THE GREAT PLAINS SPECIES OF SCUTELLARIA (LAMIACEAE): A TAXONOMIC REVISION

by

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INTRODUCTION

Scutellaria L. is a nonaromatic mint genus of ca 300 species, distributed throughout temperate and tropical regions of the world, except central and southern Africa and Polynesia (Leonard 1927, Epling 1942). The major center for diversity is the central Mexican plateau. Scutellaria, by virtue of a single striking character, i.e., the conformation of the two-parted calyx with a scutellum on the upper half, has been considered a well defined, natural group. Students have found the task of defining species difficult in many cases. This has led to a number of different taxonomic views of the genus (cf Taxonomic History section).

The genus is of no economic importance beyond an ancient use of S. lateriflora as a medicinal plant and the limited modern use of a red-flowered tropical Scutellaria as an ornamental.

The Great Plains, as defined by The Great Plains Flora Association (Fig. 45), is a geographic area bordered by Canada on the north, the Rocky Mountains on the west, where the deciduous forest becomes continuous on the east, and southern Oklahoma and the panhandle of Texas on the south. In the Great Plains Scutellaria is represented by nine species (sensu Epling 1942): S. brittonii Porter, S. parvula Michx., S. drummondii Benth., S. galericulata L., S. lateriflora L., S. leonardi Epl., S. australis Epl., S. resinosa Torr., and S.

wrightii Gray. Two other species, S. ovata Hill and S. incana Spreng., also are found within the boundary of the Great Plains. They are more associated with eastern deciduous forest than with grassland vegetation and may represent recent introductions following modern forest encroachment into the Great Plains (Bragg and Hulbert 1976). Scutellaria incana and S. ovata only are dealt with in the Taxonomic Treatment of this study.

Defining relationships within two species complexes, S. resinosa-S. wrightii and S. parvula-S. australis-S. leonardi, are the major problems to which this study is addressed. Epling (1942) saw S. resinosa and S. wrightii, two stiff upland perennials, as closely related species, separated mainly by the degree of stem pubescence. Distinguishing these two taxa has become a problem for many Great Plains taxonomists. In fact, Epling had problems attaching a name to some specimens, as seen by his annotating of Demaree 12470 (NY) "S.? Wrightii." Epling also distinguished between S. parvula, S. australis, and S. leonardi on the type of pubescence and to a lesser extent on leaf morphology. The distinction between S. parvula and S. australis is difficult to make in some cases. In the Great Plains both species may occur in the same population and along with intermediates.

Carl Epling (1942) in the most recent treatment of Scutellaria ascribed the American species to eighteen sections, none of which is predominately Great Plains in distribution. Three of these sections have representative species in the Great Plains: Lateriflorae Benth., Galericularia A. Hamilt., and Resinosae Epl. Scutellaria lateriflora, which makes up the totality of sect. Lateriflorae, occurs throughout most of the United States and southern Canada in riparian habitats. Three of the twelve species in sect. Resinosae occur in the Great Plains: S. resinosa, S. drummondii, S. wrightii. Scutellaria drummondii, a small upland herb, is the only annual Scutellaria in the Great Plains. Section Galericularia is a large, widespread group of seventeen species, five of which occur in the Great Plains. Scutellaria brittonii is a high-elevation upland herb of the eastern Rocky Mountains and extreme western Great Plains. Scutellaria galericulata is a riparian herb, occurring throughout the central to northern United States, Canada to Alaska, and Europe. The remaining three species, S. parvula, S. leonardi, and S. australis, form a complex of upland herbs occurring in rocky soils throughout the eastern half of the United States. The Great Plains may be a naturally occurring geographic area, but floristically the Great Plains species of Scutellaria make up a rather heterogeneous group, not one of which is restricted to the Great Plains.

Aside from the two aforementioned problems, this study was taken up to yield a taxonomic treatment which may be used in the upcoming Flora of the Great Plains and in the updating of the distribution maps for Scutellaria (recently published in The Atlas of the Flora of the Great Plains) using herbarium material from SMU, MO, NY, PH, and TEX and from the author's field collections. Specimens from KSC and KANU are also used in the study, being that they are already incorporated in *The Atlas*.

In order to elucidate relationships in the *S. resinosa*-*S. wrightii* and *S. parvula*-*S. australis*-*S. leonardi* complexes, it was imperative to tap new sources of data. This study incorporates scanning electron microscopic studies of pollen and mericarps and analyses of two-dimensional paper chromatograms of phenolic compound spot patterns. A review of gross morphological characters was also carried out, and reported in the Taxonomic Treatment section. Each of the new analyses was performed on a large number of individuals from a relatively small number of populations.

TAXONOMIC HISTORY

In Lobelius' Icones (1581) there is a citation to Lysimachia galericulata. This seems to be the earliest reference to a plant now classified as Scutellaria (S. galericulata) (Leonard 1927).

The name Scutellaria, proposed by Rivin in 1735, was taken up by Linnaeus (1753) in Species Plantarum, overlooking the earlier name Cassida of Tournefort. Both of these names are descriptive of the fruiting morphology. Scutellaria is derived either from the Latin word "scutella" meaning a dish (Borror 1971), which describes the lower half of the calyx after mericarp dissemination, or the Latin word "scutellum" meaning a little shield, probably referring to the projection from the upper half of the calyx. Cassida is derived from the Latin word "cassidi" meaning a helmet, which again alludes to the morphology of the upper half of the calyx. Common names have followed Cassida in meaning. The early French name, "toque," alluding to a small 16th century hat, was used. Now in the United States the common name "skullcap" is most often employed.

In Species Plantarum (1753), Linnaeus described twelve species of Scutellaria, two of them occurring in the Great Plains, S. galericulata and S. lateriflora.

Hamilton (1832) wrote the first revision to Scutellaria. By that time the number of described species had quadrupled.

Two of the new species listed were S. ambigua Nutt. and S. parvula Michx., both part of the S. parvula complex. Hamilton did not mention the close relationship between S. parvula and S. ambigua (later called S. leonardi by Epling 1939). When writing on taxa closely related to S. parvula, he mentioned only S. minor, a European species. He also listed "toque petite" as an annual, actually a perennial from a moniliform rhizome. Scutellaria ambigua was listed under "Species Little Known," with no reference as to relationships. One change that Hamilton made was to split S. galericulata into S. epilobiifolia for the New World specimens and S. galericulata for the Old World. Fernald (1921) and Penland (1924) both supported this view. The most recent and comprehensive follow-up of this split was performed by Epling (1939). He cited ranges of variation being as broad on both continents, although mean corolla lengths did differ. Epling further stated that there are not enough consistent differences to justify the split. Epling's analysis will be followed in this paper, and New World specimens will be called S. galericulata. Hamilton recognized three sections of the genus, placing S. galericulata and S. parvula in sect. Galericularia and S. lateriflora in sect. Stachymacris. These sections were based upon inflorescence and foliage differences.

Labiatarum Genera et Species (Bentham 1832-1836) was the next major work concerning Scutellaria. Bentham recognized 63 species and listed two more of the Great Plains species, S. drummondii (described in this work) and S. resinosa

(Torrey 1828). He also made the first of a series of lumping and/or splitting of the S. parvula complex. He treated S. ambigua as a synonym of S. parvula without mention to varietal status. Scutellaria epilobiifolia was treated as a synonym of S. galericulata, but a distinction was made between the predominately Old and New World forms. Bentham described the name S. galericulata var. vulgaris for the common European form and S. g. var. pubescens for the most common American form. A third variety was also described, S. g. var. glaberrima. This name was applied to a collection by Douglas in the state of Washington which was closer to S. g. var. vulgaris than S. g. var. pubescens. Bentham recognized five sections of the genus, distinguished mainly by floral and inflorescence differences. He ascribed S. lateriflora to sect. Maschalostachys Benth. and S. parvula, S. galericulata, S. resinosa, and S. drummondii to sect. Galericularia A. Hamilt.

Bentham (1848) again produced a comprehensive treatment of Scutellaria, this time for DeCandolle's Prodromus. By this time the number of species in Scutellaria had blossomed to 86, none of the new ones occurring in the Great Plains. He modified his subgeneric treatment, decreasing the number of sections from five to four, but described a number of subsections. No nomenclatural changes were made regarding the Great Plains species. S. galericulata (including S. epilobiifolia), S. parvula (including S. ambigua), S. resinosa, and S. drummondii were placed in sect. Galericularia, subsect. Genuinae. Scutellaria lateriflora was placed in sect. Galericularia, subsect. Lateriflorae (from the demoted sect. Maschalostachys).

Gray (1878), in his Synoptical Flora of North America, described S. parvula var. mollis. In 1894 Britton elevated the variety to species, calling it S. campestris. This taxon, as pointed out by successive workers, was not different from S. parvula except for its luxuriant habit. These names were short lived, being relegated to synonomy by Penland (1924), Leonard (1927), and Epling (1942).

Briquet (1897) next treated Scutellaria. He noted ca 180 species, none of the new ones of the Great Plains. The genus was broken into two sections based on the presence or absence of a band on the mericarps. He split the first section into three subsections and the third subsection into seven groups. Scutellaria galericulata, S. parvula, and S. resinosa were placed in sect. Euscutellaria Briq., subsect. Vulgares Benth., and group F, the Galericulatae Boiss. He ended his description of this group by listing some North American species and then "etc." It is assumed that S. drummondii, S. wrightii, and S. brittonii were each an "et cetera" since these names were not listed in any other group. Scutellaria lateriflora was placed in the same section and subsection, but in group G, the Lateriflorae (Benth.) Briq. He did not treat infraspecific taxa. Briquet's treatment differed from the earlier ones by incorporating Gray's (1878) use of mericarp morphology in defining sections.

Porter (1894) described S. brittonii, segregating the rhizomatous plants from the typical, taprooted S. resinosa (see S. resinosa Nomenclature in this section). Nelson (1898) segregated robust plants with the name S. virgulata. Rydberg (1906) quickly reduced this taxon to a variety of S. brittonii. Rydberg cited S. b. var. virgulata as "A luxuriant variety with larger and thinner leaves." It has a much smaller range than the typical S. brittonii.

In 1903 Small split S. drummondii into a perennial entity, S. helleri, and an annual group, S. drummondii. This division has not been supported by any of the later students of Scutellaria.

In 1924 Penland's revision of North American Scutellaria was published. He gave wholehearted support to mericarp morphological data in circumscribing species. He listed 21 species for North America (north of Mexico) and did not concern himself with defining sections of the genus. The Great Plains species included S. lateriflora, S. parvula (including S. p. var. ambigua), S. drummondii, S. brittonii (with no mention of S. virgulata), S. resinosa (with S. wrightii as a synonym), and S. epilobiifolia.

Emery C. Leonard (1927) monographed Scutellaria for North America (including Mexico) and listed 62 species. He, like Penland, did not assign sections to the genus. Leonard listed the Great Plains species as follows: S. lateriflora, S. epilobiifolia, S. brittonii, S. brittonii var. virgulata, S. parvula, S. ambigua (the only change from Penland's treatment), S. drummondii, and S. resinosa.

Epling's (1942) treatment of the American species of

Scutellaria listed a number of changes. In 1937 Fassett described S. parvula var. australis. He cited differences in cauline pubescence. Epling agreed with Fassett but elevated the taxon to species, S. australis. He mentioned that the pubescence was variable, especially in Texas and Louisana. Epling (1939) also described S. leonardi. This name referred to a group of plants which had come to be known as S. ambigua. It seems as though Epling saw fit to change the name because specimens of both S. ambigua and S. australis were on the type sheet of S. ambigua. From his own analysis of Old versus New World specimens of S. galericulata he concluded that both groups showed large enough variation to call the New World plants S. galericulata instead of S. epilobiifolia. Epling recognized S. brittonii and did not recognize S. b. var. virgulata. He did mention in the short discussion that two forms of S. brittonii are distinguishable. The fact that he did not recognize infraspecific taxa here, even though differences in pubescence are seen, compared with his splitting the S. parvula complex into three species (S. parvula, S. leonardi, and S. australis), seems to be rather inconsistent. All of the before-mentioned taxa were assigned to sect. Galericularia A. Hamilt. Scutellaria lateriflora was placed into its own section, the Lateriflorae Benth. The remaining Great Plains species (S. resinosa, S. wrightii, and S. drummondii) were all placed in sect. Resinosae Epl.

Flower color variants are infrequently seen, such as reddish or whitish forms. This has been reflected in the publishing of the following names: S. lateriflora forma rhodantha, S. l. forma albiflora, S. l. var. albiflora, S. galericulata forma rosea, S. g. forma albiflora, S. epilobiifolia forma rosea, and S. e. forma albiflora.

The species concept in Scutellaria has narrowed significantly over time. Linnaeus and other early workers distinguished species by relatively large differences, e.g., rhizomatous versus taprooted, or of riparian habitats versus of dry uplands. Students then started recognizing small variations and in some cases, e.g., Fassett (1937), described taxa upon differences in degree of pubescence. This view, consisting of a greater number of narrowly defined species, was carried to an extreme by Epling (1942). Recent floristicists have seen Epling's circumscriptions as perhaps too fine and have used varieties in place of some of his species, e.g., S. parvula var. leonardi instead of S. leonardi and S. p. var. australis instead of S. australis (Fernald 1950, Barkley 1968).

Scutellaria resinosa Nomenclature

Scutellaria resinosa, a taprooted perennial with many stems from a woody caudex, was described in 1828. It occurred in the southern Great Plains and into Texas. Another Scutellaria, undescribed in 1828, occurred in the eastern Rocky Mountains of Colorado and the extreme western Great Plains. This second species, a rhizomatous plant variously branched with larger flowers, was also known as S. resinosa (although the type specimen clearly showed only the first plant). Asa Gray recognized the difference between the two plants but applied the name S. resinosa, incorrectly so, to the rhizomatous plant (Gray 1872, 1878). He then renamed the taprooted plant S. wrightii (Gray 1872), the type specimen of which is very similar to the type of S. resinosa. This taxonomy was used in his Synoptical Flora of North America (1878). Porter (1894), seeing that Gray's description of S. resinosa differed from the type description, correctly replaced the name S. resinosa on the taprooted plant, saying, "S. resinosa of Torrey...is beyond question nothing else than S. Wrightii A. Gray." Porter went on to author the name S. brittonii for the rhizomatous plant. To this point in time S. wrightii (superfluous when published) and S. resinosa were synonyms for the same group of plant populations, and S. brittonii finally had been recognized as a unique taxon. Penland (1924) supported this taxonomy with studies of fruit morphology. Leonard's (1927) monograph also listed S. wrightii as a synonym of S. resinosa. Epling (1942) resurrected the use of S. wrightii. The type specimen of S. wrightii differs slightly from the type of S. resinosa on two points: (a) the cauline pubescence is retrorse in S. wrightii, while in S. resinosa it is spreading or only slightly retrorse, and (b) the leaves of S. wrightii tend to be elliptic, while those of S. resinosa tend to be more ovate. Epling used these differences to split the large group of populations formerly called S. resinosa into a mainly northern group, S. resinosa, and a mainly southern group, S. wrightii. This changed the broader meaning originally put forth for these names.

MERICARP STUDY

Introduction. Early workers in Scutellaria mentioned external mericarp morphology, but they did not recognize its full taxonomic utility (e.g., Hamilton 1832). One of the first works to emphasize external fruit morphology was Synoptical Flora of North America (Gray 1878). The first dichotomy in Gray's key to species of Scutellaria was "1. Nutlets wingless..." vs. "2. Nutlets raised on a slender gynobase, each surrounded by a conspicuous membranaceous wing..." Briquet (1897), in his treatment of Scutellaria in Die Naturlichen Pflanzenfamilien, utilized Gray's division and split Scutellaria into two sections, those with mericarps showing a membranaceous band and those without such a band. This differed from the earlier comprehensive treatment by Bentham (1832) who exploited foliage and inflorescence characters to define five sections of Scutellaria.

C.W. Penland (1924), after reading Gray's (1872) account of winged mericarps in Perilomia and Scutellaria, and seeing Fernald's (1921) recognition of the New World S. galericulata as S. epilobiifolia mainly by mericarp characters, decided to inspect critically mericarps throughout the North American species. After examining some 2000 herbarium sheets, he was able to write a key to the Scutellaria of North America by mericarp characters alone. He assumed that fruit characters, being less variable, were more conservative than pubescence or leaf morphological characters and would be better predictors of species units.

Leonard's (1927) revision of North American _Scutellaria_ incorporated some mericarp morphology but de-emphasized it, using mainly vegetative and inflorescence characters in the key. Epling (1942) viewed mericarp morphology in a strikingly different manner from Penland. As stated by Epling (1939) regarding mericarps, "As far as one may judge in those instances where they have been preserved, they are frequently rather variable in pattern within a species. On the whole they apparently do not form a very trustworthy basis for specific segregation." The differing viewpoints of Penland and Epling are the impetus for concentration on mericarp morphology in this study.

Recently four European papers have dealt with mericarp morphology and/or anatomy. Wunderlich (1967) commented on mericarp morphology but was mainly interested in pollen and embryology. Fabre and Nicoli (1965) studied mericarps of French labiates and recognized their taxonomic utility at the generic and specific levels. In a voluminous work and a sequel, Wojciechowska (1966, 1972) documented mericarp morphology and anatomy for over 70 labiates (including nine species of _Scutellaria_, two being _S. lateriflora_ and _S. galericulata_). She, like Penland and Fabre and Nicoli, emphasized fruit characters as taxonomically significant at the species level. She brought out the point by writing a key to the genera and species studied, based only on mericarp anatomy and morphology.

The analysis of mericarps was threefold: (a) external, and to a lesser extent internal, characters were studied with a scanning electron microscope; (b) anatomy of some mericarps was observed on a compound light microscope; (c) variation of external morphology and fruit size was noted with the use of a dissecting microscope.

Materials and Methods. Mericarps were taken from the author's field collections and herbarium specimens (KSC, KANU, MO, NY, PH, SMU) for all analyses.

