overlap in range in southwestern Colorado. These facts coupled with the comparatively small amount of significant morphological difference between them has caused this investigator to agree with Dr. Keck that P. strictiformis is a subspecies of P. strictus.

This subspecies flowers from June to August in the same sort of ecological setting as the species. It is found

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[56] Alex Rydberg, "Studies on the Rocky Mountain Flora XIII," Bulletin of the Torrey Botanical Club, 31:642, 1904.

in southwestern Colorado, northwestern New Mexico, and occasionally in northeastern Arizona.

Rio Arriba: El Vado Lake, Mankin 851 (NM,CI); 4 miles west of Lindrith, Mankin 852 (NM); 10 miles north Regina, Mankin 853 (NM,CI); Chama, Wooton 2796 (S); Near Canjillon, Martin 263 (CI). Sandoval: Senorita Pass, east of Cuba, Aztec Museum 52.

40. PENSTEMON VIRGATUS A. Gray

(Fig. 23)

Penstemon virgatus A. Gray in Torr., Bot. Mex. Bound. 113, 1859. "Santa Rita del Cobre, on the mountains; Bigelow, Wright, (1476); also gathered by Dr. Woodhouse."

Stems 2.5-6 dm. tall (occasionally taller), puberulent or glabrous, slender, solitary or few; leaves 3-10 cm. long, 2-10 mm. wide, linear to lanceolate, glabrous or puberulent; inflorescence glabrous or puberulent, not glandular, strict, usually somewhat secund, peduncles and pedicels short, the verticillasters one to several flowered; sepals 3-4 mm. long, lobes ovate, acute to obtuse, margins scarious and usually more or less erose; corolla 15-22 mm. long, 8-10 mm. wide, usually pale violet with strong red-purple guide lines, but may be white, darker violet, or occasionally pink with a lavender cast, strongly bilabiate, tube short, throat strongly dilated, lobes about equal in length, spreading, throat glabrous or lightly bearded at the base of the lower lobes; anther-sacs oblong, opposite, completely dehiscent, not ex-

FIGURE 23

DISTRIBUTION OF PENSTEMON VIRGATUS A. GRAY (+)
AND PENSTEMON VIRGATUS SUBSP. NEOMEXICANUS
(WOOT. & STANDL.) KECK & NISBET (⊙)

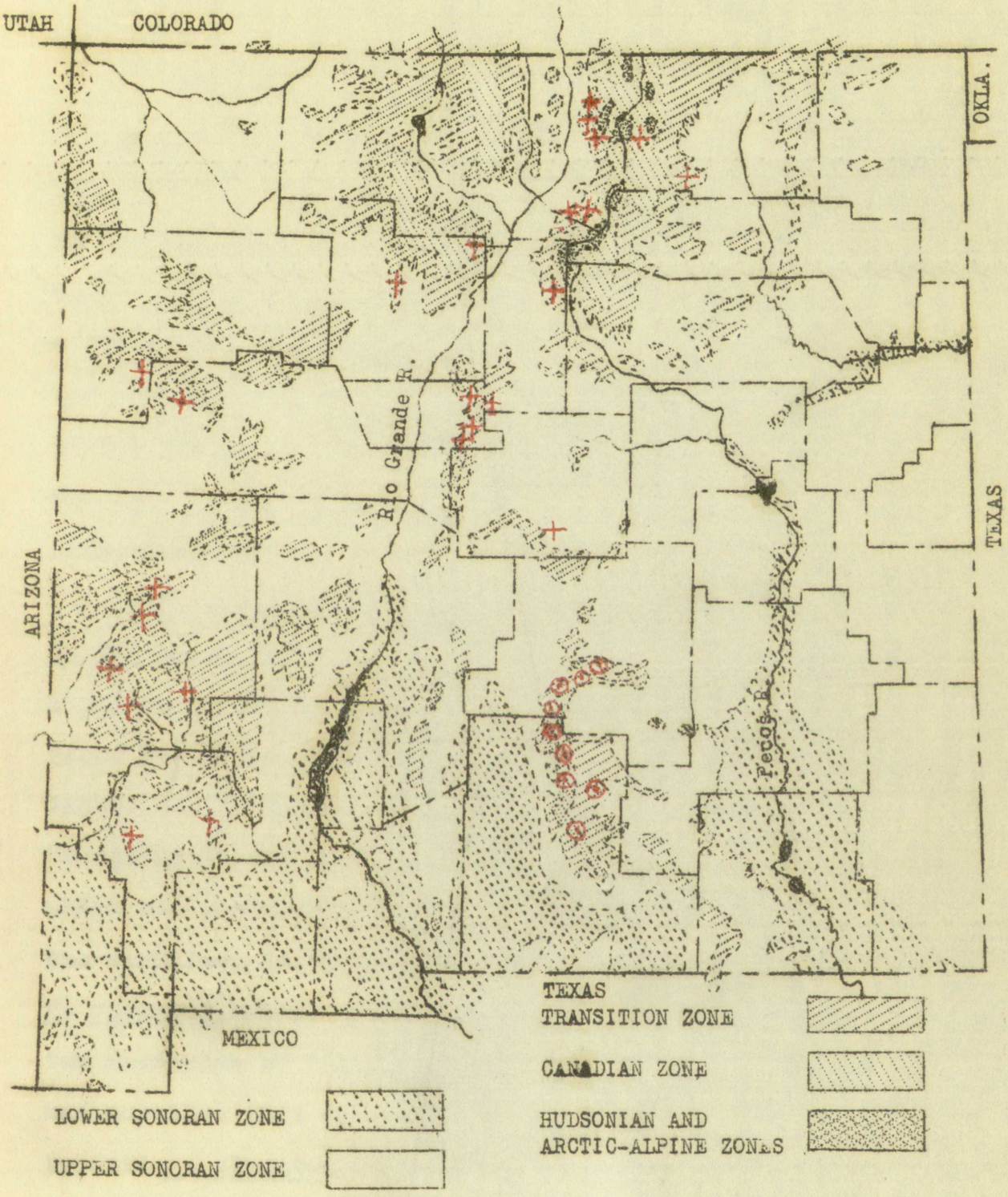
UTAH
COLORADO
OKLA.
TEXAS
ARIZONA
Rio Grande R.
Pecos R.
MEXICO
TEXAS
TRANSITION ZONE
CANADIAN ZONE
HUDSONIAN AND
ARCTIC-ALPINE ZONES
LOWER SONORAN ZONE
UPPER SONORAN ZONE

