A revision of the genus Sphaeralcea (Malvaceae) for the state of Utah

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A REVISION OF THE GENUS SPHAERALCEA
(MALVACEAE) FOR THE STATE OF UTAH

A Thesis
Presented to the
Department of Botany and Range Science
Brigham Young University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Jane Ardis Murray Jefferies
August 1972
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A special thanks goes to my husband Bruce for his unwavering assistance with our three children during the past summer and for his invaluable help in the field.
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The genus Sphaeralcea is classified in the subgenus Sphaeralcea, although the subgenus Sphaeralcea has been subjected to revision recently (Keeley 1975). There is some confusion as to the application of that revision to members of the subgenus in the state. This difficulty in the course of general botany.

Grass morphologic characteristics are an important feature of separation, hence formerly-used diagnostic features such as pubescence development (and configuration) are not identified. The species are arranged to some degree of genetic radiation in that autopolyploidy has been reported (Hesner 1933). The range of several species of Sphaeralcea extends to Utah and overlap, giving rise to great amount of variable hybridization. In some instances, one species will grade into another; thus, a network of intergradational forms. These forms are the basis of attempts to separate the taxa into the traditional categories of subspecies or varieties. Absence of illustrations in the gathering will require interpretation of written description difficult, especially without clear diagnostic features.

It is, therefore, the purpose of the present writer to present a precise picture of the genus Sphaeralcea as it occurs in California. Descriptions, a specific key, distribution maps, illustrations and pertinent taxonomy are presented.
INTRODUCTION

General

The genus Sphaeralcea as it occurs in Utah has been relegated entirely to the subgenus Sphaeralcea. Although the subgenus Sphaeralcea has been subjected to revision recently (Kearney 1935), there is some confusion as to the application of that revision to members of the subgenus in the state. This difficulty is the result of several factors. Gross morphologic characteristics are sensitive to the environment, hence formerly-used diagnostic features such as pubescence density and leaf configuration are not stressed. The species are subject to some degree of genetic radiation in that autoploidy has been reported (Webber 1935). The ranges of several species of Sphaeralcea converge in Utah and overlap, giving rise to great numbers of probable hybrids. In some instances one species will grade into others forming a network of inter-related forms. These forms are the basis of attempts to segregate the taxa into the hierarchial categories of subspecies or varieties. Absence of illustrations in the earlier work renders interpretation of written description difficult, especially where salient diagnostic features are not emphasized.

It is the attempt of the present writer to present a concise picture of the genus Sphaeralcea as it occurs in the state. Descriptions, a specific key, distribution maps, illustrations and pertinent synonymy are presented.
Material and Methods

The plant materials used in this study were mounted herbarium specimens from the major institutional herbaria of Utah along with fresh collections made by the author from 10 counties during the summers of 1971 and 1972.

Measurements of the larger morphological structures were made by using a metric ruler. Measurements of the smaller structures were made by using an ocular micrometer situated within one eyepiece of a binocular microscope.

The taxonomic presentation follows the conventional pattern established by previous revisions written at Brigham Young University. The number following each species description indicates the total number of specimens seen, and the number in parenthesis indicates the number of specimens collected by the author. A representation of specimens examined during this study are listed in alphabetical order by county.

Floristic divisions used to describe general habitats are from Intermountain Flora (Cronquist et al. 1972.)

Standard abbreviations of herbaria are from Index Herbariorum (Lanjouw & Stafleu 1964) when available. These are listed to indicate the herbaria where a given specimen may be found. Abbreviations used are as follows:

BRY Brigham Young University Herbarium, Provo, Utah.
CED Southern Utah State College, Cedar City, Utah.
DIX Dixie Junior College, St. George, Utah.
F Chicago Natural History Museum, Chicago, Illinois.
G Conservatoire et Jardin Botaniques, Genève, Switzerland.
K The Herbarium and Library, Kew, Great Britain.
History

The genus *Sphaeralcea* was established by St. Hilaire (1827) and is based on *S. cisplatina* St. Hil., a Brazilian species which had earlier been described by Cavanilles (1786) as *Malva bonarienses* (Krapovickas 1949). Numerous species of *Sphaeralcea* have been described since. These come from North America, South America and South Africa. The genus presently contains four subgenera: *Sphaeralcea* - herbaceous, carpels only partially dehiscent and divided into a reticulate basal and a smooth apical portion; *Iliamna* - herbaceous, carpel dehiscent to base, lateral face entire; *Phymosia* - shrubby or arborescent, carpel dehiscent to base, stigmas capitate, involucel deciduous; *Meliphlea* - shrubby or arborescent, carpel dehiscent to base, stigmas obliquely truncate, involucel persistent.

The type species of the genus *Sphaeralcea*, *S. cisplatina* St. Hil. is typical of the subgenus *Sphaeralcea*.

Gray (1894) published his genus *Malvastrum* with a treatment of several species of *Sphaeralcea*. The type species of the genus *Malvastrum* is obviously *M. coccineum* A. Gray since that species is treated first in the publication wherein the genus was erected. It was not until Gray's revision of the Mallow Family (1887) that he recognized a close relationship between the two genera, noting that they are "conflu-
ent through certain species." To separate the two genera, he suggested that species with a single ovule and no empty terminal portion of carpel be retained in *Malvastrum*, and that species having either two ovules or one ovule and an empty terminal portion of carpel be transferred into *Sphaeralcea*. He included original descriptions of *S. ambigua* and *S. rusbyi*, but he failed to recognize *M. coccineum* and *M. leptophyllum* as members of the genus *Sphaeralcea* because of the reduced terminal portion of the carpels. Gray's original description of *Malvastrum* (l. c.) included *M. grossulariaefolium* and *M. munroanum* which he later transferred to *Sphaeralcea*. *M. coccineum* and *M. leptophyllum* were transferred to *Sphaeralcea* by Rydberg (1913). A. Nelson (1904) observed that included within *S. ambigua* was a form with smaller, more numerous flowers, smaller leaves and carpels and a nearly smooth reticulate face on the carpel than was typical of the species. This group he elevated to species rank as *S. parvifolia*. Marcus E. Jones (1905) discovered a new species which he described as *S. caespitosa*.

A more complete history of the genus, particularly as it relates to closely allied genera is available in Kearney's monograph (l. c.).
GENERAL MORPHOLOGY

Taproot and Caudex

All species of *Sphaeralcea* in Utah are perennials. An individual plant sprouts from a reniform seed about 2 mm high, developing a taproot and a shoot with two cotyledons. The root commonly penetrates deeply before branching, but the root of *S. caespitosa*, a species which grows in shallow rocky soil over lava, branches two to several times and grows horizontally under surrounding rocks where moisture is likely to remain after brief summer thunder storms.

The crown becomes thicker, increasingly woody and capable of producing more flowering stems as the plant matures. The most common form of caudex is a simple crown which lies near the surface of the soil and produces new shoots from its surface. A variant form is seen in specimens of *S. leptophylla* which develop a more elongate caudex that increases vertically, sending out new shoots at intervals from one growing season to the next. The most extreme variation of stem type is common to *S. coccinea*. This species will often produce slender, woody rhizomes. New shoots arise either from caudices borne on vertical off-shoots of the rhizome or directly from the rhizome. *S. rusbyi* is reported to have rhizomes occasionally, but none of the specimens examined in the present study was collected with a rhizome.

Stems

The stems branch sparingly in some species and more profusely in
others. Plant height varies from 10-100 cm, but is usually 30-60 cm. Each stem terminates in an inflorescence. Regeneration of flowering shoots is common when stems are damaged, especially if moisture is available.

**Pubescence**

The hairs are multicellular, arising from the division of a single epidermal cell (Foster 1942) to form stellate hairs. The entire plant is pubescent except the petals and the inner surface of the calyx. Degree of pubescence ranges from dense yellow or whitish canescence to sparsely pubescent or glabrescent. Lower surfaces of leaves are generally more densely pubescent than upper surfaces. Measurements were made of the largest stem hairs growing slightly below the lowest flower. The hairs range from 0.15-0.80 mm broad and have from 8-30 rays.

The most common form of hair is tufted with rays radiating in all directions. The hairs of *S. coccinea* are appressed, however, with rays radiating in a single plane. Here, the bases of the rays are slightly united forming a flat, stalked hair. A further union of rays forming a fringed scale is typical of *S. leptophylla*.