For scanning electron microscopic (SEM) work, mericarps were taken directly from specimens and attached to aluminum stubs with silver paste. Samples were pre-coated with carbon and then coated with gold-paladium alloy in an evaporator, while rotating at 45^{o} with respect to the alloy filament. Electron micrographs were recorded of each sample at ca 50X (lateral, dorsal, and ventral views) and at up to 5000X to document various surface details. Some internal fruit structure was also recorded. Mericarps were either freeze fractured, cut, or torn apart. An ETEC Autoscan U-2 was used in all SEM work.

For light microscopic work of mericarp sections, fruits were cut, fixed, infiltrated, embedded, and cured as shown in Table 1. Spurr's (1969) embedding medium, hard modification, was used. After curing, blocks were trimmed of excess resin and sections were cut with a glass knife at ca 1 micrometer on a Reichert OM-2 ultramicrotome. Sections were then transferred and heat fixed to a microscope slide. Staining was carried out directly with toluidine blue and slight heat over an alcohol lamp for ca 2 minutes. Slides were then rinsed, dried, and made permanent with permount and coverslips.

For gross morphological variation observations and for fruit measurements, a dissecting light microscope was used at (20X) 30X. Sixty mericarps from each taxon (20 per population, 3 populations) was the usual sample size. However, this was not realized for all taxa. Measurements of each fruit were made in three dimensions: axial, radial, and tangential (Fig. 1).

Three points are noteworthy on the type of material to use: (a) old fruits may collapse from dehydrating and/or pressing (Fig. 31); (b) in the last few days of maturation, mericarps change greatly in size and shape, e.g., in S. parvula the band is much expanded outwardly, appearing like a wing just prior to maturation. The band then curls under with final maturation (Figs. 8-10); and (c) as Tomb (1974) pointed out, if seed (or fruit) tissue is in contact with other tissues (e.g., ovary wall, other mericarps) during maturation, surface patterns or morphology may be changed to a smooth or depressed condition (Fig. 12). Only fresh, mature fruits should be used when studying morphology for the conclusion to be accurate.

Results. In Table 2 are listed mericarp size measurements, sample sizes, and populations studied. Scanning electron micrographs of Scutellaria mericarps are shown in Figs. 2-23, 25-28, and 31. Light micrographs of internal fruit structure of S. resinosa and S. drummondii are shown in Figs. 24 and 30.

TABLE 1

Fixation and embedding procedure for Scutellaria mericarp study (pers. comm. Jerry Kreitner).

1. Cut mericarp in quarters in a drop of glutaraldehyde-cacodylate fixative.

2. Transfer tissues into a vial containing ca 1 ml. glutarald. Fix. Swirl occasionally, keep cold and capped. 1 hr.

3. Replace fix with fresh. 1 hr. 2X.

4. Rinse 4X (total 1 hr.) with cold cacodylate-sucrose rinse.

5. Replace solution with ca 1 ml. cold osmium cacodylate fix. 30 min. 2X.

6. Wash with cacodylate sucrose rinse (cold). 5 min.

7. Rinse in distilled H_2O. 5 min. 2X. (warm to room temp.)

8. Dehydrate in ETOH series: 30%, 50%, 70%, 95%, 100% (3X), ca 12 min. in each.

9. Place into Spurr's resin (SR) series: 1 SR:2 100% ETOH 2-3 hrs., 1 SR:1 100% ETOH 2-3 hrs., 2 SR:1 100% ETOH 2-3 hrs., 100% SR 4-6 hrs.

10. Flat embed in fresh 100% SR and cure for 48 hrs. at 66^{o} C.

Mericarp Description for Genus (including mericarps of Great Plains species only).

Mericarps are four per flower, conduplicate, yellow to olive or dark brown to black in color. General shape is spherical to (more often) ovoid, more or less flattened dorso-ventrally. Fruit size is 0.9-2.1 mm in the axial direction (Fig. 1), by 0.7-1.6 mm in the tangential direction, by 0.7-1.7 mm in the radial direction. External morphology is variable, including fruits uniformly covered with short papillae or lamellae, to those which show a distinct band with longer (up to 200 micrometers) papillae. Externally mericarps may show sessile glands. The pattern shown by the surface cells is also variable, from irregularly shaped cells with or without protuberances to uniformly rotund cells with small apical evaginations. The fruit wall is 1-15 cells thick and on the internal surface is covered with sessile glands (Figs. 8-9, 12-13). The gross morphological features may be a result of cell enlargement and/or increased cell division at the site of the papillae (or lamellae or band) and/or undulation of the entire fruit wall.

Mericarp Descriptions for Species

Section Galericularia A. Hamilt.

Scutellaria brittonii (Figs. 2-7, Table 2). Mericarps dark brown to black, ovoid to slightly compressed dorso-ventrally. This species has the largest fruits of the taxa studied; they average 1.73 mm axially, by 1.37 mm tangentially, by 1.37 mm radially. External morphology is consistent in the presence of flattened-conical papillae (260 micrometers long and ca 190 micrometers at the base) covering the whole mericarp, but inconsistent in the presence-absence of a median band or ridge. One population may show fruits with well developed bands, while another may have only partial bands, and a third may show no bands at all (Figs. 3-5). Few sessile glands, scattered mostly on the ventral surface, are present. The surface cells are irregularly shaped in outline and show well developed protuberances.

Scutellaria parvula (including, because of the lack of distinguishing characters, S. australis and S. leonardi) (Figs. 8-11, Table 2). Mericarps brown and generally ovoid. These taxa have the smallest fruits, ca 1.05 mm axially, by ca 0.96 mm tangentially, by ca 0.89 mm radially. External morphology throughout this group is very consistent. There is a well developed axial band, medially placed in lateral view (Fig. 9) and long (ca 130 micrometers, 80 micrometers broad) cylindrical papillae. The surface cells are irregular in outline and show short protuberances.

Scutellaria galericulata (Figs. 12-15, Table 2). Mericarps yellowish to buff (olive green), ovoid, slightly flattened dorso-ventrally. They are relatively large, averaging 1.55 mm axially, by 1.27 mm tangentially, by 1.14 mm radially. External morphology is consistent. The whole fruit is covered by blunt, short, broad papillae, ca 90 micrometers long by ca 110 micrometers wide. Common over the whole surface are sessile glands ca 0.03 mm in diameter. Most of them occur between papillae. Surface cells have an irregular outline and lack any protuberances. Internally the fruit wall is made up of a relatively large number of cell layers (Fig. 15) in comparison to S. drummondii (Fig. 30) and S. resinosa (Figs. 24-25). The external morphology is a result of cell enlargement at the sites of the papillae rather than increased cell divisions or convolution of the fruit wall (Fig. 15).

Section Lateriflorae Benth.

Scutellaria lateriflora (Figs. 16-20, Table 2). Mericarps yellow to a yellowish-olive green, ovoid and flattened dorso-ventrally. They are of medium to small size, averaging 1.31 mm axially, by 1.05 mm tangentially, by 0.80 mm radially. External morphology is slightly variable. The surface is covered by small papillae, ca 54 micrometers long and ca 66 micrometers wide at the base, tending to be triangular in longitudinal section. Groups of papillae (2-20) may coalesce to form patches at the outside edges in dorsal or ventral view, giving a sub-banded appearance. The fruit wall is relatively thick (compare Figs. 20 and 24). The outlines of the external cells form an irregular pattern at the base of, and between, papillae. Toward the top of each papilla the surface cell outlines become elongate longitudinally and converge on a central, circular area (Fig. 19). This pattern is unique to this species when compared with the other taxa studied.

Section Resinosae Epling.

Scutellaria resinosa (including S. wrightii) (Figs. 22-25, Table 2). Mericarps dark brown to black, ovoid. They are of average size with mean values of 1.31 mm axially, by 1.03 mm tangentially, by 1.08 mm radially. External fruit morphology is consistent throughout the plant's range (including S. wrightii) in the Great Plains. Externally the fruits are covered with small, blunt papillae, ca 38 micrometers long and ca 63 micrometers wide at the base. Surface cells are more or less rotund and regularly outlined (in comparison with section Galericularia or Lateriflorae). Each cell is tipped with a small evagination made up of the material which covers the whole fruit (Figs. 24-25). In cross-section the fruit wall is relatively thin (1-3 (4) cells thick). The external morphology is a product of cell enlargement and increased cell division at the areas of the papillae and undulations of the fruit wall (Figs. 24-25).

Scutellaria drummondii (Figs. 26-31, Table 2). Mericarps dark brown to black, ovoid to circular (in ventral view), slightly elongate axially. They are of medium size, averaging 1.29 mm axially, by 1.07 mm tangentially, by 1.04 mm radially. External morphology is variable within a framework which is distinct from all other species studied. The basic morphological unit is a conical papilla (ca 125 micrometers long and ca 113 micrometers wide at the base) which may be flattened and may coalesce with 1-2 (3) others, giving a lamellate appearance. Fruits always have some lamellae present on the ventral side, but when considering the total surface, the number of papillae may outnumber the number of lamellae or vice versa. The papillae (or lamellae) are consequences of cell expansion and an undulating fruit wall (Fig. 30). The external cells have rotund surfaces, forming a regular pattern. Each cell shows a small evagination. The evaginations are made up of the material which covers the fruit and are not effects of an internal protrusion.

Discussion. As pointed out earlier (Penland 1924, Fabre and Nicoli 1965, Wojciechowska 1966, 1972) and confirmed by the present study, fruit morphology is valuable in defining species circumscriptions in *Scutellaria*. Each of the species studied (as defined in this paper, see Taxonomic Treatment) possesses mericarps with a distinct morphology. There is variability within some species but not so great as to overlap with other species.

Fruit morphological data support the sections of *Scutellaria* as defined by Epling (1942), especially by the patterns formed by the surface cells. The *Lateriflorae*, which is made up of only *S. lateriflora*, has mericarps with unique color, shape, and coalescence pattern of papillae. The cell surface pattern, consisting of the elongate cells on the papillae converging at a circular area on the tip, is also unique. The *Resinosae*, *S. resinosa* (including *S. wrightii*) and *S. drummondii*, show cohesion and uniqueness in the rotund surface cells with small evaginations forming a regular pattern. Cell surface pattern is also important in defining the Galericularia. Scutellaria galericulata, S. parvula (including S. australis and S. leonardi), and S. brittonii all show irregular surface cell patterns. Mericarps of S. parvula and S. brittonii also show large protuberances from each cell in comparison to S. resinosa. Scutellaria brittonii mericarps show a similarity to those of S. galericulata in in the presence of external sessile glands (Fig. 5) and to S. parvula in the presence of a ridge or a band in some cases (Figs. 2 and 4). Those fruits of S. brittonii which have a band may be distinguished from fruits of S. parvula by size and the presence of conical papillae in the former versus cylindrical papillae in the latter. One conflicting point in the treatment of S. brittonii mericarps by Penland versus Epling is that the former only recognized the fruits as tuberculate, while the latter described them as banded. I have shown both types of mericarps and an intermediate form in this study (Figs. 3-5).

If one keyed species by mericarp data alone, there would be six, not nine as Epling (1942) recognized. They would be S. brittonii (possibly with two varieties), S. parvula (including S. leonardi and S. australis), S. galericulata, S. drummondii, S. resinosa (including S. wrightii), and S. lateriflora. This view is close to that of Leonard (1927), except that he recognized S. parvula as two species, S. parvula and S. ambigua on differences in pubescence and leaf shape. Penland (1924), being a supporter of the use of mericarp data, viewed the Great Plains as having the six species. He classified S. ambigua as a variety of S. parvula.

Scutellaria, as with many of the mint genera, has posed ongoing problems to taxonomists since the beginning of its classification. The traditional data sources of vegetative and floral morphologies are often too variable within species and too consistent between species to resolve basic taxonomic problems. External mericarp morphology, both gross and at the cell surface, proved to be a valuable tool in defining species of Scutellaria within the Great Plains. It seems worthy of suggestion that this avenue of data be explored for all of Scutellaria, and indeed for the whole family, with the use of the scanning electron microscope.

TABLE 2

Mericarp measurements for Great Plains <u>Scutellaria</u>. For locality information of the populations, see Table 4.

Taxon & Pop.	AXIAL n	AXIAL Mean	AXIAL S.D.	AXIAL Range	AXIAL Grand Mean	TANGENTIAL n	TANGENTIAL Mean	TANGENTIAL S.D.	TANGENTIAL Range	TANGENTIAL Grand Mean	RADIAL n	RADIAL Mean	RADIAL S.D.	RADIAL Range	RADIAL Grand Mean
S. galericulata															
188	20	1.48	.08	1.29-1.63		20	1.24	.07	1.10-1.35		20	1.14	.07	1.01-1.26	
175	18	1.57	.07	1.4.-1.70		18	1.29	.09	1.16-1.57		12	1.12	.06	0.97-1.23	
193	20	1.60	.11	1.35-1.70	1.55	20	1.29	.08	1.10-1.41	1.27	20	1.14	.11	0.88-1.32	1.14
S. lateriflora															
199	20	1.32	.12	1.13-1.60		20	1.01	.11	0.75-1.23		20	0.83	.10	0.72-0.97	
166	20	1.24	.09	1.04-1.38		20	1.05	.08	0.91-1.16		20	0.76	.05	0.69-0.82	
210	20	1.36	.09	1.19-1.51	1.31	20	1.08	.09	0.97-1.26	1.05	20	0.80	.10	0.57-0.97	0.80
S. resinosa															
148	20	1.23	.10	1.04-1.45		20	0.97	.08	0.88-1.13		20	1.04	.10	0.88-1.19	
159	20	1.38	.08	1.26-1.51		20	1.09	.06	1.01-1.23		20	1.16	.08	1.04-1.26	
376	20	1.39	.08	1.26-1.51	1.33	20	1.12	.08	1.01-1.23	1.06	20	1.14	.08	0.97-1.29	1.11
S. wrightii															
370	20	1.29	.08	1.16-1.45		20	0.98	.08	0.75-1.10		20	1.05	.07	0.94-1.16	
377	20	1.19	.07	1.10-1.32		20	0.96	.07	0.85-1.07		20	0.99	.10	0.82-1.16	
374	20	1.35	.09	1.19-1.51	1.28	20	1.04	.07	0.91-1.13	0.99	20	1.10	.10	0.85-1.29	1.05

TABLE 2 (Cont.)

Taxon & Pop.	AXIAL n	Mean	S.D.	Range	Grand Mean	TANGENTIAL n	Mean	S.D.	Range	Grand Mean	RADIAL n	Mean	S.D.	Range	Grand Mean
S. brittonii															
398	11	1.86	.21	1.58-2.14		11	1.45	.11	1.35-1.63		11	1.50	.15	1.26-1.72	
A 128	20	1.66	.09	1.45-1.85		20	1.33	.11	1.01-1.45		20	1.33	.10	1.10-1.45	
C NY*	4	1.74	.13	1.57-1.95		4	1.37	.17	1.04-1.57		4	1.33	.20	1.04-1.73	
22185*	5				1.73	5				1.37	5				1.37
1201*	3					2					2				
C MO*	4	*(lumped due to				4					4				
P 296*	1	small n's)				1					1				
S. leonardi															
405	20	1.10	.08	0.94-1.26		20	0.95	.06	0.82-1.13		20	0.89	.07	0.79-1.01	
9085	10	0.96	.03	0.91-1.01		10	0.86	.04	0.79-0.91		10	0.84	.04	0.79-0.88	
3970	13	1.04	.10	0.94-1.23		13	0.91	.06	0.85-0.97		13	0.90	.04	0.82-0.97	
428	20	1.23	.12	1.01-1.45	1.11	20	1.07	.09	0.94-1.26	0.97	20	0.95	.08	0.82-1.01	0.90
S. australis															
3516	20	1.07	.04	0.97-1.13		20	1.00	.04	0.91-1.04		20	0.94	.04	0.88-1.01	
84591	20	1.04	.07	0.88-1.19		20	0.97	.07	0.85-1.13		20	0.91	.09	0.66-1.01	
T 475	20	0.92	.10	0.63-1.13	1.01	20	0.90	.11	0.69-1.10	0.97	20	0.84	.14	0.63-1.07	0.90
S. parvula															
54036	20	0.96	.07	0.88-1.16		20	0.89	.11	0.72-1.10		20	0.80	.10	0.69-0.97	
1707	20	1.10	.06	1.01-1.23	1.03	20	0.96	.04	0.88-1.07	0.93	20	0.92	.09	0.69-1.10	0.86

TABLE 2 (cont.)

Taxon & Pop.	AXIAL n	Mean	S.D.	Range	Grand Mean	TANGENTIAL n	Mean	S.D.	Range	Grand Mean	RADIAL n	Mean	S.D.	Range	Grand Mean
S. drummondii															
376	20	1.33	.09	1.13-1.57		20	1.08	.09	0.88-1.23		20	1.09	.08	0.97-1.26	
378	20	1.29	.10	1.10-1.51		20	1.06	.13	0.79-1.23		20	1.02	.14	0.82-1.32	
373	20	1.26	.08	1.13-1.41	1.29	20	1.07	.10	0.82-1.23	1.07	20	1.02	.12	0.79-1.19	1.04

Key:

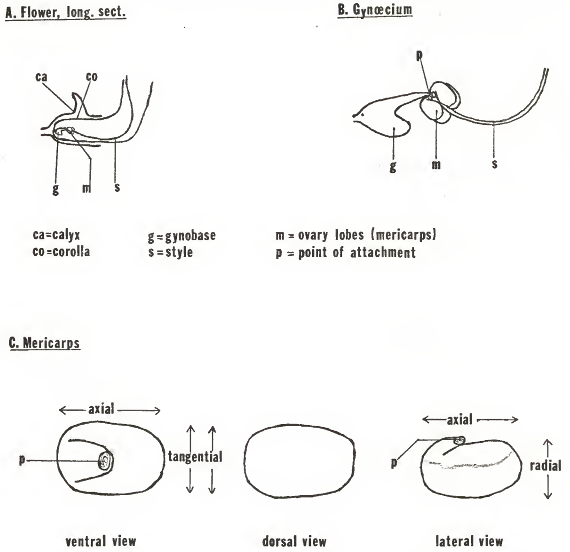
All measurements reported in millimeters
n=sample size
S.D.=standard deviation
Range=smallest-largest value
Grand Mean=mean of means

TABLE 3

Identifications of populations of Great Plains Scutellaria used in mericarp study.