FIGURE 23

UTAH
COLORADO
ARIZONA
NEW MEXICO
TEXAS
TRANSITION ZONE
UPPER SONORAN ZONE
LOWER SONORAN ZONE

planate, minutely denticulate along the edges; staminode glabrous, moderately dilated at the tip.

This is an extremely variable species. Typical P. virgatus is found in central and western New Mexico and central Arizona. In the northern and eastern part of the range in Arizona the flowers are blue; this blue-flowered phase extends over into the southwestern part of New Mexico as far north as Valencia County. A white-flowered form is found in the southwestern part of the range in Arizona and in New Mexico in the Sandia and Manzano Mountains, in the Penasco and Tres Ritos valleys, and probably elsewhere; however, the pale violet phase is more common in central New Mexico.

P. virgatus subsp. arizonicus (A. Gray) Keck, found in the White and Graham mountains of Arizona, has a bearded staminode, oblong-spatulate leaves and broadly scarious-margined and erose calyx-lobes. One or more of these characteristics are frequently found in specimens from the Mogollon Mountains in New Mexico. P. virgatus subsp. ampliflorus Keck, which has glabrous stems and leaves and large, broadly ampliate corollas, is found in the mountains of Chihuahua, Mexico. P. virgatus subsp. neomexicanus occurs in the White and Capitan mountains of Lincoln and Otero counties. This subspecies has corollas that are intermediate in size between those of typical P. virgatus and P. virgatus subsp. ampliflorus.

P. unilateralis Ryd. of Colorado and northward is

closely related to P. virgatus. In fact all of the distinctive characteristics of P. unilateralis are found in some of the variations of P. virgatus; so much so that it is impossible to write a description of the species P. virgatus that does not also include P. unilateralis. Moreover, the two forms intergrade in the mountains of western Colfax County. Typical P. unilateralis differs from P. virgatus, as it is found in Taos County, in being glabrous and having darker corollas that are sometimes bearded in the throat. Specimens of P. virgatus from Moreno Valley in western Colfax County vary in the amount of puberulence on the stem and leaves from thickly puberulent to completely glabrous. The corollas, too, vary from lighter to darker shades of blue-violet and may or may not be bearded in the throat.

As can be seen from the description and discussion of the species, P. virgatus, the above given characteristics of typical P. unilateralis are found in P. virgatus at various localities. Since this study is limited to the penstemons of New Mexico and typical P. unilateralis does not come into the state, no definite statement will be made here as to its status. However, this investigator believes it will be necessary to consider P. unilateralis a subspecies of P. virgatus.

P. virgatus blooms from June to August in the foothills and on the lower slopes of the mountains in the Upper Sonoran and Transition zones; also in open valleys and on

ridges in the Canadian Zone. The range of this species has been sufficiently discussed above.