Degree of pubescence is under both genetic and environmental control. Because of this, pubescence density may vary with the species, within the species and also on the individual plant. For instance, *S. caespitosa* is more densely pubescent than *S. grossulariaefolia*; specimens of *S. grossulariaefolia* growing on a south-facing slope in full sunlight are more densely pubescent than specimens growing on north-facing slopes in less light; a specimen of *S. grossulariaefolia* growing during a relatively dry period will be more densely pubescent than
the same specimen growing following a moderate amount of precipitation.

Leaves

The leaves are simple, palmately veined, alternate and stipulate. Stipules are 1-8 mm long, membranous, cauducous and similar to but larger than the bractlets of the involucel; these vary little within the genus. The petiole is slender or stout and much shorter to longer than the larger leaf blades; these are highly variable both within the species and on a single specimen. Leaf characteristics are similarly variable but generally the lower leaves have the same form as upper leaves except in *S. leptophylla* where lower leaves are divided and upper leaves are entire. Lower leaves are typically larger and have longer petioles than the upper leaves, especially where leaves subtend secondary floral axes. Lobing of the blade varies from none through shallowly 3- or 5-lobed to pedately parted or divided. Shape of the blade varies from cordate through cuneate to rhombic with only one species having linear leaves. The first few leaves above the cotyledon have crenate margins even in those species which ultimately develop pedately parted blades (Kearney l. c.) First season growth is rarely collected, and leaf morphology on shoots from a mature crown is as described above.

Inflorescence

The basic type of inflorescence is an open but rather narrow, loosely branching thryse which may be somewhat leafy. The main axis is indeterminant; the secondary axes are determinate but may appear indeterminant, especially where sympodial flower development occurs. It is likewise difficult to identify the secondary axes as determinate
where the development of a single flower is followed by the growth of one or more branching secondary axes from the same node. In this instance, both peduncles and pedicels arise from one node.

There is a trend toward reduction of the inflorescence within the group. The length of the peduncles can become shortened with flowers being borne in clusters around each node along the main axis. This is a thrysoid-gglomerate inflorescence and is common in *S. parvifolia*, *S. munroana* and *S. grossulariaefolia*. The number of flowers may be reduced to only one at a node, forming a much-reduced thryse. This is a racemose inflorescence because it resembles a raceme. This type is common to *S. coccinea*, *S. leptophylla* and *S. caespitosa*.

**Flower**

The pedicel is generally shorter than the calyx, but it may be much longer. An involucel is commonly found except on *S. coccinea*. It consists of 3 narrow, filiform, membranous bractlets which arise from the pedicel near the base of the calyx. The involucel is often cauducous, and when persistent is inconspicuous.

The calyx is usually a little less than half as high as the corolla and has 5 lobes. The lobes are at least half as long as the tube. Lobes vary in shape from deltoid to attenuate. Five nectaries lie inside the tube at the base of the staminal column.

The corolla is formed by five separate, asymmetrical petals, radially arranged, 7-35 mm long. These are bearded by a fringe of hairs basally. Flower color in Utah is invariably "orange" or more specifically, cadmium with a little yellow. Intensity of the color varies with the locality. When the flower is dried, the color fades to rose-pink.
The staminal filaments are coalescent in a single tube around the pistil. Bright yellow (rarely purple-tinged) anthers are borne near the summit of the tube on free portions of filament. Pollen is yellow. The upper portion of the styles are free, and the stigmas are capitate.

The fruit is of considerable diagnostic value. It is composed of 8-16 carpels, and at maturity may be a little wider than hemispherical (generally exceeded by calyx) to truncate or sub-conical (generally exceeding the calyx). The carpels are borne on the receptacle surrounding a vertical column of receptacular tissue, the gynobase, which is the source of vascular supply for the carpels and embryos. Although the internal vascular anatomy has not yet been studied, it appears from external observation that each carpel is supplied with more than one vascular trace. The most evident vascular connection leaves the receptacle at the base of the gynobase and encircles the lower half of the carpel in the position of a midrib on a leaf. While it is possible that the vascular supply to the developing ovule proceeds from this vascular trace through the reticulae and into the ovule, the gynobase appears to be at least partly formed of vascular tissue, hence, it is of a placental nature. The notch separates the indehiscent from the dehiscent portion of the carpel and is closely appressed to an expanded portion of the gynobase. It is at this position that vascular traces apparently enter the proximal edge of the carpel (Fig. 1). If the distal vascular connection is well-developed, the carpels will not readily detach from the receptacle at maturity. In some species it is rather poorly developed and carpels readily separate from the receptacle.

The carpel contains the basic distinguishing features of the sub-
Fig. 1. Generalized Carpel and Receptacle Tissues.
A. apex, B. smooth, indehiscent upper portion, C. sepal, D. gynobase, E. reticulate, indehiscent lower portion, F. base, G. receptacle, H. pedicel, I. line of coalescence between carpels, J. distal portion or back of carpel, K. lateral face, L. proximal edge, M. notch, N. midrib vascular trace or attaching thread, O. reticulae, P. lacunae, Q. bractlet of involucel or involucral bract.
The gross morphological characteristics which may be utilized in a taxonomic treatment of the genus *Lilium* are not completely variable, subject to modification by environmental factors as well as to hybridization.
genus. It is at once the most useful and most difficult organ to rely upon for the diagnostic characteristics used in establishing relationships within the genus. The carpel seems less subject to environmental variation than the stems and leaves, but some features of the carpel are variable on a single specimen and sometimes within a single flower, notably the size. Characteristics which are generally reliable are the height to width ratio, general aspect of the reticulate portion, proportion of reticulate to non-reticulate surface (measured along the height of the carpel), position and shape of the proximal notch, thickness of the walls (described as either chartaceous - thin and papery or as coriaceous - tough and leathery), and presence or absence of specific features such as the palate-like fold inside the carpels of *S. coccinea* and *S. leptophylla*. This fold is an invagination of the distal, or mid-rib vascular bundle and occurs just below the line of dehiscence. Another specific feature is the nature of the lateral face between the reticulae. The lacunae of *S. rusbyi* are as transparent as cellophane. It should be noted that the basal reticulate portion of the carpel is indehiscent while the apical portion is dehiscent.

One to three ovules may develop within the carpel depending on the species, but only one or two seeds will form. Those carpels with two seeds are generally taller than carpels with a single seed. In *S. coccinea* where only one seed develops, the indehiscent part of the carpel does not expand.

Cytology

The gross morphological characteristics which must be utilized in a taxonomic treatment of the genus *Sphaeralcea* are not completely reliable. Subject to modification by environmental stress as well as to hybridi-
zation, the species show a great deal of variability and must be suspected of harboring a rather complex genome.

Chromosome numbers and other cytogenetic data confirm the morphological evidence cited by Kearney (l. c.) that Iliamna, Meliphlea, Phymosia and Malvastrum may be valid genera (Webber 1935).

Webber's (l. c.) Study indicates the following: First, the genus is represented by a polyploid series with various polyploid levels within individual species. The basic chromosome number for the genus is \( n = 5 \). Common chromosome numbers are \( n = 5, n = 10 \) and \( n = 15 \). One plant of the 275 plants studied had the number \( n = 25 \). Four species which occur in Utah were included in the study. These with their corresponding chromosome numbers are _S. ambigua_ \( (n = 10, n = 15) \), _S. rusbyi_ \( (n = 5, n = 10) \), _S. parvifolia_ \( (n = 5, n = 10) \) and _S. coccinea_ \( (n = 5) \). Second, Sphaeralcea differs from Iliamna, Meliphlea and Phymosia by being largely self-sterile. This observation was based on the inability of isolated plants (being grown for cytologic study) to set seed. Third, there is pronounced cross-compatibility within the genus. There is frequent occurrence of apparent natural hybrids which show relatively high fertility and a high degree of chromosome pairing. Fourth, during normal meiosis 1, 2 and 3 chiasmata are common.

It is interesting to note that among the specimens exhibiting regular meiotic behaviour there were several plants that were intermediate between species according to gross morphology (Webber l. c.).
PHYLOGENY

This study encompasses only a small portion of the total taxa within the genus *Sphaeralcea*. Because of this the discussion of phylogeny presented below must be considered tentative at best. A phyletic diagram depicting the supposed phylogeny of the genus in Utah is presented (Fig. 2).