Species (sensu Epling 1942)	Population, Locality, Voucher
S. galericulata	Lane 188 Marshall Co., SD (KSC) Lane 175 Day Co., SD (KSC) Lane 193 Roberts Co., SD (KSC)
S. lateriflora	Lane 199 Richland Co., ND (KSC) Lane 166 Moody Co., SD (KSC) Lane 210 Barnes Co., ND (KSC)
S. resinosa	Lane 148 Rooks Co., KS (KSC) Lane 159 Graham Co., KS (KSC) Lane 386 Donley Co., TX (KSC)
S. wrightii	Lane 370 Comanche Co., OK (KSC) Lane 377 Harmon Co., OK (KSC) Lane 374 Kiowa Co., OK (KSC)
S. brittonii	Lane 398 Laramie Co., WY (KSC) Allen 128 Larimer Co., CO (MO) Clements 95 CO-WY (NY) Rollins 1201 El Paso Co., CO (NY) Pennell & Schaeffer 22185 Garfield Co., CO (PH) Clements 95 CO-WY (MO) Patterson 296 Boulder Co., CO (NY)
S. drummondii	Lane 376 Harmon Co., OK (KSC) Lane 378 Greer Co., OK (KSC) Lane 373 Comanche Co., OK (KSC)
S. leonardi	Lane 405 Washington Co., KS (KSC) Hayden 9085 Clay Co., IA (SMU) Barker 3970 Chase Co., KS (KANU) Lane 428 Riley Co., KS (KSC)
S. australis	Barker 3516 Cowley Co., KS (KANU) Stephens 84591 Sumner Co., KS (KANU) Thompson 475 Bourbon Co., KS (KANU)
S. parvula	Palmer 54036 Cherokee Co., KS (KANU) Croat 1707 Labette Co., KS (KANU)

Figure 1. Longitudinal section of a Scutellaria flower near base and enlargements of fruiting structure. Note definitions for axial, tangential, and radial directions with respect to mericarps. Ventral, dorsal, and lateral views are shown.



Mericarps of _Scutellaria_ _brittonii_

Figure 2. SEM micrograph of an equatorially banded mericarp, dorsal view, line = 400 micrometers. _Allen_ _128_ (MO).

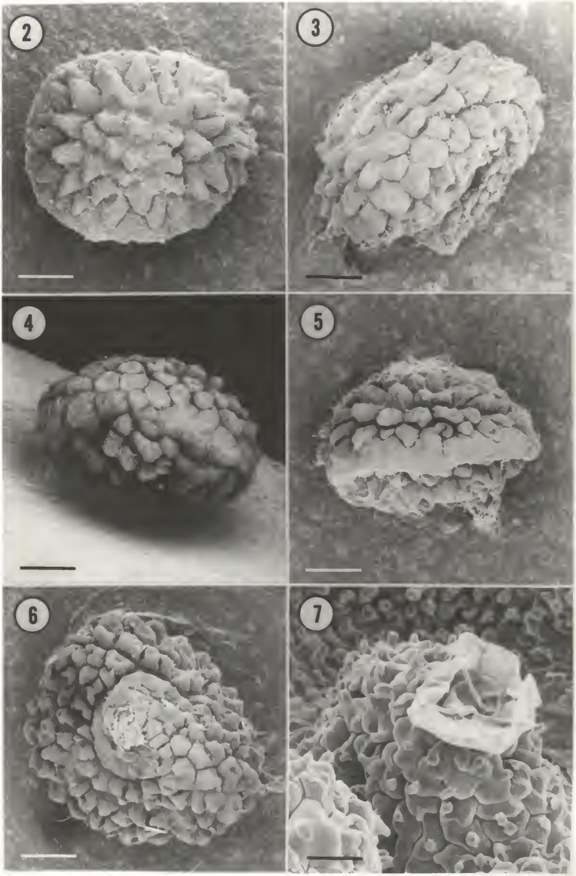
Figure 3. SEM micrograph of a non-banded mericarp, lateral view, line = 400 micrometers. _Clements_ _95_ (MO).

Figure 4. SEM micrograph of a partially banded mericarp, lateral view, line = 400 micrometers. _Patterson_ _296_ (NY).

Figure 5. SEM micrograph of a banded mericarp, lateral view, line = 400 micrometers. _Allen_ _128_ (MO).

Figure 6. SEM micrograph of a non-banded mericarp, ventral view, line = 400 micrometers. _Clements_ _95_ (MO).

Figure 7. SEM micrograph of a ventrally located papilla, showing a collapsed sessile gland, line = 15 micrometers. _Clements_ _95_ (MO).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Mericarps of *Scutellaria* spp.

Figure 8. SEM micrograph of a mericarp of *S. australis*, dorsal view, line = 200 micrometers. Barker 3516 (KANU).

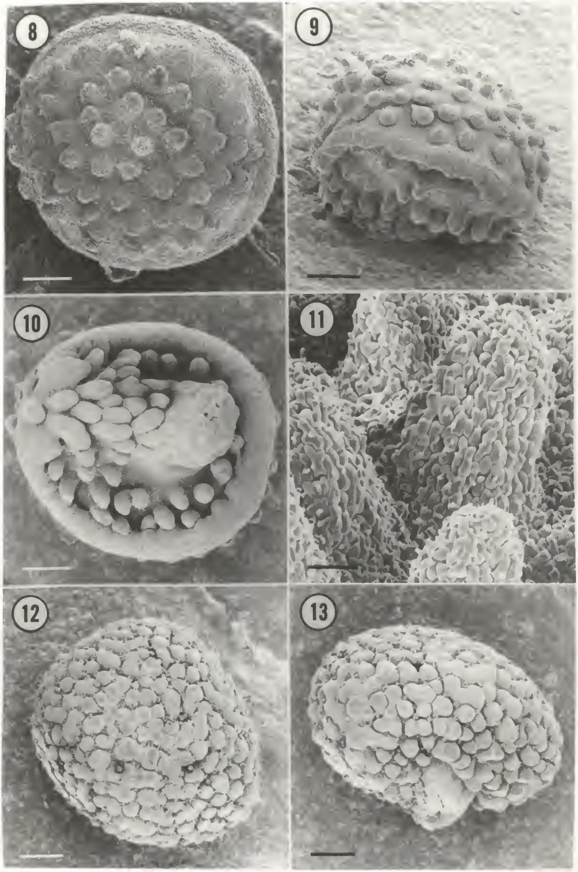
Figure 9. SEM micrograph of a mericarp of *S. leonardi*, lateral view, line = 250 micrometers. Komarek s.n. (KSC).

Figure 10. SEM micrograph of a mericarp of *S. parvula*, ventral view, line = 200 micrometers. Palmer 54036 (KANU).

Figure 11. SEM micrograph of a papilla on a mericarp of *S. leonardi*, line = 25 micrometers. Morton and Dorman s.n. (KANU).

Figure 12. SEM micrograph of *S. galericulata*, dorsal view. Note slightly depressed papillae near center of mericarp, due to contact with other tissue during development or while plant was pressed. Line = 250 micrometers. Lane 197 (KSC).

Figure 13. SEM micrograph of a mericarp of *S. galericulata*, lateral view, line = 250 micrometers. Lane 197 (KSC).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Mericarps of Scutellaria spp.

Figure 14. SEM micrograph of a mericarp of S. galericulata, ventral view, line = 250 micrometers. Lane 197 (KSC).

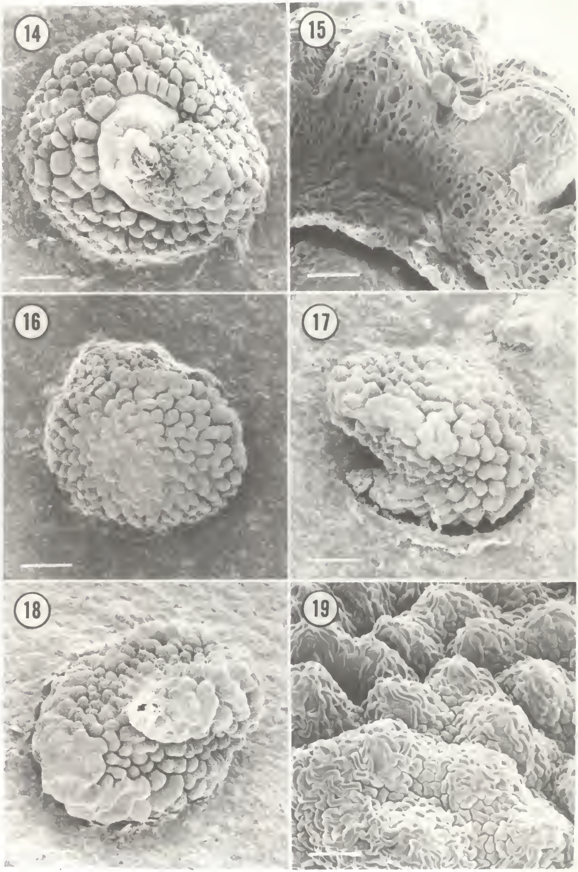
Figure 15. SEM micrograph of a torn fruit wall of S. galericulata. Note relatively small cells in front of papilla on right, and relatively large cells in the papilla on left. Line = 50 micrometers. Lane 195 (KSC).

Figure 16. SEM micrograph of a mericarp of S. lateriflora, dorsal view, line = 250 micrometers. Blocker 444 (KANU).

Figure 17. SEM micrograph of a mericarp of S. lateriflora, lateral view, line = 250 micrometers. Lane 201 (KSC).

Figure 18. SEM micrograph of a mericarp of S. lateriflora, ventral view, line = 250 micrometers. Lane 201 (KSC).

Figure 19. SEM micrograph of a papillae on the fruit wall of S. lateriflora, line = 50 micrometers. Lane 201 (KSC).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Mericarps of Scutellaria spp.

Figure 20. SEM micrograph of torn fruit wall of S. lateriflora, external surface toward top of micrograph. Note many cell layers. Line = 50 micrometers. Lane 201 (KSC).

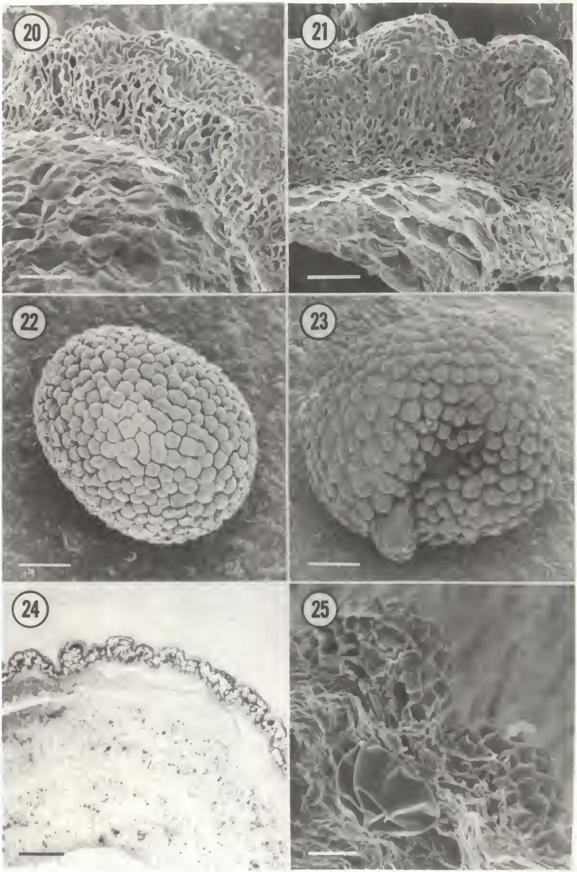
Figure 21. SEM micrograph of torn fruit wall of S. galericulata, external surface toward top of micrograph. Note sessile glands on internal surface. Line = 50 micrometers. Lane 195 (KSC).

Figure 22. SEM micrograph of a mericarp of S. wrightii, dorsal view, line = 250 micrometers. Stratton 5859 (KANU).

Figure 23. SEM micrograph of a mericarp of S. resinosa, lateral view, line = 250 micrometers. Lane 143 (KSC).

Figure 24. Light micrograph of a fruit in cross-section of S. wrightii. Note relatively few cell layers in fruit wall (dark cells across top of picture). Line = 100 micrometers. Stratton 5859 (KANU).

Figure 25. SEM micrograph of torn fruit wall of S. resinosa. Note sessile gland on internal surface. Line = 20 micrometers. Lane 149 (KSC).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Mericarps of *Scutellaria drummondii*

Figure 26. SEM micrograph, dorsal view. Note both conical papillae and lamellae. Line = 200 micrometers. *Tharp* and *Barkley* *51-866* (KANU).

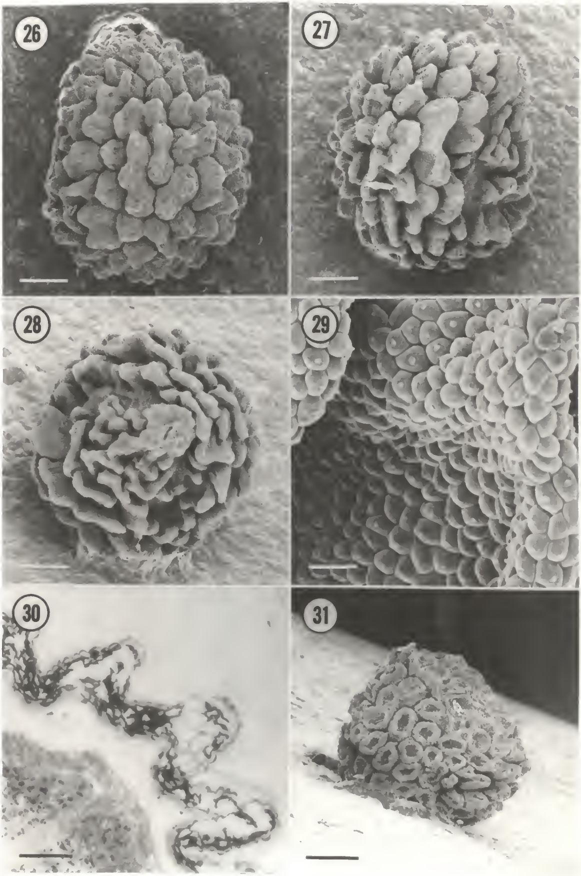
Figure 27. SEM micrograph, lateral view, line = 200 micrometers. *Tharp* and *Barkley* *51-866* (KANU).

Figure 28. SEM micrograph, ventral view, line = 200 micrometers. *Tharp* and *Barkley* *51-866* (KANU).

Figure 29. SEM micrograph of the surface, line = 20 micrometers. *Tharp* and *Barkley* *51-866* (KANU).

Figure 30. Light micrograph of a cross-section of a mericarp. Note undulating wall running diagonally through the picture. Line = 60 micrometers. *Tharp* and *Barkley* *51-866* (KANU).

Figure 31. SEM micrograph of an old collapsed mericarp, line = 250 micrometers. *Lindhiemer* *s.n.* (KSC).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PHENOLIC COMPOUND STUDY

Introduction. Alston and Turner (1959, 1963) documented the utility of chromatographic spot patterns of flavonoids, especially for the legume Baptisia. Since then, flavonoid analysis has become one of many standard procedures for resolving taxonomic problems.

Within Scutellaria a number of species have been studied with regard to flavonoids. As long ago as 1901 the flavonoid 7-β-D-glucuronide was isolated from S. altissima and given the trivial name scutellarein (Molish and Goldschmidt 1901). Recently this compound has proved useful as a phyletic marker in higher plants (Harborne and Williams 1971). The known flavonoids for Scutellaria are listed in Table 4. Of the Great Plains Scutellaria, only S. lateriflora and S. galericulata (including S. epilobiifolia) have been studied extensively.

A populational analysis of two-dimensional paper chromatograms of phenolic compounds was carried out in hope of gaining insight into the relationships between Great Plains species of Scutellaria. Special attention was paid to the two taxonomically problematic groups, S. resinosa-S. wrightii and S. parvula-S. australis-S. leonardi.

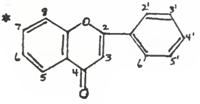
Materials and Methods. Leaf and stem material for flavonoid analysis was taken either from bulk material collected in the field or, with permission, from herbarium sheets. After air drying, the vegetative material was ground for

TABLE 4

Known flavonoids, both the basic skeleton and the various substituent patterns, from Scutellaria spp. Those known from the Great Plains species are marked as follows: S. lateriflora, with l, and S. galericulata, with g (Hegnauer 1966, Sanders unpublished, Zinchenko and Bandyukova 1969).

Flavone Skeleton*	Hydroxylation Pattern	Methoxylation Pattern	Monoglycoside Pattern	Bioside Pattern
5,7-dihydroxy (Chrysin) (g)	8 (g) 2'	7 8 (g) 2'(g) 6,8 6,8,2'	7 (g) 8 (g)	
5,6,7-trihydroxy (Baicalein) (g)	8,2' 8,2',6'	6 7	7 (g)	
5,7,4'-trihydroxy (Apigenin) (g)			7 (g)	
5,6,7,4'-tetrahydroxy (Scutellarein) (l,g)		6 4' 6,4'	7 (g,l)	7
5,7,3',4'-tetrahydroxy (Luteolin)			7	
Flavanone Skeleton**				
5,7-dihydroxy	2'	2'(g)	2'-methoxy-7 (g)	
5,6,7-trihydroxy (g)			7 (g)	

*



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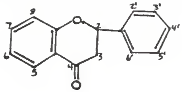


approximately one minute in a blender. Phenolic compounds were then extracted from the powder in 85% methanol overnight on an automatic shaker machine. The resultant solution was filtered and used directly or stored near 0° C until use.

Plant extract was spotted on 46 x 57 cm Whatman 3MM chromatography paper. The chromatograms were then developed in two directions by standard procedures (Mabry et al. 1970). The solvent employed for the first and longer direction consisted of 3 parts tertiary butyl alcohol:1 part glacial acetic acid: 1 part distilled water. Developing time was from 19-25 hours. The chromatogram was then dried for ca 18 hrs. The second direction was developed in 15% acetic acid for 3.5-5.5 hours. It was then dried for ca 6 hrs.