Bernalillo: Forest Park, Sandia Mts., Nisbet 213, Castetter 430 (NM); Cedro Mts., Div. of Graz. (NM); 25-28 miles southeast of Albuquerque, Nisbet 751, 753, 754 (NM); Catron: West Fork of Gila River, Metcalfe 368 (S); Middle Fork of Gila, Wooton (S); Jewett Gap, north of Reserve, 23951 (F); north of Reserve, Wooton (S); 18 miles north of Mogollon (CI); Luna Valley, For. Ser. 48234 (F). Colfax: Moreno Valley, Nisbet 780, 782, 865 (NM); 30 miles west of Springer, Nisbet 10 (NM,CI). Grant: Santa Rita Mts., Metcalfe 1466 (S); Burro Mts., Blummer 52 (CI). McKinley: North of Ramah, Wooton (S). Santa Fe: Glorietta, Bro. Arsene and Bro. Benedict 15787 (St); east of the Sandias, Wakefield (NM). Sandoval: 10 miles above Jemez Pueblo, A. Nelson 935 (NM); North of Bandelier National Monument, Nisbet 857 (NM). Torrance: 15 miles south of Mountainair, Nisbet 755 (NM). Taos: 2 miles north of San Cristobal, Nisbet 6 (NM,CI); Red River Box Canyon, Nisbet 343 (NM); Foot of U. S. Hill, Nisbet 7 (NM,CI); Penasco Valley, Nisbet 8 (NM,CI); Arroyo Hondo, A. Nelson 1726 (NM). Valencia: Inscription Rock, Wooton 325 (S).

41. PENSTEMON VIRGATUS subsp. NEOMEXICANUS

(Woot. & Standl.) Keck & Nisbet, comb. nov.

(Fig. 23)

Penstemon neomexicanus Woot. & Standl., Contr. U. S. Nat. Herb. 16:172. 1913. "Type in U. S. National Herbarium, No. 561371. Collected in pine woods near Gillmore's Ranch on Eagle Creek in the White Mts. alt. 2200 meters, August 15, 1907, by E. O. Wooton and Paul Standley (No. 3507)."

Penstemon virgatus subsp. neomexicanus (Woot. & Standl.) Keck & Nisbet, comb. nov.

Stems glabrous; leaves usually lanceolate but occasionally linear, to 10 cm. long and to 18 mm. wide; internodes of the inflorescence usually longer than in typical P. virgatus

and the peduncles usually only 1-3 flowered; calyx-lobes 4-5 mm. long oblong or oval, obtuse or truncate with a short, pointed tip, scarious and erose; corolla 20-30 mm. long, 10-14 mm. wide, blue or dark blue-violet, usually strongly bearded at the base of lower lobes; staminode usually strongly dilated.

The reasons for considering P. neomexicanus as a subspecies of P. virgatus A. Gray have been very hard to put into words; nevertheless after examining many specimens in herbaria and in the field, it has seemed necessary to attempt to do so. P. virgatus subsp. neomexicanus is found in the White, Capitan, and Sacramento mountains. Thus, this subspecies is more or less separated geographically from the other members of the species; however, there is a connection with the Manzano Mountains through the Jicarilla Mountains and a series of low wooded hills. In the Jicarilla Mountains and the hills to the north, more collecting needs to be done to completely establish intergrading, or lack of intergrading, between P. virgatus, of the Sandia and Manzano mountain regions, and P. neomexicanus of the White Mountain region.

Some evidence of this intergrading has been found. In specimens from south of Mountainair, the stems vary from puberulent to glabrous, many of the corollas are larger and darker in color than those from the Manzano Mountains, and

the corollas are more or less bearded in the throat. Specimens from Nogal Lake in the north end of the White Mountains often have an inflorescence with short internodes and many flowers similar to P. virgatus, instead of the longer internodes and fewer flowers of typical P. neomexicanus. Scattered specimens from the White and Capitan mountains are slightly puberulent on the stems, and the truncate sepals are not constant.

P. virgatus from the mountains west of Springer, Colfax County, is mostly glabrous with dark blue corollas bearded in the throat; but the internodes of the inflorescence are short, the peduncles many flowered, and the corollas no larger than in typical P. virgatus.

Scattered specimens of P. virgatus from western New Mexico are glabrous, but the majority are puberulent at least below the inflorescence. The color in the west varies from pale violet to blue and dark blue-violet. Bearding in the throat is present or absent, seemingly indiscriminately. Thus it would seem that the best characteristics by which to distinguish P. virgatus subsp. neomexicanus are the larger corollas, the longer internodes and fewer flowers of the inflorescence, and the usually more densely bearded lower lip.