The genus in Utah is in the midst of the evolutionary process. For this reason, morphological criteria must be considered as dynamic rather than static (Hall & Clements 1923), and in many instances it becomes difficult if not impossible to apply a given specific appellation to a particular specimen.

The ancestral forms were undoubtedly variable sharing many of the characteristics of related subgenera. The forms that gave rise to the genus *Sphaeralcea* probably had a fairly open, numerously-flowered thrysoïd inflorescence and carpels capable of producing three seeds.

Separation into the two basic groups of plants recognizable in Utah occurred as the tendency toward reduction of parts resulted in the *S. coccinea* - *S. leptophylla* group. In this group, the inflorescence became much reduced to a racemose condition, and the ability to produce more than one ovule per carpel was lost. With the reduction of the distal ovules, the upper portion of the carpel failed to develop leaving an increasingly heavy-walled lower section protecting the single remaining seed. The close relationship of these two species is indicated by common carpel features, e.g. inclusion of a solitary seed within the locule,
reduced upper portion, coriaceous wall and especially coarse and heavy reticulae. Another feature in common and found exclusively in this group is the appressed stellate hair which has rays that are at least sparingly united and are extended in a single plane. While these two species share features in common, they are sufficiently distinctive on the basis of both vegetative and fruiting characteristics that the two are easily separable. *S. leptophylla* bears hairs which have undergone a fusion of rays resulting in a fringed scale. The leaf blade also is modified in *S. leptophylla* from the form characteristic of *S. coccinea*. The leaf blade has become reduced from a tri-parted blade to a blade with a single remaining lobe on the upper portions of the plant.

The other basic group of plants recognizable in Utah includes *S. ambigu*a, *S. parvifolia*, *S. munroana*, *S. grossulariaefolia*, *S. caespitosa* and possibly *S. rusbyi*. Relationship of these species in intimated by the numerous intermediates which are encountered in the field and is further indicated by similar carpel features, e.g. inclusion of from 1-2 seeds within the locule, expanded upper portion, chartaceous wall and generally moderate to fine reticulae. Other features in common are the thrysoid inflorescence and stellate hairs with rays radiating in all directions. While these species share features in common, they are usually distinctive on the basis of vegetative and sometimes fruiting characteristics.

The *S. ambigu*a - *S. parvifolia* - *S. grossulariaefolia* assemblage contains plants which retain the ability to produce more than one ovule as well as the more open, more numerously-flowered inflorescence. The species which developed along this line are sufficiently similar genetically that little difficulty is encountered in forming hybrids with
one another, and as was pointed out in the section on cytology, many of these hybrids seem to have little difficulty in behaving normally during reduction division. Out of this genetic pool, S. rusbyi, a form with transparent lacunae and a reduced, nearly racemose inflorescence may have been derived. Subsequently, S. ambigua separated from the S. parvifolia - S. grossulariaefolia assemblage. S. ambigua retained the open, loosely branching, usually leafy inflorescence pattern (flower number may have been reduced somewhat), and the carpels remained tall with the capacity to produce two ovules and two seeds.

The S. parvifolia - S. grossulariaefolia complex underwent contraction of the inflorescence producing at the extreme (the form most commonly encountered when moisture is abundant) a tight thryse with peduncles shortened or reduced altogether, and with nodes of the primary axis being elongate to form a thrysoid-glomerate inflorescence. The flower number was not significantly reduced genetically (although it frequently is under environmental stress). The nutritional requirements of a smaller plant with numerous flowers possibly led to development of smaller flowers. S. parvifolia, a form with reduced reticulation on the carpel, generally 2 seeds and a mildly lobed leaf is differentiated from S. grossulariaefolia, a form with well-formed reticulae, one or two seeds and a parted or divided leaf blade. These two are well on the way to becoming distinct. S. munroana is intermediate between S. parvifolia and S. grossulariaefolia and was possibly derived through introgressive hybridization between the two. Known from a limited habitat, S. munroana, has 1 or 2 seeds, leaves ranging from divided to entire and herbage generally sparsely pubescent.

A heavily pubescent, two-seeded form of S. grossulariaefolia appar-
ently gave rise to *S. caespitosa*, possibly by way of mutation. *S. caespitosa* is a species with internodes which generally fail to elongate. The intermediates that are found between *S. caespitosa* and *S. grossulariaeefolia* (Jeff. & Jeff. 161-163 BRY) show a smooth transition between the two species.

Although this phylogeny is purely speculative, it is intended to show possible relationships based on morphological similarities, and it should offer a clue to understanding the complexity of the genus in Utah. A further ramification of the phylogeny of this group—present day interrelations between the entities—is discussed under the section on ecology and is depicted in Fig. 3.
Fig. 2. Phylogeny of the Genus *Sphaeralcea* in Utah
ECOLOGY

General

The various species of *Sphaeralcea* are generally widely distributed and grow in numerous habitats. Due to the attractive flowers and common roadside distribution, *Sphaeralcea* occurs in collections well out of proportion to its actual relative abundance in Utah.

Habitat

Members of the genus *Sphaeralcea* are xerophytic and find abundant habitat in the state of Utah where average annual temperatures range from 12-84° F and average annual precipitation ranges from 6-20 inches.

Modifications which enable these hardy plants to endure the extremes of heat and dryness are numerous. Root systems are extensive and penetrate to considerable depth in most species. The roots of *S. caespitosa*, however, penetrate less deeply but branch considerably and infiltrate great volumes of soil.

A viscid, mucilaginous glandular secretion is common throughout the genus and may have some capability of increasing the osmotic pressure or in some way enhancing the ability of the plant to endure desiccation.

The leaves of *Sphaeralcea*, notably *S. grossulariaeafolia*, will form an abscission layer and drop during periods of water stress. This prevents excessive transpiration and possibly forms a protective mulch over the crown. The smaller, immature leaves, due partially to undeveloped vacuolation are highly drought resistant and will endure considerable
dryness. Markedly resilient, *S. grossulariaefolia* is capable of renewing growth during any season that growth conditions become favorable (Brewster 1971). *S. coccinea* likewise is known as a drought resistant forb for similar reasons. It is said to have increased in abundance during the extended drought of the 1930's. Its ability to survive is due to the depth to which the taproot penetrates before branching, its capacity to begin growth relatively early in the season and its habit of leaf abscission during dry periods (Weaver and Albertson 1956).

Pubescence is generally dense on leaves and stems providing a shading effect and slowed air movement over the leaf surface. The pubescence gives the plant a white, grey or yellow cast which would aid in the reflection rather than the absorption of light and heat.

Some of the species have much reduced leaf blades. In *S. coccinea* and *S. leptophylla* the deeply divided leaves are also conduplicate which restricts exposure. It is common for specimens growing during particularly dry seasons to be depauperate with fewer and smaller leaves and flowers than is otherwise expected for the species.

Of the various habitats where *Sphaeralcea* is found, none is more likely than along roadsides. Here various species often grow in profusion. The relative abundance of *Sphaeralcea* along paved roadways is due not to specific drought-resistant adaptations, but to the increased moisture supply which is periodically provided by highway runoff. This habitat is of increasing significance in light of the following information provided by the Utah State Division of Highways. Since the early 1930's the miles of highway in Utah have increased no more than 1%. Construction of interstate highways and a road into Canyonlands National Park accounts for the increase in roadway length. Roads, however, are
now built much wider than previously. A road now has 10-12 foot wide lanes with a paved shoulder 6-10 feet wide. The fills and cuts are widened so that from the shoulder to the edge of the graded land is a minimum of 15 feet (Wadley 1971). This increased roadside habitat, coupled with the assured runoff, enables an abundance of morphological variations to survive without having to develop specific means of contending with severe drought.

Pollination

Although there is abundant opportunity for self-pollination, there are reports (Kearney l. c., Webber l. c.) that Sphaeralcea is self-sterile to a great extent and must be cross-pollinated. The flowers are showy and have an extremely faint but sweet fragrance, produce copious amounts of pollen and bear nectaries inside the calyx. Each of these factors is undoubtedly responsible for attracting pollinators and effecting cross-pollination. For a list of known insect pollinators see Kearney (l. c.).