Chromatograms were examined and spots outlined over ultraviolet light. Spots were again examined in the presence of ultraviolet light and ammonia vapors. Spot color and any color change in the presence of NH_3 were noted. R_f values (distance between origin and spot divided by distance between origin and solvent front) were also calculated for each spot. Spots appearing purple, olive green, or yellowish in U.V. light were emphasized. Masses of blue spots near the solvent front and blue spots which appeared only in the presence of NH_3 were not recorded for analysis.

Spots with similar R_f values and color behavior on different chromatograms were assumed to be made by the same compound and were listed in the same column in Table 6.

In preliminary identification work of a sulfated-flavonoid in S. resinosa, a hydrolysis and an electrophoretic technique were used. The hydrolysis consisted of the following procedure: (a) dissolve the precipitate (assumed to be the sulfated-flavonoid) from the plant extract in 1N trifloroacetic acid in a small pear-shaped flask; (b) cover with aluminum foil and place on a steam bath for one hour; (c) rotary evaporate to dryness; (d) add a few drops of water and evaporate to dryness (twice); (e) add ca one ml ethyl acetate and two to four mls of water to the flask, shake, and transfer to a 60 ml separatory funnel; (f) discard the ethyl acetate fraction (with aglycone) and add $BaCl_2$ to the water fraction in a small flask. If a sulfate group was present in the water fraction, it would precipitate out as $BaSO_4$.

All known flavonoids, except those which are sulfated, are nonpolar. Therefore, a quick check for sulfated flavonoids is done by placing the compound in a charged field. The electrophoretic technique used is as follows: (a) flavonoid solutions were spotted in one cm streaks along a center line on 27 by 82 cm Whatman 3MM chromatography paper, each streak separated by one cm; (b) paper was folded in half, wetted with pH 1.9 buffer, placed on a rack and placed in the electrophoresis machine with pH 1.9 buffer (High Voltage Electrophorator Model D, Gilson Medical Electronics); (c) the electrophoretogram was subjected to high voltage for 1½ hours; (d) it was then dried and read over ultraviolet light and ultraviolet light in the presence of ammonia vapor. If any migration occurred, it was noted. Spot color behavior was also recorded.

Results and Discussion. Table 5 lists R_f values and color behavior for flavonoid spots recognized on chromatograms of Great Plains Scutellaria. Table 6 lists the distribution of spots throughout the populations studied, and in Table 7 are the identifications and localities of populations.

Caution must be taken when drawing conclusions from Table 6. Some of the differences seen may be due to the original concentration of the plant extract. Although the presence or structure of phenolic compounds will not change with solution concentration, their recognizability on the chromatogram will. If the spot of the original extract was light in intensity, some resultant separated spots may be too light to recognize as present in the U.V. analysis.

Preliminary identification work of flavonoids suggests that a flavonoid sulfate exists in several Scutellaria taxa. A precipitation occurred in the methanol extract of S. resinosa. This was centrifuged from solution and subjected to three analyses: (a) the dissolved precipitate (in excess hot methanol) showed movement in the electrophoretic analysis. This means that the flavonoid is charged (the only known charged flavonoids are ones that are sulfated). Migration was ca 1 cm. It has been shown that sulfated flavonoids migrage ca 1 cm for each sulfate substituent; therefore, the precipitate is most likely a monosulfated flavonoid; (b) the hydrolysis and $BaCl_2$ test results did show a precipitate, interpreted as $BaSO_4$. This solidifies the conclusion that a sulfated flavonoid occurs in Scutellaria resinosa; (c) the dissolved precipitate was chromatographed (standard two-dimensional) and the R_f value and color behavior were noted. These data suggest that spot number 1 is the sulfated flavonoid. Table 6 shows spot 1 present in S. drummondii, S. resinosa, S. brittonii, S. parvula, S. leonardi, S. australis, and one population of S. lateriflora. This is the first report of a flavonoid sulfate in the Lamiaceae (Harborne 1977).

There are two spots which are common to all but one species. Spot 1 occurs in all species but S. galericulata, and spot 3 occurs in all but S. lateriflora. Two other spots, 2 and 12, occur in all but two of the taxa. This supports the idea that Scutellaria is a cohesive, natural group.

Flavonoid spot pattern is most complex in S. resinosa-S. wrightii, with up to 13 spots, while the least complex patterns are seen in S. brittonii and S. lateriflora, 4 to 6 spots. All species, or species groups, show unique flavonoids except S. galericulata. If S. galericulata is a progenitor of American Scutellaria (e.g., Penland 1924), as may also be supposed by its wide distribution in the Northern Hemisphere, it seems logical that it should share its flavonoids with the other species. Being that there are species specific spots, hybrids within the group could be recognized by analysis of chromatograms of each putative parent and the hybrid. Hybrids usually show a composite spot pattern incorporating both parental patterns.

What does the flavonoid data suggest in regard to the taxonomically problematic groups of S. resinosa-S. wrightii and S. parvula-S. australis-S. lecnardi? Except for spots 21 and 22, which were light in intensity and hard to recognize, there is no difference between S. resinosa and S. wrightii. Within the S. parvula complex there is little difference in spot patterns. S. parvula shows two unique spots, 4 and 23. Spot 4 is a large, fairly dark spot which is in common with S. brittonii. Spot 23 is light in intensity and hard to recognize. These two spots do little to set S. parvula off as a separate species. S. australis and S. parvula show some affinity for each other in sharing spot 8. This can also be seen in their close gross morphologies. S. leonardi, which does not show spot 8, is also most distinct within the complex when analyzing leaf morphology and pubescence.

If defining the Great Plains Scutellaria on flavonoid data alone, the following would result: S. resinosa distinct and most closely allied to S. drummondii; S. brittonii fairly distinct; S. parvula with possibly two varieties; S. galericulata with affinities to most of the rest; and S. lateriflora with similarities to many of the others. This breakdown agrees (except for dividing S. parvula into two varieties) with data collected on mericarp morphology and anatomy.

TABLE 5

R_f values and color behavior in U.V. light and U.V. light plus NH_3 of flavonoid spots recognized on two-dimensional paper chromatograms for Great Plains Scutellaria.

Spot	Color U.V.	Color $+NH_3$	R_f values TBA	R_f values HOAc
1	p	o	.29	.14
2	p	y	.49	.24
3	p	p	.68	.52
4	o	o	.44	.67
5	p	y o	.61	.43
6	o	o	.68	.76
7	p	o	.77	.50
8	p	o	.58	.37
9	p	dk g	.81	.09
10	p	o	.90	.16
11	p	o	.68	.51
12	p	y o	.33	.14
13	y	y	.42	.14
14	y	y	.40	.61
15	p	p	.57	.66
16	p	o	.37	.25
17	p	o	.23	.44
18	p	o	.26	.53
19	p	y or	.60	.37
20	p	p	.72	.61
21	p	p	.60	.02
22	p	p	.71	.01
23	p	o	.13	.06
24	p	y	.74	.00
25	p	o	.49	.29
26	p	p	.52	.40
27	p	p	.77	.65

Color Key:
p = purple   y = yellowish   or = orange
o = olive green   g = green   dk = dark

TABLE 6

Spot distribution for Great Plains Scutellaria. For locality information of the populations studied see Table 7.

Species and Population	Spot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
S. drummondii																											
376	x	x	x					x	x	x				x													
378	x	x	x					x	x	x			x	x													
379	x	x	x					x	x	x	x	x	x	x	x												
S. resinosa																											
151	x	x	x					x	x			x		x		x	x	x	x		x	x					
386	x	x						x	x			x				x			x								
387	x	x						x	x			x				x			x								
388	x	x	x					x	x			x				x			x								
139		x	x					x	x			x		x		x	x	x	x								
160		x	x					x	x			x		x		x	x	x	x	x	x	x					
S. wrightii																											
384	x	x						x	x			x				x			x								
374	x	x	x					x	x			x				x			x	x							
372	x	x	x					x	x			x					x	x	x	x							
S. resinosa - wrightii																											
380	x	x	x					x	x			x				x	x	x	x	x							
382	x	x	x					x	x			x				x	x	x	x	x							
S. brittonii																											
390	x	x	x	x	x		x																				
397	x	x	x	x																							
391	x	x	x	x	x	x																					
398	x	x	x	x																							
401	x	x	x	x		x																					

TABLE 6 (Cont.)

Species and Population	Spot																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
S. *leonardi*																											
353	x	x	x									x															
1016	x	x	x			x						x	x	x									x				
3649	x	x	x			x						x	x	x									x				
S. *parvula*																											
6837	x		x	x		x		x				x	x	x									x				
45036	x	x	x									x											x	x			
S. *australis*																											
345	x	x	x			x		x				x	x	x													
3516	x	x	x					x				x															
6718	x	x	x			x		x				x											x				
S. *galericulata*																											
191			x			x			x	x		x														x	
194			x			x			x	x		x														x	
204			x			x			x	x		x														x	
S. *lateriflora*																											
166						x			x	x																x	x
171	x					x			x	x															x	x	
201									x	x																x	x

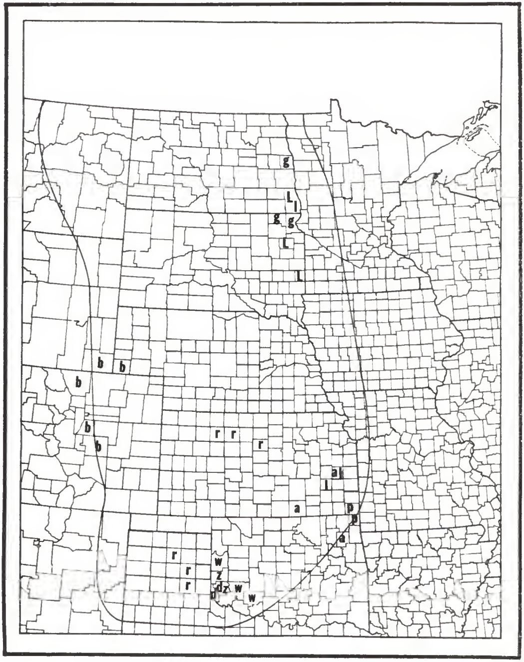
TABLE 7

Identification of populations of Great Plains Scutellaria studied for flavonoids.

Species (sensu Epling 1942)	Population, Locality, Voucher
S. drummondii	Lane 376 Harmon Co., OK (KSC) Lane 378 Greer Co., OK (KSC) Lane 379 Greer Co., OK (KSC)
S. resinosa	Lane 151 Rooks Co., KS (KSC) Lane 386 Donley Co., TX (KSC) Lane 387 Gray Co., TX (KSC) Lane 388 Hutchison Co., TX (KSC) Lane 139 Lincoln Co., KS (KSC) Lane 160 Graham Co., KS (KSC)
S. wrightii	Lane 384 Roger Mills Co., OK (KSC) Lane 374 Kiowa Co., OK (KSC) Lane 372 Comanche Co., OK (KSC)
S. resinosa - wrightii	Lane 380 Greer Co., OK (KSC) Lane 382 Beckham Co., OK (KSC)
S. brittonii	Lane 390 El Paso Co., CO (KSC) Lane 397 Larimer Co., CO (KSC) Lane 391 Douglas Co., CO (KSC) Lane 398 Laramie Co., WY (KSC) Lane 401 Kimball Co., NB (KSC)
S. leonardi	Lane 353 Woodson Co., KS (KSC) Stevens 1016 Richland Co., ND (KANU) Wagenknecht 3649 Anderson Co., KS (KANU)
S. parvula	Wallis 6837 Ottawa Co., OK (KANU) Palmer 54036 Cherokee Co., KS (KANU)
S. australis	Lane 345 Anderson Co., KS (KSC) Barker 3516 Cowley Co., KS (KANU) Wallis 6718 Mayes Co., OK (KANU)
S. galericulata	Lane 191 Marshall Co., SD (KSC) Lane 194 Roberts Co., SD (KSC) Lane 204 Traill Co., ND (KSC)
S. lateriflora	Lane 166 Moody Co., SD (KSC) Lane 171 Coddington Co., SD (KSC) Lane 201 Richland Co., ND (KSC)

Figure 32. Localities of populations sampled for flavonoid study.

Key: g = S. galericulata
L = S. lateriflora
b = S. brittonii
d = S. drummondii
r = S. resinosa
w = S. wrightii
p = S. parvula var. parvula
a = S. parvula var. australis
l = S. parvula var. leonardi
z = pops with both S. resinosa and S. wrightii



POLLEN STUDY

Introduction. Palynological data have proved useful in taxonomy. Tomb and co-workers have shown many relationships within the Lactuceae, especially within subtribal groups (Tomb et al. 1974, Tomb 1975, Feuer and Tomb 1977, Zeleznak 1978). In *Dicentra* (Fumariaceae) external pollen morphology has proved most useful at the species level (Stern 1962).

Palynological data of the Lamiaceae (Leitner 1942, Erdtman 1945) have best been used in consort with several other lines of data to show a natural division within the family (gametophytic and embryonic developmental patterns, internal seed structure data of Wunderlich 1967, and a numerical analysis of over 300 morphological features by El-Gazzar and Watson 1970). There are two discontinuous groups; one is characterized by tricolpate, binucleate pollen grains and as poor in essential oils, and the other shows hexacolpate, trinucleate pollen and rich in essential oils (e.g., *Mentha*). *Scutellaria* belongs to the first group. Pollen morphology has not been shown to be useful in distinguishing between labiate species.

Risch (1940), in his examination of the labiate pollen of Germany, studied four species of *Scutellaria*, including *S. galericulata*, a Great Plains species. Size and general external morphology were noted. Risch along with Wunderlich (1967), who used Risch's diagrams, were the only modern studies of *Scutellaria* pollen morphology.

This study has incorporated light microscopical and scanning electron microscopical external pollen morphological data. Hopes were to elucidate species relationships within Scutellaria. All nine Great Plains species (sensu Epling 1942) representing three sections of the genus were studied: S. brittonii, S. galericulata, S. parvula, S. leonardi, and S. australis of section Galericularia; S. drummondii, S. resinosa, and S. wrightii of section Resinosae; and S. lateriflora of section Lateriflorae.

Materials and Methods. Unopened flowers were taken from herbarium specimens (SMU, KANU, MO, KSC, TEX, and PH) or from the author's pressed field collections. Floral tissue was then softened overnight (sometimes longer) in 10% potassium hydroxide. To remove larger pieces of material, the tissue was mashed through a ca 200 mesh copper screen, rinsed with 95% ethanol, and processed through the acetolysis method (Erdtman 1960, modified by Faegri and Iverson 1964). This method dissolves soft tissues (e.g., cellulose and lignin), leaving only the hard outer pollen wall of sporopollinin (exine) for study.

For scanning electron microscopical study, acetolysed pollen residues in water were placed on round coverslips which were cemented to aluminum stubs with silver paste. Initially the samples were left to air dry. This yielded badly collapsed pollen grains. To prevent this condition, the residues were freeze-dried. Specimen stubs were then coated with gold-paladium alloy in an evaporator while rotating at 45° with respect to the alloy filament. Pollen electron micrographs were recorded for each sample at 3000X (polar and equatorial views) and 10,000X (polar and equatorial regions) on an ETEC Autoscan U-2.

For light microscopical study, acetolysed, aqueous pollen residues were mixed with warm glycerin jelly on a microscope slide. A coverslip was then placed on the mixture and the slide was allowed to cool. The slide was then made permanent by ringing the coverslip with clear nail polish. Each slide represented one population, and three slides were made for each of the nine species. Thirty measurements of equatorial and polar diameter were taken from each slide. Means and standard deviations were calculated from these measurements. Therefore, there were 180 measurements taken per three populations per each species. Most measurements were made at 2000X. When the light microscope slide was thick, the measurements were taken at 800X.

Results and Discussion. Table 1 shows pollen size measurements for all taxa. All populations showed spherical pollen grains, polar to equatorial ratios from 0.97 to 1.05. This disagrees somewhat with Risch (1940) who diagrammed *S. galericulata* pollen as strongly prolate (Fig. 42). It is possible that he was looking at collapsed grains (Fig. 41). Pollen size ranged from 21.2/20.2 micrometers (polar/equatorial lengths) in *S. wrightii* to 25.0/24.3 micrometers in *S. brittonii*. This size pollen grain is among the smallest in the Lamiaceae. Erdtman (1952) stated the range of grain diameter within the mint family as 20 to 125 micrometers. I am not certain that conclusions should be drawn from the grand means as stated in Table 8. A closer examination of the populational means shows a wide variation within a number of the species (e.g., S. australis mean equatorial diameters of 21.2, 20.3, and 30.1 micrometers). The one seemingly large value (two in S. brittonii and one in S. resinosa, S. galericulata, S. leonardi, and S. australis) may be due to very long (a week or more) soaking periods in potassium hydroxide prior to acetolysis. If one ignores the large mean values and looks at only the smaller ones within each species, then S. lateriflora has the largest pollen. Indeed, this is what is shown in Figs. 33, 35, 37, 39, and 43.

External pollen morphology for the taxa studied is remarkably similar. Generally these grains are tricolpate and spherical with a diameter of ca 21.8 micrometers. The surface is minutely perforate throughout. The colpi are long, running to ca 1.3 micrometers from the poles. They are ca 2.6 micrometers wide at the equator. The circumcolpi regions (ca 1.3 micrometers in width) are without sculpturing. These regions coalesce at the poles (Figs. 39 and 43). Between the circumcolpi regions on the bulk of the grain there is a reticulate pattern (Figs. 33-41 and 43). The ridges of the reticulation are ca 0.2 micrometers in height. This general pattern or type grain is seen in S. drummondii, S. brittonii, S. galericulata, S. resinosa, and S. wrightii. Deviation from the type grain is seen in two groups: S. parvula (including S. leonardi and S. australis) and S. lateriflora.