P. virgatus subsp. neomexicanus blooms from late June to August mostly in the Transition Zone but also in the Upper part of the Upper Sonoran and into the Canadian Zone.

Lincoln: Head of Rodamaker, Lincoln Forest 50841 (F); Bonita Creek (A); Gilmore's Ranch on Eagle Creek, Wooton and Standley 3507 (S); Capitan Pass, Nisbet 748 (NM,CI); Nogal Lake, Nisbet 765 (NM); 3 miles north of Alta, Nisbet 766 (NM); South Fork of Little Eagle, Nisbet 768 (NM,CI). Otero: Mayhill, Hershey (S); Cloudcroft, Hershey (S); James Canyon, Sacramento Mts., Wooton (S); Tularosa Canyon, Wharton and Huber (CI); South Fork of Carrizo Creek, Wharton and Huber (CI).

CHAPTER VI

PENSTEMONS INCLUDED BY WOOTON AND STANDLEY BUT EXCLUDED FROM THE PRESENT KEY

As has been stated in Chapter I, an effort has been made to bring together all latest available information about New Mexican members of the genus Penstemon. Those members of the genus that are at the present known to occur in the state have been discussed in Chapter V. Certain species found in Wooton and Standley's key have been excluded from the present key for reasons which are given below.

P. spinulosus Woot. & Standl. was collected by C. R. Vassey, June 1881, in the Magdalena Mountains. It has never been re-collected there or elsewhere. This investigator has made an effort to find this species in the Magdalena Mountains but has been unsuccessful, which of course does not prove that it is not there. The Magdalena Mountains are rough and rugged and thorough botanizing is difficult.

When this investigator suggested to Dr. Keck that P. spinulosus might be non-existent, he replied:

> P. spinulosus, I too have come to believe, is a botanical error as far as the flora of New Mexico is concerned. Probably an introduction of P. heterophyllus from California was made in the Magdalena Mountains by some unknown agency. But I feel sure that the plant has not become naturalized there and that it is no longer a member of the New Mexican flora.[57]

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[57] Personal Correspondence of the Author, letter from Dr. D. D. Keck, Carnegie Institution of Washington, Stanford University, California, September 12, 1940.

Dr. Pennell has made the suggestion that P. spinulosus be dropped from New Mexican species for the following reason, "I am convinced that the type originally came from California."[58]

For the above stated reasons P. spinulosus has not been retained among New Mexican species.

P. comarrhenus A. Gray may possibly come into New Mexico in Rio Arriba or San Juan counties, but it seems doubtful. Records show that it comes into Colorado only in the tier of counties that border on Utah, in which state it is more common. Since this investigator has not seen Standley's 8118 from Dulce,[59] Rio Arriba County, no statement can be made as to its identity. Recent material from Rio Arriba County that might be confused with P. comarrhenus has been identified as P. strictus subsp. strictiformis (Ryd.) Keck.

P. teucrioides Greene is found only in central Colorado and is not known from New Mexico. P. humilis Nutt. comes no nearer New Mexico than extreme northwestern Colorado. Undoubtedly specimens of P. gracilis Nutt. were misidentified as P. humilis. P. gracilis is common on Sierra

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[58] Personal Correspondence of the Author, letter from Dr. Francis W. Pennell, Curator, Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, February 6, 1942.

[59] E. O. Wooton and Paul C. Standley, Flora of New Mexico, Contributions from the United States National Herbarium, Vol. XIX, (Bulletin of the U. S. National Museum. Washington: Government Printing Office, 1915), p. 583.

Grande, which is one of the locations for P. humilis by Wooton and Standley.

P. unilateralis Ryd. has been omitted because its range lies largely in Colorado, and those specimens from northern New Mexico which might be referred to P. unilateralis may with equal propriety be referred to P. virgatus A. Gray. A discussion of the relation of these two closely allied forms has been given in Chapter V.

P. stenosepalus (A. Gray) Howell and P. metcalfei Woot. and Standl. have been found to be synonyms of P. whippleanus A. Gray. P. similis A. Nels. has been discussed under P. jamesii Benth. with which it is synonomous. P. crassulus Woot. and Standl. has been considered a synonym of P. cardinalis Woot. and Standl.

P. cyathophorus Ryd. is found only in southern Wyoming and northern Colorado; therefore, it has been dropped from New Mexican species. P. spectabilis Thurb. does not come into New Mexico, but the New Mexican plant is P. pseudospectabilis subsp. connatifolius (A. Nels.) Keck.