Seed Dissemination

Specific adaptations providing an efficient means of seed dissemination are present in the genus. The vascular connection of the carpel to the receptacle, if well-developed, will retain the carpels until well after they are matured. Then, when the wind blows, the seeds are broadcast as salt from a shaker. On the other hand, when the vascular connection is fragile, the carpels can depart from the receptacle singly or en masse. In either case, the wind can blow the carpels a considerable distance before the lowermost ovule falls free.

At maturity an abscission layer often forms in the stem or the ped-
icel permitting the flowers to fall to the ground.

Seeds and carpels are pubescent, allowing the possibility that these structures might cling to animal fur or insect setae and be transported away from the parent plant.

Host Relations

The various species of Sphaeralcea can host rust infections. Two in particular are S. coccinea (Ag. Handbook No. 165) and S. parvifolia (Jeff. & Jeff. 181 BRY) which do host Puccinia sherardiana Koern.

Insects are commonly found on the surface of the plant. Small ants (red, black and yellow) were observed by the author as they visited inflorescences of Sphaeralcea plants throughout the state. Perhaps these ants were responsible for the damaged petals at the tips of many young buds. Leaves of S. parvifolia (Jeff. & Jeff. 180 BRY) collected in Washington County were rather densely covered with egg cases of the lace bug (family Tingidae). Other specimens of S. parvifolia from the same vicinity were collected with numerous white, cottony scale insects densely covering the root just below the caudex. Aphids are commonly found on stems and leaves of various species of Sphaeralcea, but not always in conjunction with the small ants mentioned previously.

Much insect damage is done to developing carpels by larvae which burrow around the gynobase eating the growing ovules. S. munroana (Jeff. & Toft 151-152 BRY) is frequently found to be infested by this type of unidentified insect. Weevils of the genus Macrorhoptus are suspected of being largely responsible for this type of damage (Kearney l. c.).

Effect of Environmental Manipulations
The bureau of Land Management has set aside plots of land which are chained and/or burned in an attempt to control species of low palatability such as Juniperus and Artemesia, thereby improving the range for livestock and game. Sphaeralcea, especially S. grossulariaefolia in Washington County, flourishes when its habitat is chained, but becomes even more abundant when the habitat is burned. For example, a plot of land was burned and chained in Whitmore Canyon two years previous to this observation. S. grossulariaefolia is now the most abundant forb if not the most abundant species in that area. Similar situations were observed on the road to Motoqua, Wash. Co., and on the Cedar City-Parowan Front Range Rehabilitation Project in Iron County.

The remarkable resiliency of S. grossulariaefolia when subjected to water stress was studied by Brewster (l. c.). To his observations can be added that the species is as remarkably resilient when subjected to both physical disruption and fire. Evidently chaining removes the trees and shrubs which are primary competitors for moisture, but only breaks off the flowering shoots of Sphaeralcea leaving the deeply-rooted crown undisturbed. The crown is capable of replacing flowering shoots quickly when the moisture supply is adequate. Burning similarly does not destroy the crown which is protected below the surface of the soil. With the increased moisture supply afforded by the destruction of species which were formerly competing for the available water, Sphaeralcea is capable of growing new shoots that will produce seed. The seed is disseminated over the newly cleared habitat, and within two years young plants are well-established.

Economic Factors

Although Sphaeralcea is suspected by stockmen and sheep ranchers of
being poisonous to livestock or of causing stillborn young, the evidence is purely speculative (Jensen 1972). There have been no investigations that lead to the foregoing conclusion. On the other hand, other genera which are found growing concurrently with *Sphaeralcea* are known to be poisonous to livestock. These are *Astragalus* and *Oxytropis* (causing loco, a nervous disorder which may result in still-born young or death of the adult), *Juniperus* (possibly causes abortion when ingested in moderate amounts) and *Pinus* (causes a disposition to abortion) (Kingsbury 1964).

**Ecological Relationships between Species**

The ranges of nearly all the species of *Sphaeralcea* in Utah overlap, producing abundant opportunity for hybridization, but special geographical patterns of distribution allow the following intergradations.

*S. ambiguа* is restricted to the Dixie Corridor in Utah. Here the range of *S. parvifolia* overlaps and intermediate forms are encountered.

*S. parvifolia* and *S. grossulariaefolia* are likewise concurrent in the Dixie Corridor as well as in the Utah Plateaus and Canyonlands sections. Intermediates are known from these regions, notably Cronquist 10149-10151 (BRY).

*S. munroana* is generally restricted to the Wasatch Mountains but has been encountered in the Uinta Basin and Canyonlands sections. This species is found with a range of leaf forms from sparingly lobed to deeply parted or divided. The sparingly lobed form strongly resembles *S. parvifolia*. Ranges of these two species are concurrent in the Uinta Basin (this is outside the general range of both species). The deeply divided leaf form strongly resembles *S. grossulariaefolia*. Ranges of *S. munroana* and *S. grossulariaefolia* intergrade in the Wasatch Mountains.
S. caespitosa is found in the Calcareous Mountains section of the Great Basin where that section extends briefly into Utah. Here, the range is shared with S. grossulariaefolia and intermediates are known (Jeff. & Jeff. 161-163 BRY) which show a transition from S. grossulariaefolia in the valley to S. caespitosa on the steep rocky slopes.

S. rusbyi is found only in the southern regions of the Utah Plateaus and Canyonlands sections of the Colorado Plateau. Here the range is shared with S. grossulariaefolia. Our Utah specimens are not good S. rusbyi as it is described by Kearney (1. c.) from specimens collected in Arizona.

S. coccinea and S. grossulariaefolia are encountered together along the Wasatch Mountains and the Utah Plateaus. The intermediate forms are readily distinguishable as one species or the other on the basis of inflorescence type, presence or absence of the bractlets of the involucel and general carpel structure.

S. coccinea and S. leptophylla, two closely related species, are both found in the Canyonlands section of the Colorado Plateau. Intermediates are not common, but there are aberrant forms of S. leptophylla.

Since S. digitata has not been satisfactorily determined to grow in Utah, it is difficult to assess its relationship to Utah species. It may be allied with S. grossulariaefolia on the basis of described leaf and carpel characteristics, however.

For a diagrammatic representation of the inter-relationships discussed herein see Fig. 3, Relationships of Sphaeralcea within Utah.
Fig. 3. Relationships of Sphaeralcea within Utah

S. coccinea
S. leptophylla
S. grossulariaefolia
S. munroana
S. parvifolia
S. caespitosa
S. digitata
S. rusbyi
S. ambigua
TAXONOMIC TREATMENT

Synonomy

*Sphaeralcea* St. Hil. *Fl. Bras. Mer.* i. 209. 1825.


*Cristaria* (Heist.) Cav. *Ic.* 10:418. 1799. pro parte.


*Sida* Schlechtendahl *Linnaea* 3:269. 1828. pro parte.

*Sphaeroma* Schlechtendahl *Linnaea* 11:352. 1837. pro parte.


The above list of generic synonomy is taken from *Index Kewensis* (Jackson 1895) and *Gray Herbarium Index* (Clark 1968) and probably is not complete because it has not been possible to investigate the types and original description of each one of these synonyms.

Generic Description

Annual or perennial herbs from a taproot or rhizomes; stems simple or branched from a caudex, cortex and pith with mucilage cells or ducts; herbage glabrescent to canescent, hairs stellate; leaves simple, entire
Fig. 4. Carpel Illustrations I.

A. S. grossulariaefolia, B. S. ambigua, C. S. parvifolia, D. S. parvifolia. Note: The reticulae on S. parvifolia may be as illustrated to nearly indistinguishable.
Fig. 5. Carpel Illustrations II.

A. *S. rusbyi* (from Utah), B. *S. rusbyi* var. *giliensis* (from Arizona - depicting the transparent lacunae), C. *S. caespitosa*, D. *S. munroana*, E. *S. munroana*. Both examples of *S. munroana* were collected from the same vicinity. D. was collected 30 years earlier than E.
Fig. 6. Carpel Illustrations III.

to lobed or divided, palmately veined; stipules present; inflorescence racemose to thrysoid, secondary floral axes determinant; flowers perfect, radially symmetrical, often with involucre of 3 or fewer filiform bractlets; calyx 5-merous, speals partially coalescent; corolla 5-merous, petals free except bases adnate to filament tube; stamens numerous, filaments coalescent into an elongate tube, anther with a single pollen chamber; styles several, united, branches above equaling number of carpels, stigmas capitate; carpels 8-20, in 1 series, lightly coalescent until maturity, divided by proximal notch into basal indehiscent reticulate portion and apical dehiscent smooth portion; placentae axile but derived from intrusion of parietal placentae; ovules 1-3, anatropus; seeds 1-3. (See Figures 4, 5 and 6 for illustrations of Sphaeralcea carpels.)