Scutellaria parvula has the same general pattern but may show a greater number of ridges per unit area in the reticulate pattern and slightly shorter ridges (Figs. 33-34). The major deviation is in S. lateriflora, where the pollen grains are not as well defined sculpturally. There are slightly larger and fewer of the minute perforations, and the ridges in the reticulate pattern are not as sharply differentiated as in the type grain (Figs. 35-36). Scutellaria lateriflora pollen could be interpreted as being a more primitive type grain. If it does represent an "ancestral" grain type, it fits well with phylogenetic schemes of several authors, placing S. lateriflora as a progenitor of many North American Scutellaria (e.g., Penland 1924).

The operculum, or that part of the pollen wall which covers the colpus, in Scutellaria dissolves or breaks away from the grain proper in small pieces (Fig. 43). In contrast, pollen of Teucrium canadense shows opercula which break away as a unit, separating via furrows in the pollen wall (Fig. 44). This type data may have taxonomic significance within the Lamiaceae and may yield interesting results if studied between genera.

The palynological data collected here do little to define species within the Great Plains Scutellaria. They do set off S. lateriflora, which is readily defined by gross morphological characters, and they support the fact that Scutellaria is a well defined, natural group.

TABLE 8

POLLEN GRAIN MEASUREMENTS
(Micrometers)

Taxon and Population (sensu Epling 1942)	Mean Eq.* Diam.	S.D.** Eq. Diam.	Mean Polar Length	S.D. Polar Length	Grand Mean Eq.	Grand Mean Polar	Polar to Eq. Ratio
S. brittonii							
Stephens 22812 (KANU)	27.1	1.3	26.7	1.1			
Ramaley 15984 (TEX)	25.6	1.6	26.4	1.5			
Green 47 (PH)	20.2	0.96	21.9	0.90	24.3	25.0	1.03
S. galericulata							
Lane 177 (KSC)	21.3	0.83	22.3	0.83			
Lane 204 (KSC)	22.0	0.79	22.7	0.75			
Lane 198 (KSC)	28.8	1.8	28.1	1.9	24.0	24.4	1.02
S. parvula							
Bush s.n. (MO)	22.9	0.89	22.5	1.2			
Dewart s.n. (MO)	21.8	1.1	23.4	1.0			
Bare 164 (KANU)	20.8	1.2	21.5	1.4	21.8	22.5	1.03
S. australis							
Erlich 343 (KSC)	20.3	1.6	20.8	0.99			
Cory 55540 (SMU)	21.2	0.98	22.1	0.92			
Richards 356 (KANU)	30.1	2.1	29.9	2.3	23.9	24.3	1.02
S. leonardi							
Stephens 53810 (KANU)	22.0	1.0	21.6	0.80			
Lathrop 3411 (KANU)	22.6	0.94	21.2	0.97			
Fish 519 (KSC)	26.3	1.3	26.2	1.3	23.6	23.0	0.97
S. lateriflora							
Lane 200 (KSC)	25.2	1.7	25.5	0.90			
Lane 167 (KSC)	23.6	1.2	23.2	0.75			
McGregor 14616 (KANU)	23.1	1.8	20.9	1.3	24.0	23.2	0.97

TABLE 8 (Cont.)

Taxon and Population (sensu Epling 1942)	Mean Eq.* Diam.	S.D.** Eq. Diam.	Mean Polar Length	S.D. Polar Length	Grand Mean Eq.	Grand Mean Polar	Polar to Eq. Ratio
S. resinosa							
Lane 161 (KSC)	28.4	1.4	27.5	1.3			
Stephens 74750 (KANU)	21.0	0.91	21.2	0.61			
Lane 139 (KSC)	20.2	0.99	20.5	0.85	23.2	23.1	0.99
S. wrightii							
Stephens 20687 (KANU)	20.4	0.80	22.1	0.65			
Stephens 20819 (KANU)	19.5	0.75	21.8	0.46			
Stratton 741 (KANU)	20.8	0.80	19.6	0.77	20.2	21.2	1.05
S. drummondii							
Shinners 19515 (SMU)	19.9	0.90	20.1	0.74			
Correll 29176 (TEX)	21.9	1.2	23.5	0.96			
Merrill 155 (TEX)	22.3	0.80	21.1	0.58	21.4	22.6	1.05

* Equatorial Diameter
** Standard Deviation

Pollen of Scutellaria spp.

Figure 33. SEM micrograph of a pollen grain of *S. parvula*, polar view, line = 5 micrometers. Bare 164 (NY).

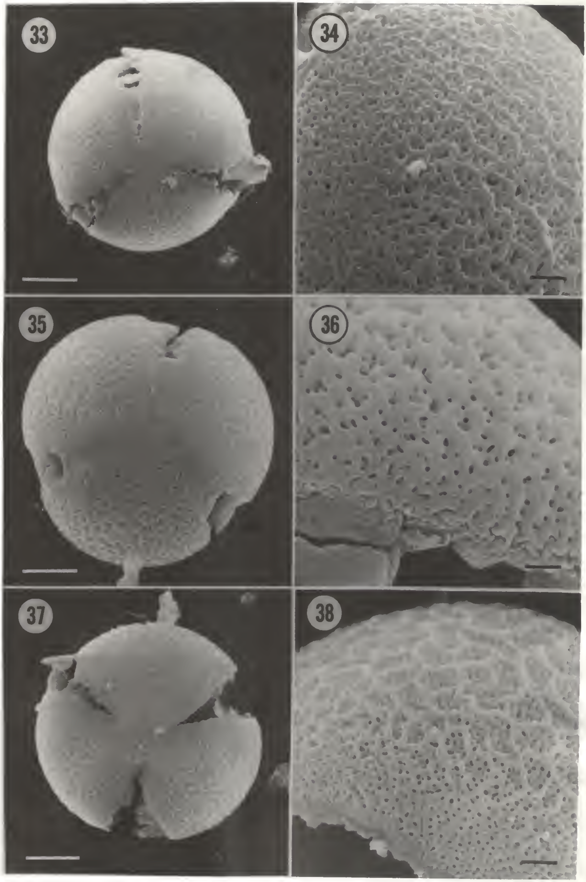
Figure 34. SEM micrograph of pollen grain surface of *S. leonardi*, colpus at upper left, line = 1 micrometer. Norton 411 (NY).

Figure 35. SEM micrograph of a pollen grain of *S. lateriflora*, polar view, line = 5 micrometers. Lane 200 (KSC).

Figure 36. SEM micrograph of pollen grain surface of *S. lateriflora*, colpus across bottom, line = 1 micrometer. Lane 200 (KSC).

Figure 37. SEM micrograph of a pollen grain of *S. galericulata*, polar view, line = 5 micrometers. Lane 198 (KSC).

Figure 38. SEM micrograph of pollen grain surface of *S. galericulata*, colpus at lower left, line = 1 micrometer. Lane 198 (KSC).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Pollen of Scutellaria spp. and Teucrium canadense

Figure 39. SEM micrograph of a pollen grain of *S. drummondii*, polar view, line = 5 micrometers. Shinners 19515 (SMU).

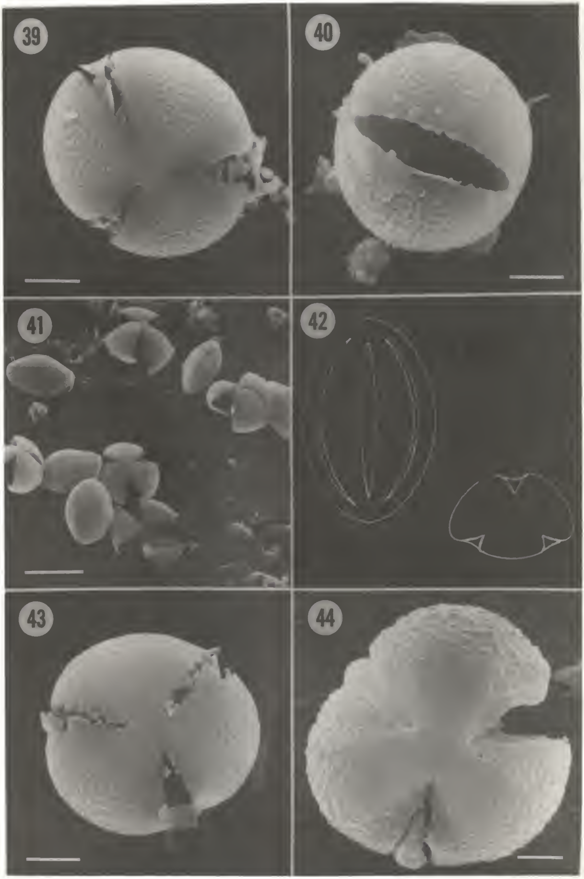
Figure 40. SEM micrograph of a pollen grain of *S. resinosa*, equatorial view, line = 5 micrometers. Lane 161 (KSC).

Figure 41. SEM micrograph of collapsed pollen grains of *S. wrightii*. This condition occurs when air dried from water. Line = 20 micrometers. Stevens 20739 (KANU).

Figure 42. Line drawings of *Scutellaria* pollen taken from Risch (1940). Compare with the collapsed grains of Figure 9.

Figure 43. SEM micrograph of a pollen grain of *S. brittonii*, polar view, line = 5 micrometers. Stephens and Brooks 22812 (KANU).

Figure 44. SEM micrograph of a pollen grain of *Teucrium canadense*, polar view. Compare operculum with that of *Scutellaria* (Fig. 11). Line = 5 micrometers. Hulbert 3306 (KSC).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TAXONOMIC TREATMENT

SCUTELLARIA L. Skullcap

Nonaromatic herbs to subshrubs, all but one of ours perennial; stems quadrangular, procumbant to erect, simple to variously branched; taprooted or rhizomatous with or without underground stolons. Leaves opposite, simple, small and chiefly entire or larger and crenate to serrate; basal leaves usually petiolate, upper ones sessile or petiolate. Inflorescence of axillary or terminal racemes with flowers arising from reduced bracts, or flowers solitary from axils of foliage leaves. Flowers borne on a pedicel 2-4 mm long; calyx zygomorphic, accrescent and closing in fruit, 2-parted, upper lobe with an ascending shield-like protrusion (scutellum); corolla blue to purple, rarely white or pink, falling after anthesis, zygomorphic with a well developed straight or more often sigmoid tube, upper lip galeate, lower lip flattened and expanded with a variously spotted white patch extending to the tube; stamens didynamous and usually covered by the galea, basally abaxial pair adnate ca 0.5 their length, curving up to become the longer pair, adaxial pair adnate 0.6-0.8 their length, anthers 2-celled, ciliate on margins and longitudinally dehiscent; pollen ca 23 micrometers in diameter, tricolpate, reticulately sculptured; stigma inserted between pairs of anthers or in one species exerted from galea, style usually free and gynobasic, ovary 4-lobed. Fruit, 4 mericarps, yellowish to brown or black, spherical to ovoid, 1-1.8 mm axially, verrucose to covered with prominent papillae, with or without a band. (2n=30, 32, 88) Of riparian, marshy, or more often upland habitats. All GP species native.

The name Scutellaria is derived from either of two latin words, scutella meaning a dish or scutellum meaning a little shield. Both terms refer to part of the calyx in fruit.

This is a world-wide genus of ca 300 species.

References: Leonard, E. C. (1927). The North American Species of Scutellaria. Cont. U. S. Nat. Herb. 22:703-748.; Epling, C. (1942). The American Species of Scutellaria. Univ. Calif. Publ. Botany 20:1-146.

1 Flowers in axillary or terminal racemes, each arising from the axil of a reduced bract.

2 Flowers chiefly in axillary racemes; corolla straight, 6-7 mm long; mericarps yellowish....1. S. lateriflora

2 Flowers in terminal racemes; corolla sigmoid, 15-23 mm long; mericarps brown to black.

3 Leaves cordate to truncate at the base; stigma inserted between the pairs of anthers, not exerted from tube; corolla without an internal ring of hair............................2. S. ovata

3 Upper leaves obtuse and somewhat attenuate at the base; stigma/style exceeding stamens in length, stigma exerted 1-2 mm from corolla; corolla with an internal ring of hair...........3. S. incana

1 Flowers two per node, each arising from the axil of a foliage leaf.

4 Leaves thin, shallowly serrate; plants fibrously rooted from lower nodes, rhizomatous; mericarps yellowish or buff, covered with sessile glands; of marshy habitats............................4. S. galericulata

4 Leaves somewhat thickened, chiefly entire; plants taprooted or from thickened rhizomes; mericarps brown to black; of uplands.

5 Plants from thickened rhizomes; mericarps with prominent papillae, usually banded.

6 Flowers less than 1.2 cm long; plants with a moniliform rhizome; mericarps brown with cylendrical blunt papillae, banded........5. S. parvula

6 Flowers more than 1.8 cm long; plants with a thickened rhizome; mericarps dark brown to black with conical papillae, may or may not be banded.. ....6. S. brittonii

5 Plants taprooted; mericarps either somewhat lamellate (imbricate) of finely papillate.

7 Plants perennial; many stemmed from a branched woody crown; mericarps finely and evenly papillate; flowers more than 1.5 cm long.7. S. resinosa

7 Plants usually annual; mericarps somewhat lamellate; flowers less than 1.3 cm long.8. S. drummondii

1. S. lateriflora L., mad-dog or blue skullcap. Delicate upright (procumbant) perennial herb, (1) 2-6 (10) dm tall, stems glabrate, leaves with few hairs usually on veins. Stems simple to variously branched above; fibrously rooted from lower nodes, rhizomatous. Leaves thin, ovate, 3-11 cm long and 1.5-5.5 cm wide, ca 2X longer than wide, crenate to serrate, obtuse to truncate at the base; petiole ca 0.25X as long as blade; leaves progressively reduced upwards. Flowers chiefly in axillary racemes, arising from axils of reduced leaf-like bracts; basal bracts ca 13 mm long and ca 5 mm wide, greatly reduced upwards; calyx ca 2 mm long in flower and ca 3 mm long in fruit, scutellum ca 2 mm tall in fruit, not impressed, clothed with coarse antrorse hairs; corolla 6-7 mm long, tube straight, lower lip less than 2X as wide as tube. Mericarps yellowish, ovoid, ca 1.3 mm axially, covered with short papillae which may be irregularly coalesced. (2n=88) Jul.--Sep. Riparian habitats, usually stream banks; w central to e GP: CO, IA, KS, MN, MO, NE, NM, ND, OK, SD, TX. Native.

2. S. ovata Hill, eggleaf skullcap. Perennial herb 1.8-6 (10) dm tall, stem capitate pilose with slightly smaller eglandular hairs. Plants rhizomatous with slender underground stolons. Leaves thin to slightly thickened or puckered; clothed above with long spreading capitate or eglandular hairs and much shorter eglandular hairs, clothed below with long capitate or eglandular hairs, veins densely covered with

slightly shorter eglandular hairs; cordate to ovate, median leaves (2.5) 3.5-6 (7) cm wide and (4) 5-8 (12) cm long, (1) 1.3 (1.5)X longer than wide, dentate-serrate, truncate to cordate at the base; petiole 0.8-4 (6) cm long, 0.3-0.8X as long as blade. Flowers from axils of reduced leaf-like bracts in terminal racemes, racemes may arise from top 1-2 (3) nodes; bracts ovate-cordate 4-9 mm long and 3-6 mm wide; calyx ca 4 mm long in flower, ca 6 mm long in fruit, scutellum ca 4 mm tall in fruit, impressed; corolla 17-23 mm long, base of tube ca 2 mm in diameter, lower lip ca 10 mm across. Mericarps brown (black), ovoid, evenly covered with prominent conical papillae, with or without a median band laterally. Woods and open woods, often in sandy soil; extreme se GP: KS:Chautauqua Co., Cherokee Co., Linn Co., Miami Co., Wyandotte Co.; MO:Clay Co., Jackson Co., Jasper Co.; OK:Caddo Co., Comanche Co., Garvin Co., Mayes Co., Ottawa Co., Tulsa Co. Native. *S. versicolor* Nutt.--Robinson and Fernald.

This is a widespread, variable species of the e US. Leonard (1927) listed three varieties, while Epling (1942) recognized 12 subspecies. Epling has annotated GP specimens as *S. o.* ssp. *bracteata*, *S. o.* ssp. *versicolor*, and *S. o.* ssp. *mississippiensis*. There is no consistent morphological difference between any of these three ssp. in our range. If there is need to recognize infraspecific taxa, the older varietal names circumscribing larger morphological variation are more appropriate. *S. ovata* var. *bracteata* (Benth.) Blake may be recognized by bracts which exceed the calyces in length and slightly thickened (puckered) leaves. S. ovata var. versicolor (Nutt.) Fern. canbe recognized by virtue of its bracts shorter than the calyces and relatively thin leaves.

3. S. incana Biehler, hoary skullcap. Tall perennial herb, (5) 6-8 (12) dm tall, usually unbranched below the inflorescence, minutely ascending tomentose and dotted with sessile glands throughout, corolla capitate pubescent. Leaves ovate, 6.5-9.5 cm long and 3.5-5 cm wide, ca 2X longer than wide, margin crenate-serrate, base sub-cordate to obtuse on basal leaves, obtuse and somewhat attenuate on the upper ones; petiole 1-2 (3) cm long, shortest above. Inflorescence a panicle of 3-many terminal racemes; bracts small, lanceolate, largest ca 6 mm long and 2 mm wide, margin entire. Flowers single from axils of reduced bracts; calyx 2-3 mm long in flower, 5-6 mm long in fruit, scutellum ca 4 mm tall in fruit, impressed; corolla 15-23 mm long with an internal ring of hair, tube base 2-3 mm in diameter; stigma/style longer than stamens and exerted from corolla 1-2 mm. Mericarps dark brown, spherical-ovoid, ca 1.5 mm axially, covered chiefly with short papillae, giving a verrucose appearance. (2n=30) Jun.--Aug. Upland woods; KS:Cherokee Co., MO:Jasper Co. Native. S. canescens Nutt.--Robinson and Fernald.

This species is widespread e of our range. It rarely has been collected in the GP.