CHAPTER VII

SUMMARY AND CONCLUSIONS

This study has shown that there are forty species and subspecies and one variety of the genus Penstemon that are known to occur in New Mexico. A brief summary will be given here of these species.

Penstemons included in the present key, but that are not found in Wooton and Standley's key are as follows: P. pseudospectabilis subsp. connatifolius (A. Nels.) Keck has been accepted as the correct name for the P. spectabilis of Wooton and Standley. P. cardinalis subsp. regalis (A. Nels.) Nisbet is a Guadalupe Mountain form of P. cardinalis Woot. and Standl. P. alamosensis Pennell and Nisbet is a new species from the western slope of the Sacramento Mountains. P. buckleyi Pennell has been found in the lower Pecos Valley and P. angustifolius subsp. venosus Keck in the northwestern corner of the state.

P. ambiguus subsp. laevissimus Keck is a glabrous form of P. ambiguus Thurb. that is common in the southern part of the state. P. linarioides subsp. maguirei Keck is found in the Gila Valley and P. linarioides subsp. coloradoensis (A. Nels.) Keck in the northwestern corner. Variety taosensis of P. crandallii subsp. glabrescens (Pennell) Keck apparently occurs in Taos County only.

P. albidus Nutt. has been found to come into New Mexico along the northeastern edge, and P. dasyphyllus A. Gray in the southwestern corner. Two subspecies of P. jamesii Benth. have been recognized, subspecies ophianthus (Pennell) Keck and breviculus Keck, both found in western New Mexico. P. auriberbis Pennell appears in the extreme northeastern part of the state.

A number of penstemons recognized as species by Wooton and Standley have been reclassified in recent years. P. torreyi Benth. and P. trichander (A. Gray) Ryd. have been considered as subspecies of P. barbatus (Cav.) Nutt. P. caudatus Heller has been regarded as a subspecies of P. angustifolius Nutt.; P. strictiformis Ryd. a subspecies of P. strictus Benth.; P. neomexicanus Woot. and Standl. a subspecies of P. virgatus A. Gray.

P. crandallii A. Nels. is now restricted to Colorado and Utah and the New Mexican material is P. crandallii subsp. glabrescens (Pennell) Keck. A discussion of the above reclassifications has been given in Chapter V.

The range of P. pinifolius Greene has been extended to include the Magdalena Mountains. P. strictus Benth. has been found to be quite common in the Sangre de Cristo, Sandia, and Manzano mountains. Wooton and Standley restricted P. oliganthus to the type locality in Valencia County, but it has a much larger range as shown by Figure 19.

P. gracilis Nutt. does not occur in the Sandia Mountains as stated by Wooton and Standley, but the closely allied species, P. oliganthus Woot. and Standl., is common there. Much misunderstanding of New Mexican material has arisen because of an error in regard to P. gracilis in the Wooton and Standley key. P. gracilis normally has finely serrate leaves. In their key the species in under the characteristic "leaves entire".[60] For this reason P. gracilis has often been misidentified as P. humilis, which does not occur in New Mexico, and P. oliganthus often mistaken for P. gracilis.

Greene in 1906 set off the two species, P. ambiguus Torr. and P. thurberi Torr., under a new genus name, Leiostemon. This classification was used by Wooton and Standley; but it has not been generally accepted, as these species are not sufficiently distinct to warrant it.

That information on New Mexican penstemons is far from complete is freely admitted. Considerable field work needs to be done to procure the specimens necessary to work out completely the more confused units. Certain areas in the state have been badly neglected by field workers, largely, of course, because of their inaccessibility. The southwestern corner of the state, particularly Hidalgo County, needs working. In this corner several species that occur

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[60] Ibid. pp. 580-581.

in Mexico come into the state. Among the species in this area that have been collected in New Mexico very few times are P. superbus A. Nels., P. lanceolatus Benth., P. pulchellus Lindl., and P. dasyphyllus A. Gray.

P. bridgesii A. Gray should be watched for in western Catron County and P. buckleyi Pennell in the lower Pecos Valley.

P. jamesii subsp. ophianthus, P. jamesii subsp. breviculus, P. angustifolius subsp. venosus, and P. eatonii from the northwestern part of the state, need to be collected. The number of collections of these species from New Mexico is very small.

The Sacramento Mountains, the northern part of the Guadalupe Mountains, the Jicarilla Mountains and the San Andres Mountains might prove interesting hunting grounds for penstemons.

It is sincerely hoped that this study will have in some measure clarified the confusion that has surrounded the New Mexican penstemons, and that it may form a basis for future work on this interesting genus.

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