Key to the Species

1a. Inflorescence racemose, rarely with more than one flower at each node, involucral bracts present or wanting . . . . . . . . (2)

1b. Inflorescence sub-thrysoid to thrysoid-glomerate, more than one flower at most nodes, involucral bracts present . . . . . (4)

2a. Plant caespitose, herbage densely tomentose; hairs with rays radiating in more than a single plane; leaf blades flat, sparingly 3- or 5-lobed if at all, margins irregularly dentate or crenate; involucral bracts present; more than 1/2 of carpel face smooth 2. S. caespitosa

2b. Plant not caespitose, internodes elongate, herbage moderately pubescent; hairs appressed; leaf blades conduplicate, some 3- or 5-parted or divided; involucral bracts present or wanting; more than 1/2 of carpel face
35

reticulate ........................................... (3)

3a. Herbage silvery-lepidote; hairs with rays more than 1/4 coalescent; bractlets of involucel present; lower leaves 3-divided, upper leaves with a single lobe, all lobes entire ................................. 5. S. leptophylla

3b. Herbage greyish to whitish pubescent; hairs with rays only sparingly coalescent; bractlets of involucel wanting; leaves 3- or 5-parted or divided, lobes coarsely, often regularly toothed ................. 3. S. coccinea

4a. Plants sparsely pubescent, herbage bright green ....... (5)

4b. Plants moderately to densely pubescent or canescent, herbage (especially on younger stems) appearing yellowish, whitish or greyish ................. (7)

5a. Leaves pedately 3- or 5-parted or divided, lobes with narrow, regularly pinnatifid, toothed margins, the teeth at nearly right angles to the vein; carpels with transparent aerolae. Rare, S. Utah only ....... 8. S. rusbyi

5b. Leaves sparingly 3- to 5-lobed to pedately parted or divided, lobes broader, margins irregularly dentate or variously lobed, not as above; carpels with opaque aerolae .......... (6)

6a. Leaves faintly lobed with coarsely and unevenly dentate margins or deeply parted to divided with marging coarsely and irregularly lobed, the base subcordate to cuneate. N. Utah in Wasatch Mountains ... 6. S. munroana

6b. Leaves 3- or 5-parted or divided, margins more regularly cleft, lobed or toothed, base subcordate to deeply cordate. S. Utah, Colorado Plateau 4. S. grossulariaefolia
7a. Inflorescence loosely thrysoid (may appear paniculate), leafy; flowers not numerous at each node; peduncles generally elongate; calyx tall, always surpassing fruit; carpels tall with heavy, well-defined reticulae which extend onto back of carpel. Southwestern Utah ............ 1. *S. ambigua*

7b. Inflorescence thrysoid-glomerate, flowers generally numerous at each node, not predominantly leafy; calyx small, often equalled or surpassed by fruit; carpels with moderately well-defined to extremely faint reticulae, the reticulae confined to lateral face of carpel .................... (8)

8a. Leaves 3- or 5-cleft, parted or divided; herbage moderately pubescent to white-canescence or subtomentose; carpels with moderately well-defined reticulae on less than 1/2 of carpel face. Widespread in western and southern Utah ............ 4. *S. grossulariaefolia*

8b. Leaves shallowly 3- or 5-lobed; herbage moderately pubescent to densely white or yellowish canescence; carpels with finely defined or nearly obscure reticulae on lower 1/3 of carpel. Widespread in southern and southeastern Utah ............ 7. *S. parvifolia*

**Description of the Species**

1. **Sphaeralcea ambigua** Gray (Fig. 7)

*Sphaeralcea ambigua* Gray Proc. Amer. Acad. 22:292. 1887


1932. Type: Big Canyon of the Colorado, Newberry s. n. 1858 (G).


Herbage densely yellowish or whitish canescent, stem hairs stiff, 0.3-0.5 mm long, 16-23 rays; stems 30-60 cm tall or taller; petioles stout, 2.5-4.3 cm long, generally shorter than leaf blade; larger blades 2-6 cm long, approximately as wide as long, the blade thickish, often rugose, broad-ovate to nearly orbicular, base cordate or subcordate, apex obtuse to rounded, shallowly 3- or 5-lobed, the margins crenate, often undulate; inflorescence open (elongate internodes and peduncles), thrysoid, generally leafy; pedicels stout, shorter than calyx; calyx 10-15 mm high at anthesis, the lobes lanceolate, attenuate-acuminate, 1-4 times longer than calyx tube; petals 1.7-2.0 (3.5) cm long; fruit hemispherical, not more than 2/3 as high as calyx; carpels 12-16, walls chartaceous, 3.5-5.0 mm high, about 2/3 as wide as high, the indehiscent portion forming 1/3 of carpel, reticulae prominent (Fig. 4b); ovules 2; seeds 2.

Collections: 10 (0). Representative: Washington Co.: Beaver Dam Mts., 4 mi. south of Castle Cliffs, Hwy. 91, Higgins 308 (BRY).

Habitat: Sandy or gravelly slopes at elevations below 3500 feet. Growing in *Larrea* community. Collected in flower in mid-March through November.

Distribution: Southwestern Utah across southern Nevada into southern California, Arizona and northern Sonora. In Utah, from the Dixie Corridor of the Colorado Plateau with waifs in Canyonlands (Fig. 8).
Fig. 7. Illustration of *Sphaeralcea ambiguа* Gray
Fig. 8. Distribution Map - **Sphaeralcea ambigua** Gray
Discussion: *S. ambiguа* is one of the more xerophytic species treated in this paper. The species as described by Gray (l. c.) is a large, somewhat woody plant, flowers few to numerous (these borne in axils of leaves, with the calyx longer than carpels, carpels galeate and heavily reticulate below. *S. ambiguа* does not extend into Utah to a great extent and thus is not well-represented in our collections. Its influence is seen, however, as *S. ambiguа* characteristics appear in specimens of *S. parvifolia* collected from the vicinity of the Dixie Corridor.

2. *Sphaeralcea caespitosa* Jones (Fig. 9)

*Sphaeralcea caespitosa* Jones Contr. West. Bot. 12:4. 1908. Type:

Utah: Beaver Co.: Wah Wah, 6000 ft. elev., Jones s.n., 1906. (P)

Plants caespitose from woody root and broader, stout woody caudex; herbage clothed with a tomentum of stellate hairs, appearing greyish-green, the stem hairs 0.4-0.7 mm long, with 12-15 rays; stems short, unbranched, seldom over 10 cm tall, the leaves mostly basal, up to 6 on each shoot; petioles terete, to 3 cm long, longer than blade; larger leaf blades 1.9-6.7 cm wide, 2.1-5.5 cm long, broadly deltoid to rhombic, base truncate to cuneate, apex rounded to acute, margin coarsely and irregularly dentate to crenate, rarely 3- or 5-lobed, the veins 5-7; inflorescence a much-reduced thyrses, appearing racemose, seldom with more than 6 flowers per stem; pedicels short, stout, shorter than calyx; bractlets of the involucel becoming purplish, these filiform and tomentose, 1/2 to nearly as long as calyx; calyx 1.0-1.5 cm high at anthesis, angulate, the lobes lanceolate to deltoid, more than twice as long as calyx tube; petals 1.5-2.0 cm long; fruit hemispherical, about 1/2 as high as calyx; carpels 12-14, chartaceous, 4-6 mm high, 2.5-3.0 mm wide (Fig. 5c), indehiscent portion forming slightly more than 1/3 of carpel;
usually 2-seeded, seeds sparsely pubescent.

Collections: 20 (2). Representative: Millard Co.: Warm Point Ridge, Maguire 20876 (BRY).

Habitat: Poor volcanic soil over lava on talus slopes in crevices of rocks and in nearly bare places at elevations of 5000-6000 feet. Growing sporadically with Pinus monophylla, Ephedra nevadensis, Juniperus utahensis, Eurotia lanata, Atriplex confertifolia, Oryzopsis hymenoides, Hilaria jamesii, Zygadenus, Penstemon, Abronia and Leptodactylon. Collected in flower from early May through August.