4. S. galericulata L., marsh skullcap. Delicate upright or procumbant perennial herbs, (1.3) 2-6 (10) dm tall, glabrate to sparsely retrorsely strigose, especially on the calyx and undersides of the leaves. Stems simple to freely branching above; fibrously rooted from lower nodes, rhizomatous. Leaves thin lanceolate-ovate, truncate to sub-cordate at the base, shallowly serrate, (1.8) 3-6 (9) cm long and (0.5) 1-2 (3) cm wide, (2.5) 3 (5)X longer than wide, reduced upwards; petiole 0-4 mm long. Flowers axillary, 2 per node in upper part of plant; pedicel 2-3 mm long; calyx strigose and covered with sessile glands, 3-4 mm long in flower and 4-6 mm long in fruit, scutellum ca 3 mm tall in fruit, impressed; corolla (14) 16-19 (21) mm long, tube ca 2 mm in diameter at the base, lower lip ca 7 mm across. Mericarps yellowish to buff, ovoid, ca 1.5 mm axially, uniformly covered with short, blunt papillae and sessile glands. (2n=32) Jun.-Aug. Aquatic habitats, especially marshes; GP except KS, MO, and OK; in TX:Hemphill Co. Native. S. epilobiifolia Hamilt.--Steyermark.

This is a wide spread species of North America and Eurasia. Some taxonomists have called the American specimens S. epilobiifolia and the Eurasian S. galericulata. Epling (1939) studied variation within these two assemblages and concluded that except for a 2 mm mean difference in corolla length, populations on each continent show wide variation with respect to degree of pubescence, and leaf and mericarp morphologies.

Because of overlapping ranges in morpholgical variation, all specimens are here refered to as S. galericulata.

5. S. parvula Michx., small skullcap. Small perennial herbs, 8-25 (30) cm tall, glabrate to appressed scabrescent or capitate pilose, leaves and calyx with or without sessile glands. Plants often branched at base, infrequently above; fibrously rooted from a moniliform rhizome. Leaves slightly thickened, broadly ovate to lanceolate, median leaves 9-20 mm long and 5-15 mm wide, 1.25-2.25X longer than wide, narrowing above; veins anastomosing near margins in pilose plants; basal leaves petiolate, 2-14 mm long. Flowers 2 per node on upper 0.4 of plant, arising from axils of foliage leaves; pedicel 3-4 mm long; calyx 2-3 mm long in flower, 3-5 mm long in fruit, scutellum impressed, arising at ca 45^{o} angle from upper calyx lobe; corolla 6-11 mm long, tube 1-2 mm in diameter, lower lip 4-7 mm across. Mericarps brown, ovoid, ca 1 mm axially, with a prominent band and long, conical, blunt papillae. Apr.--Jun. Upland praires and open woodlands, often of limestone ledges and rocky and/or sandy soil; e GP. Native.

This is a wide spread species of the e US. Three varieties can be recognized in the GP.

1 Plants capitate pubescent; leaves ovate to broadly ovate.

2 Capitate pubescence 0.2-0.35X as long as stem is wide, usually dense; abaxial leaf surface dotted with sessile

glands and many eglandular hairs along veins; median leaves ovate to narrowly ovate......5a. var. parvula

2 Capitate pubescence 0.35-0.7X as long as stem is wide, usually sparse; abaxial leaf surface with long spreading, usually capitate hairs mostly along veins; median leaves broadly ovate to ovate..............5b. var. australis

1 Plants appearing glabrate,or with few antrorse-appressed eglandular hairs; median leaves narrowly ovate to lanceolate................................5c. var. leonardi

5a. S parvula var. parvula. Plants with dense, spreading capitate pubescence 0.2-0.35X as long as stem is wide, usually with shorter retrorse hairs, calyx and abaxial leaf surface dotted with sessile glands, abaxial leaf veins more densely covered with eglandular hairs. Leaves ovate to narrowly ovate, median ones ca 1.7X longer than wide, veins sub-anastomosed near magins, margin revolute. KS, MO, and OK.

This is the least common of the three vars. in the GP. It is rarely found growing near the others. Infrequently, plants have been collected which lack sessile glands on the abaxial leaf surface.

5b. S. parvula var. australis Fassett, southern small skullcap. Plants with long spreading capitate pubescence, 0.35-0.7X as long as stem is wide. Leaves broadly ovate to ovate, median ones ca 1.25X longer than wide, veins anastomosing to form a vein along the leaf margin, sparsely clothed with long capitate hairs above and below, especially along veins, margin slightly, if at all revolute. KS, MO, and OK.

This var. is fairly common within its range in the GP. It can be found growing at the same locality with var. leonardi, although few intermediate plants have been collected. In TX many eglandular plants, otherwise the same as GP var. australis have been collected.

5c. S. parvula var. leonardi (Epl.) Fern., Leonard's small skullcap. Plants glabrate to antrorse-appressed scabrescent, with or without scattered capitate hairs near the base. Leaves ovate to lanceolate, median ones ca 2.2X longer than wide, veins rarely branched or joining at leaf margins, margin quite revolute. e GP. S. leonardi Epl.--Epling, S. ambigua Nutt.--Rydberg, S. parvula var. ambigua (Nutt.) Fern.--Robinson and Fernald.

This is the most common var. in the GP, especially in the e central and ne. It may occur at the same locality as var. australis although few intermediates have been collected.

6. S. brittonii Porter. Ascending perennial herbs, (6) 8-20 (33) cm tall, retrorsely puberulent to clothed with longer retrorse hairs or long spreading capitate hairs. Stems often branched at the base, rarely above; arising from a thickened horizontal rhizome. Leaves slightly thickened, ovate to lanceolate to narrowly elliptic, median leaves 1.5-3.3 cm long and 0.5-1 cm wide, ca 3.3X longer than wide, reduced and narrower above; petiole most pronounced on basal leaves, 5-10 mm long, sub-sessile above. Flowers two per

node in upper 0.5– 0.3 of plant, arising from axils of foliage leaves; pedicel 2-4 mm long; calyx 4-6 mm long in flower, 6-8 mm long in fruit, clothed as stated above and with sessile glands, scutellum 3-4 mm tall in fruit; corolla 19-31 mm long, tube ca 2 mm in diameter at the base, lower lip ca 11 mm across. Mericarps dark brown to black, ovoid, ca 1.7 mm axially, covered with prominent flattened conical papillae, may or may not be banded. May--Jul. Upland praires and open pine woods, rocky and/or sandy soil; extreme w GP: CO, KS, NE, NM, WY. Native. S. brittonii var. virgulata (A. Nels.) Rydb.--Rydberg.

In the GP a puberulent to retrorsely strigose form, with banded mericarps is most common. Few capitate hairs may also be found on stems of these plants. There is also a predominantly long-glandular pubescent form which has been collected w of our range in CO:Boulder Co., Clear Cr. Co., Jefferson Co., and Teller Co. Banded and non-banded mericarps can be found with both forms.

7. S. resinosa Torr., resinous skullcap. Stiff upland perennial herbs (subshrubs), (0.6) 1-3 (5) dm tall, clothed with minute, conical, spreading to strongly retrorse hairs, slightly longer on calyx, plants covered with sessile glands, rarely with scattered spreading capitate hairs. Many stems arising from a branched woody crown, stems persisting to next season; strongly taprooted. Leaves slightly thickened, ovate to elliptic, 6-10 (12) mm wide and (7) 9-13 mm long, reduced

above, ca 1.5X longer than wide, apex rounded, margin entire, base obtuse to attenuate; petiole 1-2 (5) mm long, most pronounced on basal leaves. Flowers 2 per node in upper 0.5-0.75 of plant, arising from axils of foliage leaves; pedicel 2-3 mm long; calyx 2-3 mm long in flower, 4-5 mm long in fruit, scutellum ca 3 mm tall in fruit, impressed; corolla (11) 14-16 (21) mm long, sigmoid, tube 1-2 mm in diameter at the base, lower lip 8-9 (12) mm across. Mericarps dark brown to black, ovoid, ca 1.3 mm axially, uniformly covered with small papillae, giving a pebbled appearance. Apr.--Jun. Dry rocky-sandy upland short to mid grass praires; KS, OK, TX. Native. S. wrightii Gray--Correll and Johnston.

The name S. resinosa originally was published to circumscribe a group of plant populations (as described here) which occurred in the GP into TX, NM, and Mex. Before S. brittonii was described, specimens belonging to that name also were called S. resinosa. Asa Gray, misunderstanding the circumscription of S. resinosa, placed this name only on specimens now referred to as S. brittonii, and renamed the old S. reinosa populations S. wrightii. This error was recognized by Porter(1894) when he replaced S. resinosa where originally described, described S. brittonii, and reduced S. wrightii to a synonym of S. resinosa. Epling (1942) changed the concept of the names S. resinosa and S. wrightii, defining them more narrowly, when he ascribed the former name to a group of more northern populations with spreading pubescence and reportedly ovate leaves, and the latter to a more southern group with retrorse pubescence and elliptic leaves. Leaf shape is not consistently different between Epling's two species, in fact, in one of the northern most papulations, plants show elliptic leaves and spreading pubescence. There is a north/south and east/west difference in angle of pubescence, but there is no sharp line between Epling's two species. As one procedes from n KS or the TX panhandle into sw OK, angle of pubescence changes from slightly antrorse/slightly retrorse to slightly retrorse/ moderately retrorse to moderately retrorse/strongly retrorse. Intermediate populations have individuals which can be keyed out to both of Epling's species. Because of the lack of populational integrity of S. resinosa versus S. wrightii (sensu Epling), all specimens are here referredto as S. resinosa (sensu Torrey or Porter).

Scutellaria resinosa is quite variable s of the GP. Many collections from near Dallas, TX have narrowly elliptic leaves. Few other TX populauions show pubescence grading into that of S. drummondii.

8. S. drummondii Benth. Small upland annual, rarely perennial in extreme s GP, 5-20 (28) cm tall, densely capitate pilose, especially on younger parts, with or without less conspicuous retrorse or spreading eglandular hairs, leaves and calyx with sessile glands. Stems often branched at base, less often above, arising from a slender taproot. Leaves ovate, less often elliptic, larger ones 1.1-1.5 (2.4) cm long and

0.6-1 (1.6) cm wide, ca 1.5X longer than wide, apex rounded-acute, margin entire, lowest leaves may have few shallow teeth, base attenuate; petiole 0-9 (20) mm long, longest on lower leaves, ca 1-2 mm long on upper ones. Flowers 2 per node in upper 0.5-0.7 of plant, arising from axils of foliage leaves; pedicel 2-3 mm long; calyx 2-4 mm long in flower, ca 5 mm long in fruit, scutellum arising at ca 45° angle from upper lobe; corolla 6-10 (13) mm long, tube ca 1 mm in diameter at the base, lower lip 3-5 mm across. Mericarps dark brown to black, ovoid, ca 1.3 mm axially, covered with large flattened conical papillae and lamellae (especially on ventral surface). Apr.--Jun. Upland praires or open woodlands, often in sandy or rocky soils; OK, TX. Native.

REPRESENTATIVE SPECIMENS:

1. Scutellaria lateriflora:
COLORADO: Yuma Co.: 5 Aug. 1909, Osterhout 4080 (NY).

IOWA: Clay Co.: Mud Lake, 30 July 1937, Hayden 9045 (SMU). Greene Co.: 7 mi ne Jefferson, 11 Aug. 1969, Davidse 1859 (MO). Palo Alto Co.: 0.8 mi nw Graettinger, 7 Aug. 1940, Hayden 1939 (PH). Washington Co.: 6 mi se Riverside, 31 Aug. 1953, Wagenknecht 1182 (KANU).

KANSAS: Allen Co.: 2 mi w Iola, 31 Aug. 1970, Stephens 44475 (KANU). Atchison Co.: 0.5 mi n Atchison, 21 Aug. 1952, Blocker 444 (KSC). Barber Co.: 0.5 mi s Sun City, 5 Aug. 1959, McGregor 14715 (KANU). Brown Co.: State Lake, 14 Aug. 1961, McGregor 17079 (KANU). Chatauqua Co.: 3.5 mi e, 10.5 mi n Sedan, 2 Oct. 1970, Stephens 46094 (KANU). Cherokee Co.: 5 mi e Baxter Springs, 12 Aug. 1960, McGregor 15922 (KANU). Cheyenne Co.: 5 mi s, 7 mi w St. Francis, 25 July 1953, Horr 4700 (KANU). Clay Co.: 3 mi se Clay Center, 11 Oct. 1976, McGregor 30049 (KANU). Cowley Co.: State Lake, 27 Aug. 1976, McGregor 29525 (KANU). Decator Co.: State Lake, 29 July 1964, Harms 1772 (KANU). Douglas Co.: 3 mi se Baldwin, 20 Aug. 1941, McGregor 614 (KANU). Elk Co.: 1 mi n Grenola, 18 Sep. 1975 Stephens 88232 (KANU). Ellsworth Co.: Kanopolis Res., 12 Aug. 1964, Kolstad & Harms 1945 (KANU). Franklin Co.: 4 mi e Ottawa, 2 Oct. 1975, Stephens 88591 (KANU). Geary Co.: 8 mi s Junction City, 14 July 1972, Stephens 56968 (NY). Hamilton Co.: Syracuse, 13 July 1893, Thompson 115 (NY). Jackson Co.: Praire Lake (Holton), 19 Aug. 1964, Kolstad & Harms 2079 (KANU). Jefferson Co.: sw edge Perry, 15 Sep. 1976, McGregor 29770 (KANU). Leavenworth Co.: State Lake, 21 Sep. 1976, McGregor 29899 (KANU). Lincoln Co.: 3 mi sw Sylvan Grove, 9 Aug. 1976, McGregor 29359 (KANU). Linn Co.: 1 mi n 1 mi w Trading Post, 13 Aug. 1971, Stephens 51028 (KANU). Marion Co.: 1 mi s Florence, 15 Oct. 1974, Stephens 83524 (KANU). Marshall Co.: w edge Marysville, 20 Sep. 1976, McGregor 29813 (KANU). McPherson Co.: State Lake, 7 Aug. 1976, Seiler 5815 (KANU). Miami Co.: 1 mi n, 0.5 mi e Fontana, 26 Aug. 1970, Stephens & Brooks 44262 (KANU). Montgomery Co.: 1.5 mi s Liberty, 31 Aug. 1970, Stephens 44465 (KANU). Morris Co.: 5.5 mi n Council Grove, 12 Oct. 1974, Stephens 83363 (KANU). Nemaha Co.: 3 mi w Bern, 3 Aug. 1970, Magrath 5708 (KANU). Osage Co.: 11 mi n, 1 mi e Lyndon, 2 Sep. 1972, Stephens (KANU). Ottawa Co.: 5 mi n, 1 mi e Bennington, 16 Aug. 1972, Stephens 59113 (KANU). Pottawatomie Co.: State Lake #2, 7 Sep. 1976, McGregor 29614 (KANU). Reno Co.: 31 july 1899, White 73 (MO). Republic Co.: sec. 2 T35 R3W, 22 Aug. 1960, Morley 856 (KANU). Riley Co.: s edge Manhattan, 8 Sep. 1976, McGregor 29710 (KANU). Russell Co.: 8 mi s lucas, 10 Aug. 1976, McGregor 29387 (KANU). Scott Co.: 14 mi n, 1 mi w Scott City, 17 July 1972, Stephens 57147 (KANU). Shawnee Co.: State Lake, 17 Aug. 1964, Kolstad 2062

(KANU). Stafford Co.: sec.20 T21S R11W, 13 Aug. 1958, Ungar 663 (KANU). Wabaunsee Co.: Lake Wabaunsee, 3 Oct. 1974, Brooks 8925 (KANU). Wallace Co.: 1 mi s 1.5 w Wallace, 18 July 1975, Stephens 86514 (KANU). Washington Co.: 0.3 mi w Arlington, 8 Sep.1972, Stephens 60741 (KANU). Woodson Co.: State Lake, 13 Aug. 1964, Harms 1983 (KANU).

MINNESOTA: Kittson Co.: Boggy Cr., Two Rivers State Park, 18 July 1941, Johnson 465 (NY). Wilkin Co.: 0.5 mi n Kent, 18 Aug. 1974, Brooks 8384 (KANU).

MISSOURI: Atchison Co.: swales Watson, 3 Sep. 1920, Bush 9180 (MO). Cass Co.: wet bottoms, 15 Aug. 1864, Broadhead s.n. (MO). Jackson Co.: 26 Aug. 1893, Bush s.n. (MO). Jasper Co.: Neck City, 8 Sep. 1909, Palmer 1909 (MO). Linn Co.: Lewis Lake, 21 Sep. 1955, Steyermark 79835 (KANU).

NEBRASKA: Adams Co.: 1 mi n 0.2 w Ayr, 24 Aug. 1970, Magrath 6104 (KANU). Buffalo Co.: 1 mi s Elm Cr., 14 July 1968, McGregor & Bare 1655 (KANU). Butler Co.: 3 mi s 1.5 e David City, 7 Sep. 1972, Stephens 60597 (KANU). Cass Co.: 2 mi se Louisville, 5 July 1934, Morrison 1206 (MO). Chase Co.: 4 mi n Imperial, 28 Aug. 1966, McGregor 20137 (KANU). Cherry Co.: 20 mi s 6 w Valentine, 30 Aug. 1967, McGregor & Bare (KANU). Cuming Co.: 1 mi s Beemer, 4 Sep. 1969, Stephens 36405 (KANU). Custer Co.: 0.5 mi s Arnold, 31 Aug. 1965, McGregor 19588 (KANU). Dundy Co.: n of Rock Cr. Fish Hatcheries, 29 July 1941, Tolstead 411149 (MO). Greeley Co.: 2 mi s Scotia, 2 Aug. 1967, Stephens 15726 (KANU). Hamilton Co.: 0.5 mie 5 n Marquette, 5 Sep. 1972, Stephens 60355 (KANU). Harlan Co.: 1 mi se Republic City, 30 Aug. 1965, McGregor 19507 (KANU). Hayes Co.: 8 mi ne Hayes Center, 7 Aug. 1941, Tolstead 411599 (MO). Howard Co.: 4 mi n St. Paul, 28 Aug. 1967, McGregor & Bare 403 (KANU). Kearney Co.: 0.7 mi w 1 n Denman, 23 Aug. 1970, Magrath 6000 (KANU). Merrick Co.: 0.5 mi w Merrick-Polk Co. line, 22 Aug. 1970, Magrath 6051 (KANU). Nance Co.: 1 mi s Fullerton, 6 Sep. 1972, Stephens 60453 (KANU). Pawnee Co.: 3 mi e 1 n Burchard, 4 Sep. 1970, Stephens 44604 (KANU). Polk Co.: 0.5 mi s Silver City, 13 Aug. 1977, Lane 215 (KSC). Red Willow Co.: 1 mi s Bartley, 4 Oct. 1967, Stephens 19045 (KANU). Richardson Co.: Herr Marsky pasture nw Humboldt, 13 July 1974, Shildneck C-6839 (KANU). Stanton Co.: 1 mi s Pilger, 6 Sep. 1970, Stephens 44744 (KANU). Thomas Co.: 1 mi w Thedford, 27 Aug. 1968, Stephens 23238 (KANU). Webster Co.: 1.5 mi s Rëd Cloud, 24 Aug. 1970, Magrath 6083 (KANU).

NORTH DAKOTA: Barnes Co.: Valley City, 14 Aug. 1977, Lane 210 (KSC). Cass Co.: 6.5 mi n 1 e Leonard, 12 Sep. 1970, Stephens 45076 (KANU). Eddy Co.: 3 mi s warwick, 9 Aug. 1973, Larson 3724 (KANU). Emmons Co.: 14 mi w 3 s Hazelton, 10 Aug. 1972, Williams 1322 (KANU). Griggs Co.: 5.5 mi n

1 w Binford, 7 Aug. 1973, Larson 3627 (KANU). McHenry Co.: Towner, 21 July 1908, Leeds s.n. (NY). Pembina Co.: 5 mi n Mountain, 25 July 1967, Stephens 14712 (KANU). Ransom Co.: 5 mi nw Lisbon, 21 Aug. 1970, Seiler 2645 (KANU). Richland Co.: along moist stream bank, on rd.3, 1.8 mi s ND 46, 14 Aug. 1977, Lane 199 (KSC). Rolette Co.: 0.5 mi n 7 w St. John, 16 july 1973, Larson 2920 (KANU). Traille Co.: 2 mi e Gailsburg, 30 July 1973, Larson 3287 (KANU). Walsh Co.: 1 mi n 5.5 w Grafton, 1 Aug. 1973, Larson 3465 (MO).

OKLAHOMA: Mayes Co.: below dam at Lake Spavinaw, 11 Aug. 1967, Mitchell 3684 (LL). Oklahoma Co.: 2.5 mi s Harrah, 26 July 1941, Waterfall 3089 (NY). Osage Co.: Pawhuska, 9 Aug. 1913, Stevens 1984 (MO). Ottawa Co.: Sycamore Cr. at Rt. 10, 20 Aug. 1965, Correll & Correll 31415 (LL).

SOUTH DAKOTA: Coddington Co.: Banks of Big Sioux River, 14 Aug 1977, Lane 167 (KSC). Day Co.: w side Blue Dog Lake, 10 Aug. 1977, Lane 174 (KSC). Marshall Co.: 6 mi e 4 n Britton, 11 Sep. 1968, Stephens 29086 (KANU). Moody Co.: 0.5 mi w Trent, 10 Aug. 1977, Lane 164 (KSC). Todd Co.: 2 mi s 1 e Parmelee, 31 July 1965, Harms 3173 (KANU). Yankton Co.: 1 mi s Volin, 7 Sep. 1970, Stephens 44784 (KANU).

TEXAS: Hemphill Co.: below dam at Club Lake, 6 Oct. 1964, Correll 30235 (LL). Oldham Co.: 2 mi n Tascosa, Aug. 1949, York & Rodgers 358 (SMU).

2. Scutellaria ovata:
MISSOURI: Jasper Co.: Scotland, 27 June 1909, Palmer 2351 (MO). Jackson Co.: Courtney, 15 June 1922, Bush 9792a (MO). Clay Co.: Independence, 15 June 1895, Bush 484 (MO).

KANSAS: Chautauqua Co.: 8 Aug. 1896, Hitchcock s.n. (KSC). Cherokee Co.: 1.5 mi s Galena, 19 July 1961, Richards 3089 (KANU). Linn Co.: 1 mi n 3 w Farlinville, 26 June 1969, Stephens 32662 (KANU). Wyandotte Co.: 8 Aug. 1897, Clothier & Whitford s.n. (KSC).

OKLAHOMA: Comanche Co.: Medicine Park, 19 June 1936, Palmer 2351 (MO). Murray Co.: 1.5 mi w Turner Falls, 16 June 1944, Muncrief 81 (TX). Ottawa Co.: 9 mi s Wyandotte, 15 July 1929, Stratton 1715 (KANU).

3. Scutellaria incana:
KANSAS: Cherokee Co.: Baxter Springs, Aug. 1892, Hitchcock s.n. (KSC).

4. Scutellaria galericulata:

COLORADO: Boulder Co.: edge of Cr., Lyons, 18 May 1891, Griffiths s.n. (MO). Larimer Co.: Ft. Collins, 9 July 1896, Baker s.n. (MO).

IOWA: Clay Co.: swampy margin Mud Lake, 27 June 1934, Hayden 9082 (PH). Dickinson Co.: 3 mi w 1 n Iowa Lakeside Lab, 15 Aug. 1950, Whitehouse 23657 (SMU). Emmet Co.: bogs, 27 July 1884, Cratty s.n. (MO). Greene Co.: 5 mi sw Scranton, 7 Aug. 1952, Fay 4608 (SMU). Hamilton Co.: Goose Lake near Jewell, 6 July 1935, Goodman 2714 (TEX).

MINNESOTA: Hubbard Co.: small stream, Park Rapids, 2 July 1930, Palmer 36832 (MO).

MONTANA: Hill Co.: 6 mi sw Havre, 21 July 1973, Stephens 68396 (NY).

NEW MEXICO: Colfax Co.: 2 mi w Ute Park, 9 Aug. 1967, Correll & Correll 34613 (LL). Mora Co.: 0.5 mi n Wagon Mound, 23 June 1967, Crutchfield 3130 (LL).

NEBRASKA: Dawson Co.: Swezey 109 (NY). Kearney Co.: 3 mi e Kearney, 13 July 1966, Stephens 6703 (KANU).

NORTH DAKOTA: Benson Co.: 1.5 mi s 1 w Tokio, 23 Aug. 1973, Larson 4104 (KANU). Bottineau Co.: Cr. bank, Antler, 28 July 1912, Bergman 2483 (PH). Eddy Co.: Sheyenne, 4 July 1908, Lunell s.n. (MO). Emmons Co.: 13 mi e Hazelton, 14 July 1972, Williams 1171 (MO). Griggs Co.: 0.3 mi e Hannaford, 12 Aug. 1977, Lane 214 (KSC). Ramsey Co.: 7 mi n 1 w Lawton, 28 June 1973, Larson 2454 (MO). Rolette Co.: Rolla, 16 July 1891, Waldron s.n. (NY). Traille Co.: 3.4 mi n Colgate, 11 Aug 1977, Lane 204 (KSC).

SOUTH DAKOTA: Brookings Co.: Lake Campbell, 28 July 1899, Douglas s.n. (NY). Coddington Co.: South Shore, 3 Aug. 1940, Johnson 27 (MO). Day Co.: w side Blue Dog Lake, 10 Aug. 1977, Lane 175 (KSC). Lawrence Co.: Iron Cr. Lake, 27 July 1939, Bennett 953 (PH). Marshall Co.: 8 mi e Lake City, 10 Aug. 1977, Lane 185 (KSC). Pennington Co.: 16 mi w Rapid City, 15 July 1925, Lee s.n. (MO). Roberts Co.: 7.5 mi w Sisseton, 10 Aug. 1977, Lane 192 (KSC). Stanley Co.: Ft. Pierre, 1853-4, Hayden s.n. (MO).

TEXAS: Hemphill Co.: 7 mi e Canadian, 7 July 1963, Correll & Ogden 28311 (LL).

WYOMING: Albany Co.: 15 mi w Laramie, 3 Aug. 1958, Porter & Porter 7616 (NY).

5a. Scutellaria parvula var. parvula:
KANSAS: Anderson Co.: 3 mi s Garnet, 20 May 1967, Bare 164 (KANU). Cherokee Co.: 1.5 mi s Galena, 29 May 1952, Palmer 54036 (KANU). Cowley Co.: June 1898, White s.n. (KSC). Elk Co.: 3 mi w Elk Falls, 6 May 1967, Stephens 10755 (NY). Labette Co.: Edna, 28 June 1929, Rydberg & Imler 378 (KANU). Riley Co.: Manhattan, 21 July 1892, Clothier s.n. (MO). Wilson Co.: Roper, 14 May 1896, Haller s.n. (KSC).

5b. Scutellaria parvula var. australis:
KANSAS: Anderson Co.: 4.5 mi s Welda, 17 May 1957, Richards 356 (KANU). Bourbon Co.: 2 mi ne Union Town, 1 May 1955, McGregor 10007 (KANU). Chautauqua Co.: 0.5 mi n Sedan, 22 June 1975, Stephens 85468 (KANU). Cherokee Co.: se Monmouth, 2 May 1930, Jacobs 54 (KSC). Cloud Co.: 1930, Fraser 447 (KSC). Cowley Co.: State Lake, 18 May 1967, Barker 3566 (KANU). Crawford Co.: 5 mi s Walnut, 16 May 1961, Holland 71 (KSC). Douglas Co.: 8 mi n Ottawa, 19 May 1936, Osborn 675R (KSC). Franklin Co.: 3 mi se Homewood, 14 May 1955, McGregor 10035 (KANU). Labette Co.: 4.5 mi w Dennis, 6 May 1970, Stephens 37726 (KANU). Linn Co.: 3.5 mi n 3 e Prescott, 16 June 1975, Brooks 10321 (KANU). McPherson Co.: 1 mi s 5 e Lindsborg, 11 June 1975, Stephens 85114 (KANU). Miami Co.: 26 May 1888, Oyster s.n. (NY). Montgomery Co.: 3 mi sw Elk City, 11 May 1957, McGregor 12830 (KANU). Neosho Co.: 1 mi e 1.5 n Erie, 8 May 1965, Holland 888 (KANU). Riley Co.: Manhattan, 28 May 1892, Zeigler s.n. (KSC). Saline Co.: w Kipp, 16 May 1930, Hansin s.n. (KSC). Sedgwick Co.: Wichita, May 1892, Miller s.n. (KSC). Shawnee Co.: Topeka, May 18--, Popenoe s.n. (KSC). Sumner Co.: 8 mi n 2.5 w Caldwell, 31 May 1975, Stephens 84591 (KANU). Wilson Co.: Neodesha, 15 May 1937, Vaugn s.n. (KANU). Woodson Co.: sec.32 R15E T23S, 26 May 1955, Lathrop 357 (NY).

OKLAHOMA: Cleveland Co.: dry sandy ridges, 23 May 1936, Demaree 12781 (SMU). Comanche Co.: Craterville Park, 23 Apr. 1938, McLean 138 (TEX). Mayes Co.: 2.8 mi ne Locust Grove, 11 May 1958, Wallis 6718 (SMU). Oklahoma Co.: 1.5 mi ne Spencer, 12 May 1940, Waterfall 1960 (NY). Ottawa Co.: 6 mi n Turkey Ford, 22 Apr. 1967, Stephens 10509 (KANU). Payne Co.: 8 mi e 1.5 s Stillwater, Hughes 59 (MO). Pawnee Co.: 1 mi s Pawnee, 26 Apr. 1969, Ehrlich 343 (KSC). Tulsa Co.: Mohawk Park, 1 May 1948, Dean 79 (SMU).

5c. Scutellaria parvula var. leonardi:
IOWA: Clay Co.: at outlet Lost Island Lake, 8 July 1935, Hayden 9085 (SMU). Guthrie Co.: Springbrook St. Park, 1 June 1952, Fay 2288 (SMU). Madison Co.: 5 mi sw Winterset, 26

Sep. 1940, Hayden 8584 (TEX). Palo Alto Co.: 5 mi e Ruthven, 22 May 1936, Hayden 9087 (PH). Union Co.: sec.28 Douglas Twp., 30 June 1952, Fay 3195a (SMU).

KANSAS: Anderson Co.: 3.2 mi s Garnet, 14 May 1970, Johnson & Bare 2453 (KANU). Brown Co.: 29 July 1897, Clothier & Whitford s.n. (KSC). Butler Co.: 2 mi s Latham, 13 May 1966, Stephens 3078 (KANU). Chase Co.: 4 mi s Matfield Green, 7 June 1966, Stephens 4528 (KANU). Chautauqua Co.: 1.5 mi e Cedarvale, 7 June 1960, Hulbert 3371 (KSC). Clay Co.: Clay Center, 1929, Weber s.n. (KSC). Cloud Co.: 4 mi e Miltonville, 7 June 1969, Magrath, Hayes, Taylor, & Taylor 4108 (KANU). Coffey Co.: 1 mi w New Strawn, 31 July 1974, Bare 2656 (KANU). Cowley Co.: 9 June 1955, McGregor 10384 (KANU). Dickinson Co.: 5 mi s Woodbine, 21 May 1969, Stephens 30809 (KANU). Douglas Co.: 2 mi w Lawrence, 1 May 1941, McGregor 436 (KANU). Elk Co.: 3 mi w Grenola, 24 June 1975, Stephens 85556 (KANU). Franklin Co.: 4 mi ese Ottawa, 27 May 1959, Hulbert 3396 (KSC). Greenwood Co.: 28 June 1930, Horr s.n. (KANU). Harvey Co.: 4.5 mi n Burrton, 11 June 1951, Horr & McGregor 3730 (KANU). Jewell Co.: 2 mi w Lovewell, 11 July 1975, Stephens 86137 (KANU). Linn Co.: town reservoir, Pleasanton, 19 June 1929, Rydberg & Imler 73 (KANU). Lyon Co.: Emporia, 24 May 1892, Bell 48 (KSC). Marion Co.: 12 mi n Hillsboro, 20 June 1960, Hulbert 4011 (KSC). Miami Co.: 5 mi sw Lancaster (New), 12 June 1957, Wagenknecht 3747 (KANU). Mitchell Co.: July 1896, Dwyer s.n. (KSC). Montgomery Co.: 1 mi s Sycamore, 31 May 1955, McGregor 10208 (KANU). Morris Co.: 30 July 1895, Norton s.n. (KSC). Neosho Co.: 3 mi sw Thaler, 26 May 1967, Holland 1954a (KSC). Osage Co.: 5 June 1899, Brown s.n. (KSC). Pottawatomie Co.: ne Garrison, 25 May 1952, Fish 519 (KANU). Republic Co.: sec.27 T4S R3W, 22 June 1960, Morley 293 (KANU). Riley Co.: 6 mi nw Manhattan, June 1962, McMurphy s.n. (KSC). Shawnee Co.: n Auburn, 7 July 1927, Maus 856 (KSC). Wabaunsee Co.: 2 mi s Maple Hill, 31 May 1969, McGregor 20407 (KANU). Washington Co.: nw Linn, 1935-36, Dodd 107 (KSC). Wilson Co.: 6 mi n Neodesha, 8 June 1960, Hulbert 3914 (KSC). Woodson Co.: sec.14 T26S R14E, 5 June 1955, Lathrop 589 (KANU). Wyandotte Co.: Rosedale, 12 July 1896, McKenzie s.n. (KSC).

OKLAHOMA: Rogers Co.: Catoosa, 8 May 1895, Bush 1253 (MO).

MINNESOTA: Redwood Co.: 8 mi s Sacred Heart, 22 June 1940, Moore 13202 (NY). Renville Co.: 1 mi e Fairfax, 22 June 1940, Moore 13219 (SMU). Rock Co.: 3 mi n Luverne, 28 June 1941, Johnson 328 (NY). Yellow Medicine Co.: near w boundary MN, 15 Aug. 1908, Moyer s.n. (NY).

MISSOURI: Atchison Co.: Watson, 7 June 1894, Bush 484 (MO).

Bates Co.: 2 mi se Merwin, 2 June 1938, Steyermark 5720 (MO). Caldwell Co.: 1.5 mi s Kingston, 23 June 1938, Steyermark 6073 (MO). Cass Co.: 30 June 1864, Broadhead s.n. (MO). Clinton Co.: 3 mi s Cameron, 22 June 1938, Steyermark 6009 (MO). Jackson Co.: Independence, 27 May 1894, Bush 825 (MO). Jasper Co.: Webb City, 18 May 1903, Palmer 510 (MO). Nodaway Co.: 2.5 mi se Pickering, 20 June 1938, Steyermark 5890 (MO).

NEBRASKA: Hall Co.: pasture n Platt River, s Wood River, 28 May 1962, Lemaire 2028 (KSC). Cuming Co.: 4 mi nw West Point, 2 June 1970, Stephens 38624 (KANU). Jefferson Co.: 2 mi sw Jansen, 30 May 1972, Stephens 53810 (KANU). Lancaster Co.: Lincoln fairgrounds area, 28 May 1954, Kiener 29582 (KANU). Nuckolls Co.: Ruderal Farm, July 1898, Hedgcock s.n. (MO). Richardson Co.: sw corner Salem Village, 15 May 1974, Shildneck 6231 (KANU). Rock Co.: 1.5 mi w Newport, 4 June 1970, Stephens 38862 (KANU). Sarpy Co.: Gretna Fish Hatchery, 29 June 1975, Churchill 6100a (KANU).

NORTH DAKOTA: Richland Co.: Abercrombie, 6 July 1947, Stevens 1016 (SMU).

SOUTH DAKOTA: Brookings Co.: Brookings, 26 June 1894, Thornber s.n. (MO).