Distribution: Endemic to the foothills around Pine Valley between the Needle Range and the Wah Wah Mts. in the Calcareous Mountains section of the Great Basin (Fig. 10).

Discussion: _S. caespitosa_ is a distinctive, heavily pubescent, low-growing plant with large flowers and carpels, thick leaves and stout petioles. Although generally low-growing, a specimen with elongate internodes was collected at the Desert Experimental Range (Alder 37, BRY).

There are undoubtedly genetic affinities between _S. caespitosa_ and _S. grossulariaefolia_ as is indicated by the similarly formed carpels and the presence of both species in the same vicinity. Morphologic confluence between the two species is readily observed among specimens collected at Tunnel Spring Mts. (Jeff. & Jeff. 161-163, BRY). These specimens show _S. caespitosa_ to be a variation of _S. grossulariaefolia_ through reduced internodal development, increased pubescence and decreased dissection of the leaf blade. _S. caespitosa_ was found to grow at slightly higher elevations and on steeper slopes than _S. grossulariaefolia_. The roots of _S. caespitosa_ do not penetrate deeply, but instead, divide below the crown and spread under the stones which typify
Fig. 9. Illustration of *Sphaeralcea caespitosa* Jones
Fig. 10. Distribution Map - *Sphaeralcea caespitosa* Jones
the habitat.

There is considerable vegetative resemblance between *S. caespitosa* and a species of the related genus *Sida* (see *Sida hederacea*) which has not been collected from the West Desert area of Utah although it is known from Oasis, Millard Co., Utah.

3. *Sphaeralcea coccinea* (Nutt.) Rydberg (Fig. 11)


Plants with typical woody caudex except caudices often arise on vertical shoots from woody rhizome; herbage moderately pubescent, the hairs composed of stiff, fine rays, these united at bases around stalk, appressed to stem, the stem hairs 0.3-(0.6)-0.8 mm long with 8-(15)-19 rays; stems 7-(14)-27 cm tall, unbranched or branched, the internodes moderately elongate, leafy only up to inflorescence; longest petioles 14-(27)-37 mm long, longer than blade; leaf blades mostly conduplicate, larger blades 1.0-2.8 cm long, 2.0-3.5 cm wide, usually wider than long, broadly deltoid in outline, pedately 3- or 5-parted or divided, lobes often pinnately cleft or divided, primary lateral divisions from 2/3 to as long as mid-lobe, these broadly oblanceolate, apex rounded to acute, base long-cuneate; inflorescence racemose, internodes short with flowers borne singly but close together, flowers 5-(10 or 18)-27; pedicels stout, shorter than calyx; bractlets of involucel wanting or early deciduous; calyx 5-(7)-9 mm high at anthesis, the lobes from deltoid-ovate to lanceolate, the apex acuminate, about 2 times as long as calyx tube; petals 10-15 mm long; fruit wider than hemispherical, 1/2-3/4 as high as calyx; carpels 8-14, coriaceous, 2-3 mm high, 2-3 mm wide, indehiscent part forming 2/3 or more of carpel, internal palate-like invagination within carpel apex (Fig. 6); ovule and seed one.


Habitat: Sandy, gravelly soil in foothills, open flats, talus slopes, along roadsides and generally arid places, also in shady canyons and cultivated fields. From elevations of 4400-8800 feet. Commonly growing with Artemisia, Atriplex, Salsola, Bromus, Hilaria and in Pinyon-Juniper communities. Less frequently reported growing with Populus tremuloides, Coleogyne-Ephedra, Quercus and Medicago sativa. Reported growing on Green River sandstone, Mancos shale, Moenkopi shale, Morrison formation and in selenium soil. Widespread. Collected in flower from May through August.

Distribution: Across the Great Plains north to southern Alberta, Saskatchewan and Manitoba, eastward to western Iowa, southward to western Texas, New Mexico and northeast Arizona and westward to Oregon, Utah and Montana. In Utah, most abundant from the Wasatch Mountains (especially the Wasatch Front) and Utah Plateaus section of the Colorado Plateau. Rare in the Bonneville Basin, but common in the Uinta Basin and Canyonlands (Fig. 12).
Discussion: *S. coccinea* is the most common species of the genus *Sphaeralcea* in the state of Utah. This taxon is most closely allied with *S. leptophylla*, a highly distinctive form found in southeastern Utah. The carpels offer the simplest means of distinguishing *S. coccinea* from other species except *S. leptophylla*. In both species the reticulate portion of the carpel is larger than the smooth portion. The empty non-reticulate portion is not developed as it is in other species.

When fruits are not present, however, there seems to be some difficulty in distinguishing *S. coccinea* from *S. grossulariaefolia*, especially when the *S. grossulariaefolia* specimen has fewer flowers than is expected. Such a specimen is frequently encountered where the ranges of the two species coincide. Here a tall form results having narrow, much dissected, 5-divided leaves and one to several flowers at a node. Putative hybrids between the two have combined characteristics, but the *S. coccinea* type of carpel is correlated with the type of hairs, involucel and inflorescence which is typical of *S. coccinea* (Fig. 13).

Kearney (l. c.) recognized two subspecies of *S. coccinea* in addition to the type variety: *dissecta* and *elata*. He stated that *dissecta* differs from the typical form in its conspicuously whitish pubescence, taller, more erect stems. *S. coccinea* ssp. *dissecta* is based on Nuttall's *Sida dissecta* which was originally described and compared to *Sida coccinea* as follows: *Sida coccinea* is near a span high, carpels about 6, calyx not involucellate; *Sida dissecta* is similar but smaller (Torrey & Gray l. c.). There are, in fact, representative specimens of *S. coccinea* which fit both Kearney's and Nuttall's differing requirements for ssp. *dissecta*, and there are specimens which fit the description of ssp. *elata*. Kearney (l. c.) in his discussion of ssp. *elata* noted that
Fig. 11. Illustration of *Sphaeralcea coccinea* (Nutt.) Rydb.
Fig. 12. Distribution Map - *Sphaeralcea coccinea* (Nutt.) Rydb.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Species</th>
<th>Characteristic</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1/2 indehiscent, well-developed but not heavy, characeous, reticulate flange</td>
<td>cent, heavy, more than 1/2 indehiscent, coriaceous, reticulate coarse</td>
<td>carpels</td>
<td></td>
</tr>
<tr>
<td>Lanceolate, parted or divaricate, cordate-subcordate, cleft</td>
<td>broad-divaricate, parted or divaricate</td>
<td>leave</td>
<td></td>
</tr>
<tr>
<td>borne in clusters</td>
<td>flowers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longer than calyx</td>
<td>shorter than calyx</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internodes few to many flowers, thyrsoïd to thyrsoid-glomerate</td>
<td>Internodes few flowers, short racemose, few flowers, short inflorescence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistence, conspicuously</td>
<td>lacking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rays shorter, tufted, rays not united</td>
<td>slightly, rays longer, appressed to stem, rays united</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5, Grossulariaceae</td>
<td>5, Coccineae</td>
<td>characteristic</td>
<td></td>
</tr>
</tbody>
</table>

"There is . . . complete intergradation with typical coccinea and many of the specimens are more or less intermediate." The intergradation is by no means smooth or predictable. In fact, our Utah materials should be viewed as portions of a highly variable interbreeding population which cannot be separated into intraspecific categories except on an arbitrary basis if one considers all possible combinations of plant size, leaf form and carpel configuration.

Degree of pubescence seems too much a function of the environment to consider it a diagnostic characteristic within the species. After further study and investigation, the short, rhizomatous form could possibly be elevated to variety level.

*Sphaeralcea coccinea* has little economic use. Specimens may be cultivated, however, in gardens as far west as the Puget Sound region of Oregon (Hitchcock & Cronquist 1961). Grazing records kept by the U. S. Department of Agriculture Forest Service indicate that palatability is poor, none or unknown, but occasionally it is rated as fair. A specimen collected by P. Plummer (70 BRY) from the Dixie Forest shows forage value to be fair and indicates that the species is grazed by cattle, horses, sheep and goats through spring and summer. There is no evidence to support the contention that this species is poisonous (Hermann, Ag. Handbook #293).

4. *Sphaeralcea grossulariaefolia* (Hook. & Arn.) Rydb. (Fig. 14)


Plants with herbage glabrescent, canescent or subtomentose, hairs short, 0.15-0.50 mm long, 8-23 rays; stems erect, 18-(40)-60 cm long; petioles longer than largest blades; larger leaf blades 0.8-(2.5)-4.5 cm long, 1.2-(3.0)-5.0 cm wide, usually wider than long, cordate in outline, base subcuneate to cordate, apex obtuse to acute, pedately 3- or 5-divided, cleft or parted, the divisions cleft, lobed or coarsely dentate, primary lateral lobes about 1/2-2/3 as long as mid-lobe, primary divisions spatulate to obovate; inflorescence thrysoid or thrysoid-gglomerate, internodes elongate; flowers few to numerous, usually more than 25; pedicels usually shorter than calyx, but sometimes considerably longer; bractlets of involucel slender, about 1/2 as high as calyx; calyx 5-(8)-10 mm high at anthesis, lobes lanceolate, acute, as long as tube; petals 10-20 mm long; fruit hemispherical or wider, lower than or equaling calyx; carpels about 10-12, chartaceous walls, nearly orbicular to ovate in outline, 2.5-4.5 mm high, 2.5-3.5 mm wide (Fig. 4a); vascular attaching threads persistent or wanting; ovules 1 or 2; seeds 1 or 2, often pubescent.


Habitat: Hillsides, canyons, valleys, along riverbottoms, roadsides, in sandy soil, stabilized dunes, tropic shale and lava soil. Found growing with Coleogyne ramossisima, Ephedra, Atriplex, Chrysopsis hymenoides. Artemesia tridentata, Tetradymia and Gutierrezia from elevations of 4300-6600 feet.

Distribution: South-central Washington southward through Oregon, Idaho, northeastern California, Nevada, Utah, New Mexico and Arizona. In Utah, found in all floristic sections exclusive of the Uinta Mts. and Uinta Basin, but the species is found predominantly in the Bonneville Basin and the Dixie Corridor (Fig. 15).

Discussion: In 1935 Kearney reduced S. pedata to a subspecies of S. grossulariaefolia, excluding it from the type subspecies on the basis of its more southerly range, less dense pubescence and taller, sometimes 2-seeded carpels. He noted that the two forms could be distinguished
only on the basis of their fruit. Seventeen of the specimens included in this study are glabrescent to sparsely pubescent. Three of these have the ssp. *grossulariaefolia* carpels and 1 has ssp. *pedata* carpels. Here there is a correlation between sparse pubescence and short carpels. The pubescent specimens collected with fruit (most of these are from southern Utah where ssp. *pedata* carpels are the predominant form) include none with ssp. *grossulariaefolia* carpels but 24 with ssp. *pedata* carpels. Here there is a correlation between dense pubescence and tall carpels as well as a more southerly range. Admittedly, this survey is limited by the small number of plants collected in fruit, but the sample is comparable to that seen by Kearney from the state of Utah (22 specimens of ssp. *grossulariaefolia* and 5 specimens of ssp. *pedata*). These results, however, lead to the conclusion that the two sub-species, at least in Utah, are not sufficiently different to be recognized as separate entities, especially not on the basis of the above characteristics, and should be synonymized.

Specimens collected by Cronquist from west of Glen Canyon City (10151, 10150, 10149 BRY) show a complete intergradation of the leaf characteristics between *S. grossulariaefolia* and *S. parvifolia*. It is interesting to note that the *S. grossulariaefolia* specimen shows a complete ontogenetic transition of leaf forms from *S. parvifolia* (the lowermost, or juvenile leaves) through the intermediate (mid-way up the stem) to the mature *S. grossulariaefolia* leaf form (just below the inflorescence).

The glabrate specimens mentioned earlier as being common to southern Utah are singularly distinctive in that the stems are often deep maroon in color, a characteristic, which when considered with a reduced
Fig. 14. Illustration of *Sphaeralcea grossulariaefolia* (Hook. & Arn.) Rydb.
Fig. 15. Distribution Map - *Sphaeralcea grossulariaefolia* (Hook. & Anr.) Rydb.
inflorescence and narrow divisions of the leaf blade, bring to mind the forms of *S. rusbyi* said to occur in that area. *S. rusbyi* may be separated from *S. grossulariaefolia* vegetatively because the leaf blade divisions of *S. rusbyi* are extremely narrow and the margins are more regularly lobed than *S. grossulariaefolia*.

5. *Sphaeralcea leptophylla* (Gray) Rydb. (Fig. 16)


*Malvastrum leptophyllum* Gray. Pl. Wright. 1:17. 1852. Type:

New Mexico: Between W. Texas and El Paso. Wright 1851 (G ?).

Plants with elongate, branching caudex; herbage silvery-lepidote, hairs soft, fine, appressed to stem, rays united 1/4 or more of length forming fringed (lepidote) scales, stem hairs 0.15-0.30 mm long, 20-30 rays; stems 19-(24)-35 cm long, less than 2 mm thick, unbranched to sparingly branched below, internodes elongate, lower 1/3 of stem more densely foliate than above; petioles stiff, 1.0-2.5 cm long, mostly shorter than blade, the leaves sessile or nearly so above; leaf blades conduplicate, main veins infossous, lower leaves 3-divided, mid-lobe 18-30 mm long, 1.5-2.5 mm wide, the lobes linear or narrowly oblanceolate, mid-lobe 1/3 longer than lateral lobes, upper leaves entire, linear, 15-35 mm long, 1.5-2.0 mm wide, apex obtuse to acute; inflorescence racemose, narrow, the internodes elongate, the nodes leafless, 2-10 flowers per inflorescence; pedicels slender, lower pedicels 2-(9)-12 mm long, the upper flowers nearly sessile; bractlets of involucel arise from pedicel 0.5-2.0 mm below calyx, these narrow-lanceolate, purple-tipped, persistent; calyx 6-8 mm high at anthesis, the lobes ovate-lanceolate, acute, 1-1 1/2 times as long as calyx tube; petals 7-11 mm long; anthers faintly purple; pistils purple; fruit hemispherical,
about 2/3 as high as calyx; carpels 7-9, coriaceous walls, 2.5 mm high, 2 mm wide, indehiscent part forming 2/3 or more of carpel, internal invagination of tissue directly within carpel apex (Fig. 6); ovule and seed one; seeds sparsely pubescent.

Collections: 15 (0). Representative: Garfield Co.: Shita Marine Creek, Pederson 17 (BRY). Grand Co.: Fiery Furnace, Welsh & Moore 2011 (BRY). Kane Co.: 15 mi. W. Glen Canyon Dam, Ogden s.n. (CED). San Juan Co.: White Rim, Canyonlands, Welsh 7085 (BRY); southwest of Bluff, Maguire 5760 (UTC).

Habitat: Abundant on Moenkopi silt or mudstone, Organ rock and Summerville sandstone formations, these are maroon-red in color in southern Utah. From elevations of 4900-5000 feet in Utah. Found growing in drainages of the Colorado Plateau among desert shrub communities, especially with Coleogyne-Ephedra and Artemesia. Collected in flower from mid-May to late June.

Distribution: From southwestern Colorado, southeastern Utah and northeastern Arizona south to southern New Mexico, western Texas and Sonora or Chuihuaha at elevations of 4000-6000 feet. In Utah, from the Canyonlands section of the Colorado Plateau (Fig. 17).

Discussion: S. leptophylla is readily distinguished from all other species of Sphaeralcea in Utah by the presence of lepidote scales. These are a variation of the appressed stellate hair characteristic of S. coccinea which is formed of rays that are only slightly coalescent. Carpels are much similar in the two species in that they are coriaceous, heavily reticulate, rugose on the back and have a palate-like fold internal from the apex (not shown in illustrations of the carpels). The presence of a persistent involucel is notable for two reasons: S.
Fig. 16. Illustration of *Sphaeralcea leptophylla* (Gray) Rydb.
Fig. 17. Distribution Map - *Sphaeralcea leptophylla* (Gray) Rydb.
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coccinea has none; it arises not from the base of the calyx but from lower on the pedicel.