6. Scutellaria brittonii:
COLORADO: Arapahoe Co.: 5 mi sw Kenwood, 29 May 1940, Pohl 1932 (PH). Douglas Co.: 4 mi e Franktown, 9 June 1978, Lane 391 (KSC). Elbert Co.: 4 mi s Elbert, 12 June 1968, Stephens 22471 (KANU). El Paso Co.: 0.5 mi w 4 n Peyton, 9 June 1978, Lane 390 (KSC). Larimer Co.: 0.3 mi n Virginia Dale, 9 June 1978, Lane 397 (KSC). Las Animas Co.: 26 mi w Trinidad, 3 July 1937, Rollins 1802 (MO). Weld Co.: New Windsor, 4 June 1900, Osterhout 2286 (NY).

KANSAS: Cheyenne Co.: 12 mi n 12 w St. Francis, 23 June 1971, McGregor 23904 (KANU).

NEBRASKA: Kimball Co.: 1 mi e Pine Bluffs WY, 10 June 1978, Lane 401 (KSC).

WYOMING: Albany Co.: e of Laramie, 14 June 1943, Porter 3199 (NY). Converse Co.: upper Wagon Hound Cr., Box Canyon, 6 June 1931, Rollins 26 (MO). Laramie Co.: 3.3 mi n Burns, 10 June 1978, Lane 398 (KSC). Platte Co.: 3.5 mi w Guernsey, 24 May 1948, Wherry s.n. (PH).

7. Scutellaria resinosa:

KANSAS: Ellis Co.: 2 mi w Hays, 18 June 1935, Shepherd 99 (MO). Ellsworth Co.: 2.5 mi n Wilson, 2 June 1969, Stephens 31106 (NY). Graham Co.: 11.1 mi s Bogue, 3 July 1977, Lane 159 (KSC). JewellCo.: 3 mi w 6 s Mankato, 18 June 1971, Stephens 48502 (KANU). Lincoln Co.: 3 mi n 1.5 w Beverly, 7 June 1969, Magrath 4119 (NY). Ness Co.: 5 mi s Ness City, 14 June 1972, Stephens 55094 (NY). Osborn Co.: within 5 mi Osborn City, 3 June 1894, Shear 82 (NY). Philipps Co.: 5 mi e Kirwin, 11 June 1978, Lane 404 (KSC). Rooks Co.: State Lake, 2 July 1977, Lane 148 (KSC). Russell Co.: 3mi e 3 s Luray, 2 July 1977, Lane 143 (KSC). Smith Co.: 0.8 mi s Smith Center, 29 June 1961, Richards 2901 (SMU). Trego Co.: 14 mi s Ogallala, 20 May 1962, McGregor 17144 (NY).

OKLAHOMA: Beckham Co.: 8.5 mi n Sayre, 6 June 1978, Lane 382 (KSC). Caddo Co.: 5 mi w Apache, 11 May 1968, Stephens 20297 (KANU). Comanche Co.: 0.2 mi e, sw gate Wichita Mts. Wildlife Refuge, 2 June 1978, Lane 371 (KSC). Ellis Co.: 12 mi n Shattuck, 8 May 1974, Stephens 75110 (NY). Greer Co.: 2 mi s Mangum, 6 June 1978, Lane 380 (KSC). Harmon Co.: 15 mi s Erick, 3 June 1978, Lane 377 (KSC). Jackson Co.: 7 mi ne El Dorado, 3 June 1978, Lane 375 (KSC). Kiowa Co.: 0.1 mi s Tom Steed Res. dam, 2 June 1978, Lane 374 (KSC). Roger Mills Co.: 5 mi n Cheyenne, 7 June 1978, Lane 384 (KSC). Washita Co.: near Rocky, 16 June 1913, Stevens 976 (MO). Woodward Co.: 3 mi se Woodward, 28 Apr. 1974, Stephens 74750 (KANU).

TEXAS: Armstrong Co.: 7 mi nw Goodnight, 2 June 1957, Correll 16586 (LL). Childress Co.: 8 mi e Memphis, 4 June 1973, Higgins 7083 (NY). Collings worth Co.: 1 mi w Samnorwood, 23 May 1961, Correll 23991 (LL). Cottle Co.: 11 mi ne Paducah, 9 June 1957, Rowell 5436 (TEX). Donley Co.: 3.6 mi s I40 on TX70, 7 June 1978, Lane 386 (KSC). Grat Co.: 8 mi s Pampa, 7 June 1978, Lane 387 (KSC). Hansford Co.: 5.5 mi w Spearman, 9 May 1974, Stephens 75215 (KANU). Hardeman Co.: 1 mi n Quanah, 15 May 1968, Stephens 20739 (KANU). Hemphill Co.: bottomlands Canadian River, 27 June 1955, Rowell 4193 (TEX). Hutchinson Co.: 2.5 mi n Stinnett, 8 June 1978, Lane 388 (KSC). Ochiltree Co.: 8.7 mi se Perryton, 13 July 1957, Wallis 4836 (SMU). Roberts Co.: 27 mi s Perryton, 6 June 1958, Wallis 7167 (TEX). Tillman Co.: 12.7 mi ne Tipton, 27 May 1944, Stratton 5859 (KANU). Wheeler Co.: 10.2 mi e Shamrock, 7 June 1978, Lane 385 (KSC). Wichita Co.: 8 mi s Electra, 14 May 1968, Stephens 20687 (KANU). Wilbarger Co.: 16.9 mi w Electra, 12 May 1945, Whitehouse 9840 (SMU).

8. Scutellaria drummondii:
OKLAHOMA: Comanche Co.: 7 mi s Lawton, 2 June 1978, Lane 373 (KSC). Cotton Co.: 1 mi e Devol, 12 May 1968, Stephens

<u>20389</u> (KANU). Greer Co.: 1 mi w Mangum, 3 June 1978, <u>Lane 378</u> (KSC). Harmon Co.: 5 mi e Gould, 3 June 1978, <u>Lane 376</u> (KSC). Kiowa Co.: 5.5 mi e Indiahoma, 23 Apr. 1938, <u>Fry s.n.</u> (TEX). Woods Co.: 5 mi s Capron, 4 May 1971, <u>Nighswonger 811</u> (SMU).

TEXAS: Childress Co.: 11 May 1931, <u>Biology Class 24</u> (TEX). Wichita Co.: sw side Wichita Falls, 29 Apr. 1954, <u>Shinners 18745</u> (SMU). Wilbarger Co.: 13.3 mi w Electra, 12 May 1945, <u>Whitehouse 9823</u> (NY).

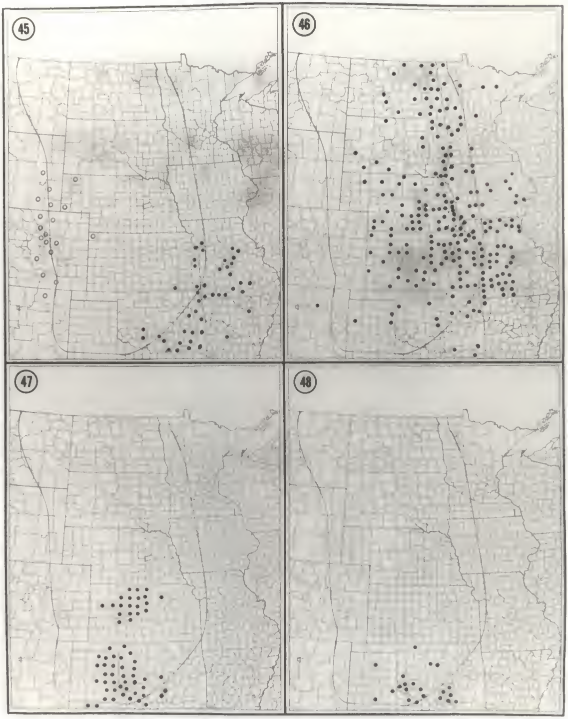
Distribution Maps for *Scutellaria* spp.

Figure 45. *S. brittonii* = ○. *S. ovata* = ●. Note boundary of the Great Plains as defined by the Great Plains Flora Association in *The Atlas of the Flora of the Great Plains*.

Figure 46. *S. lateriflora*.

Figure 47. *S. resinosa*.

Figure 48. *S. drummondii*.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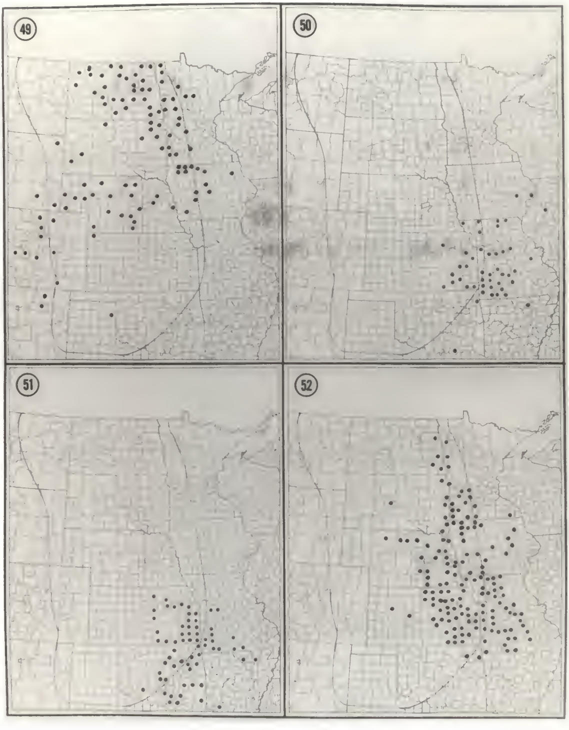
Distribution Maps for Scutellaria spp.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LITERATURE CITED

Alston, R.E. and B.L. Turner. 1959. Applications of paper chromatography to systematics: Recombination of parental biochemical components in a hybrid Baptisia population. Nature: 285-286.

_____. 1963. Biochemical Systematics. Prentice-Hall Biological Science Series. Englewood Cliffs, New Jersey. 404 pp.

Barkley, T.M. 1968. A Manual of the Flowering Plants of Kansas. Kansas St. Univ. Endowment Association. Manhattan, Kansas. p 300.

Bentham, G. 1832-1836. Labiatarum Genera et Species. James Ridgway and Sons. London. pp 416-445.

_____. 1848. In De Candolle. Prodromus Systematis Naturalis Regni Vegetabilis, pars XII. Fortin, Mason and Co. Paris. pp 412-431.

Borror, D.J. 1971. Dictionary of Root Words and Combining Forms. Mayfield Publishing Co. Palo Alto, California. 134 pp.

Bragg, T.B. and L.C. Hulbert. 1976. Woody plant invasion of unburned Kansas bluestem praire. J. Range Manage. 29: 19-24.

Briquet. 1897. In Engler and Prantl. Die Naturlichen Pflanzenfamilien, teil IV. Leipzig. pp 225-227.

Collins, J.L. 1977. A revision of the annulate Scutellaria. Dissertation. Vanderbuilt Univ.

Correll, D.S. and M.C. Johnston. 1970. Manual of the Vascular Plants of Texas. Texas Research Foundation. Renner, Texas. 1744 pp.

El-Gazzar, A. and L. Watson. 1970. Taxonomic study of Labiatae and other genera. New Phytol. 69: 451-486.

Epling, C. 1939. Notes on the Scutellariae of eastern North America. I. Amer. J. Bot. 26: 17-24.

_____. 1942. The American species of Scutellaria. Univ. of Calif. Publ. in Bot. 20: 1-146.

Erdtman, G. 1945. Pollen morphology and plant taxonomy.

IV. Svensk. Bot. Tidskr. 39: 279-285.

Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy. Hafner Publ. Co. New York. pp 217-220.

_____. 1960. The acetolysis method. Svensk. Bot. Tidskr. 54: 561-564.

Fabre, G. and R.M. Nicoli. 1965. Sur la morophologie des akenes de quelques Labiees de la flore de France. Interet systematique de cette etude. Societe botanique de France (Paris), Bulletin 112: 267-271.

Faegri, K. and Iverson. 1964. Textbook of Pollen Analysis. Munksgaard. Copenhagen. 202 pp.

Fassett, N.C. 1937. Notes from the herbarium of the Univ. of Wisconsin—XV. Rhodora 39: 377-379.

Fernald, M.L. 1921. Scutellaria epilobiifolia. Rhodora 23: 35-86.

_____. 1950. Gray's Manual of Botany, ed. 8. American Book Co. New York. pp 1218-1223.

Feuer, S. and A.S. Tomb. 1977. Pollen morphology and detailed structure of family Compositae, tribe Cichorieae. II. Subtribe Microseridinae. Amer. J. Bot. 64: 230-245.

Gray, A. 1872. Notes on Labiatae. Proc. Am. Acad. Arts and Sci.: Feb. 13, 1872, pp 365-372.

_____. 1878. Synoptical Flora of North America. Ivison, Blakeman, Taylor and Co. New York. pp 378-382.

Great Plains Flora Association. 1977. Atlas of the Flora of the Great Plains. The Iowa State Univ. Press. Ames. 600 pp.

_____. Flora of the Great Plains. As of yet unpublished.

Hamilton, A. 1932. Equisse d'une monographie du genre Scutellaria or Toque. Societe Linneenne de Lyon. 1:1-67.

Harborne, J.B. 1977. Flavonoid sulphates: a new class of natural products of ecological significance in plants. In Reinhold, W., J.B. Harborne, and T. Swain (eds.). Progress in Phytochemistry, vol. 4. Permagon Press.

_____ and C.A. Williams. 1971. 6-Hydroxyluteolin and scutellarein as phyletic markers in higher plants. Phytochem. 10: 367-378.

Hegnauer, R. 1966. Chemotaxonomie der Pflanzen, vol. 4. Birkhauser-Verlag. Basel.

Leitner, J. 1942. Ein beitrag zur kenutnis de pollenkorner de Labiatae. Osterr. Bot. Z. 91: 29-40.

Leonard, E.C. The North American species of Scutellaria. Cont. U. S. Nat. Herb. 22: 703-748.

Linnaeus, C. 1753. Species Plantarum. Impensis Laurentii Salvii. Tomus II. pp 598-599.

Lobelius. 1581. Pl. Strip. Icon. 344. In Leonard 1927.

Mabry, T.J., K.R. Markham and M.B. Thomas. 1970. The Systematic Identification of Flavonoids. Springer-Verlag. New York. 354 pp.

Molish, H. and G. Goldschmidt. 1901. Monatshblat. Chem. 22:679.

Nelson, A. 1898. Bull. Torr. Bot. Club 25: 283.

Penland, C.W. 1924. Notes on North American Scutellaria. Rhodora 26: 61-79.

Porter, T.C. 1894. Scutellaria resinosa. Bull. Torr. Bot. Club 21: 177.

Risch, C. 1940. Die pollenkorner der in Deuschland vorkommenden Labiaten. Verhandl. d. Bot. Vereins f. Bradenburg 80: 21-36.

Robinson, B.L. and M.L. Fernald, 1908. Gray's New Manual of Botany. American Book Co. New York. pp 694-696.

Rydberg, P.A. 1906. Flora of Colorado. Experimental Station, Ft. Collins, Colorado. p 296.

_____. 1932. Flora of the Praires and Plains of Central North America. New York Botanical Garden. New York. pp 681-683.

Sanders, R. unpublished. Flavonoids of the Labiatae. Botany Department, Univ. Texas, Austin.

Small, J.K. 1903. Flora of the Southeastern United States. J.K. Small. New York. p 1024.

Spurr, A.R. 1969. A low-viscosity epoxy resin embedding medium for electron microsopy. J. Ultrastructure Research 26: 31-43.

Stern, K.R. 1962. The use of pollen morphology in the taxonomy of Dicentra. Amer. J. Bot. 49: 362-368.

Steyermark, J.A. 1963. Flora of Missouri. Iowa St. Univ. Press. Ames. pp 1270-1276.

Tomb, A.S. 1974. SEM studies of small seeds. Scanning Electron Microscopy II: 375-380.

_____. 1975. Pollen morphology in tribe Lactuceae (Compositae). Granna 15: 79-89.

_____, D.A. Larson and J.J. Skvarla. 1974. Pollen morophology and detailed structure of family Compositae, tribe Cichorieae. I. Subtribe Stephanomerinae. Amer. J. Bot. 61: 436-498.

Torrey, J. 1828. Ann. Lyc. N. Y. 2: 232.

Wojciechowska, B. 1966. Morfologia i anatomia owocow i nasion z rodzing Labiatae ze szczegolnym uwzglednieniem gatunkow leczniczych. Monographiae Botanicae 21: 1-244.

_____. 1972. Morfologia i anatomia owocow u Scutellaria, Chaiturus, Galeobdolon i Sideritis z rodzing wargowych Labiatae. Morphographiae Botanicae 37: 137-169.

Wunderlich, R. 1967. Ein vorschlag zn einer naturlichen gliederung der Labiaten auf grund der pollenkorner, der samenentwicklung und des reifen samens. Osterr. Bot. Z. 114: 383-483.

Zeleznak, K.J. 1978. Pollen morphology of the Leontodontinae (Asteraceae: Lactuceae). Thesis. Kansas St. Univ.

Zinchenko, T.V. and V.A. Bandyukova. 1969. Flavonoids of the Labiatae family. Farm. Zh. 24: 49-55.

THE GREAT PLAINS SPECIES
OF SCUTELLARIA (LAMIACEAE): A TAXONOMIC REVISION

by

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ABSTRACT

Epling (1942) recognized nine species of Scutellaria occurring in the Great Plains. Each analysis in this study was conducted on species as he described them. New data were obtained through scanning electron microscopical work of pollen and mericarps, two-dimensional paper chromatography of phenolic compounds, and field observations. A key, species descriptions, range maps, and cited representative specimens are included.

Pollen morphology was rather homogeneous. Results from phenolic compound and mericarp studies in consort with the reviewed gross morphologies yielded the following as taxa: Scutellaria brittonii, S. galericulata, S. parvula var. parvula, S. parvula var. australis, S. parvula var. leonardi, S. lateriflora, S. resinosa (including S. wrightii), and S. drummondii. This view of Great Plains Scutellaria differs from Epling (1942). Mericarp micromorphology supports the assignments made by Epling of the Great Plains Scutellaria into three sections of the genus.