Two specimens collected in 1968 in Canyonlands National Park are unusually glabrescent with bright green, nearly hairless stems. The leaves are typical of _S. leptophylla_ on one specimen (Welsh 7085 BRY), but on the other the leaves are extremely short with near-obovate divisions (Welsh 7064 BRY). Similar glabrescence is commonly found on specimens of _S. rusbyi_ growing in the same vicinity. A third unusual specimen combines the characteristics of _S. leptophylla_ with the leaf form of _S. digitata_, a species which has not been satisfactorily determined to be present in the state of Utah. Unfortunately, the tops of the main stems have been broken off, possibly by grazing, and leaves adjacent to the inflorescence (these borne on secondary shoots from axillary buds) may not be typical (specimen 5756 UTC). This may be a hybrid with _S. coccinea_, the most nearly allied species to _S. leptophylla_ both genetically and geographically.

6. *Sphaeralcea munroana* (Dougl.) Spach (Fig. 18)


Type: Barren plains of the Columbia, Douglas s. n., July 1826 (K).

Plants decumbent to ascending; herbage usually bright green, sparsely pubescent, rarely canescent, the hairs soft, 0.2-0.5 mm wide, rays 11-20; stems from 20-50 cm tall; petioles slender, much longer
than lower blade; larger blades 1.5-5.0 cm long, 1.3-5.5 cm wide, usually as wide or wider than long, broad-ovate to rhombic in outline, apex usually obtuse, base cuneate to sub-cordate, outer veins generally arching outward from petiole, margin coarsely and unevenly dentate or the blade 3-cleft or 3-parted; inflorescence many-flowered (usually over 30), fairly narrow, secondary axes probably determinant, lower branches up to 3 (rarely 6) cm long; pedicels often equal to or longer than calyx tube; calyx small, 5-10 mm long, lobes deltoid-ovate, acute, 1-2 times as long as calyx tube; petals 8-15 mm long; fruit hemispherical or lower, slightly lower than calyx; carpels 10-13, chartaceous walls, ovate in outline, 2.5-3.0 mm high, slightly higher than wide, indehiscent portion forming about 1/2 of carpel, finely and prominently reticulate (Fig. 5); ovules 1 or 2; seed 1.


Habitat: Light, often sandy soils on hillsides and plains in the Wasatch Mountains from elevations of 4500-6700 feet. Growing with Artemesia, Symphoricarpos and Cynoglossum. Collected in flower from late April through July.

Distribution: Found sporadically through southern British Columbia, southwestern Montana and Wyoming, northern Utah, Nevada and California. In Utah, almost predominantly from the Wasatch Mts. division (Fig. 19).

Discussion: S. munroana is found in both the typical form and
Fig. 18. Illustration of *Sphaeralcea munroana* (Dougl.) Spach
Fig. 19. Distribution Map - *Sphaeralcea munroana* (Dougl.) Spach
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the form known as var. subrhomboidea as defined by Kearney (l. c.). Unfortunately, the characteristics given for the variety do not hold true, and such an entity cannot be clearly segregated from the typical form. The variety subrhomboidea would stand if a cuneate leaf base were present only with a parted or divided leaf blade. However, both types of leaf blade form are found with either type of leaf base (sub-cordate or sub-cuneate) growing in the same location (Jeff. & Toft 52-55).

On one hand, it is difficult to separate specimens having the divided leaf blade from some specimens of S. grossulariaefolia. Generally, S. grossulariaefolia is more common to central and southern Utah whereas S. munroana is common only to the Wasatch and Uinta Mountains. On the other hand, it is difficult to separate specimens with the undivided leaf blade from specimens of S. parvifolia where the ranges overlap. S. parvifolia has finer, less prominent reticulae on the carpel than does S. munroana (although this characteristic intergrades). Hybrids are suspected between S. munroana and S. parvifolia as well as between S. munroana and S. grossulariaefolia. Controlled hybridization studies to compare these three species would certainly be valuable in helping to establish relationships.

7. Sphaeralcea parvifolia A. Nels. (Fig. 20)


Type: Nevada: Lincoln Co., Caliente, Gooding 916, 22 May 1902 (R).


Herbage densely canescent to moderately pubescent, the stem hairs 0.2-0.7 mm long, 12-22 rays; stems 10-100 cm tall; petioles longer than largest blades; leaf blades deltoid-ovate, base usually subcordate to cordate, shallowly 3-lobed, lobes rounded, margin usually finely and regularly crenate, larger blades 2.0-4.6 cm wide and 2.0-4.5 cm long, generally longer than wide; inflorescence narrowly thyrsoid to thyrsoid-glomerate, internodes elongate, flowers numerous (often more than 25), pedicels usually shorter than calyx, lower branches of inflorescence usually less than 5 cm long, sometimes considerably longer; calyx 2-(5)-7 mm long, the lobes deltoid, acute or short-lanceolate and short-acuminate, about as long as calyx tube; petals 7-15 mm long; fruit higher than hemispherical, truncate, nearly equaling or surpassing calyx; carpels 10-12, chartaceous walls, 3-4 mm high, 1.7-2.5 mm wide, from slightly higher than wide to nearly twice as tall as wide, indehiscent part small, forming lower 1/3 to 1/4 or carpel, finely and often faintly reticulate (Fig. 4); attaching threads well-developed, carpels remaining in calyx past maturity; ovules 1 or 2; seeds 1 or 2.


Habitat: Dry, often sandy slopes and well-drained flats at elevations of 2800 to 7500 ft. Growing with Artemesia, Juniperus, Coleogyne and Pinus. Collected in flower from early April through November.

Distribution: Western Colorado westward across Utah and Nevada to eastern California, southward to northwestern New Mexico and central Arizona. In Utah, encountered predominantly from the Canyonlands section of the Colorado Plateau, with waifs recovered from the northern Bonneville Basin (Fig. 21).

Discussion: *S. parvifolia* was described as a new species by Nelson (1904) when he separated it from *S. ambiguа* on the basis of its smaller stature, more numerous and smaller flowers, and smooth-sided carpels. The specimen he based his description on appears to have been similar in appearance to collections from central Utah which have contracted many-flowered inflorescences. *S. parvifolia* in Utah is generally more robust than the type specimen. Typical *S. parvifolia* specimens are more or less densely pubescent depending on the environment they grow in. Since the species is wide-spread, it is subject to considerable environmental variation.

It is interesting to note that *S. parvifolia* generally has a tight thrysoid-glomerate inflorescence except in the southern counties of Utah where looser inflorescences (due to elongate peduncles) are common. Where *S. parvifolia* extends into the range of *S. ambiguа*, specimens pre-
Fig. 20. Illustration of *Sphaeralcea parvifolia* A. Nels.
Fig. 21. Distribution Map - *Sphaeralcea parvifolia* A. Nels.
viously called *S. ambiguа var. monticola* are encountered. This entity should be synonomized with *S. parvifolia* in the state of Utah because it is probably little more than an environmental variation of *S. parvifolia* or, at most, a hybrid between *S. parvifolia* and *S. ambiguа* which more strongly resembles *S. parvifolia* than *S. ambiguа*.

8. *Sphaeralcea rusbyi* A. Gray (Fig. 22)


Caudex sometimes arising from rhizomes; herbage sparsely pubescent to glabrescent, the hairs with soft rays 0.4 mm long, 9-18 rays; stems to 35 cm tall in ours (reported to 85 cm tall), slender, green to deep maroon, relatively unbranched, the internodes elongate, leafy up to inflorescence; longest petioles 2-4 cm long, longer than blade; leaf blades thin, flat, the larger blades 2.0-2.5 cm long, 2.4-4.0 cm wide, slightly wider than long, cordate in outline, pedately 3- or 5-divided, the primary lateral divisions shorter than mid-lobe, these cuneate-spatulate to oblanceolate with regularly pinnatifid, toothed, margins, all divisions narrow; inflorescence relatively few-flowered, 1-8 flowers per node, narrowly thrysoid but sometimes sub-paniculate with peduncles at lower nodes up to 7 cm long; pedicels slender, up to 2 cm long, often shorter than calyx; bractlets of involucel filiform, reddish, equaling calyx tube in length; calyx more pubescent than stems, the calyx 4-(5)-7 mm high at anthesis, the lobes deltoid-lanceolate, acuminate, often longer than calyx tube; petals 10-15 mm long; fruit globose-hemispherical, equaling calyx; carpels 9-12, chartaceous, 3 mm high, 1.5 mm wide, indehiscent part forming 1/3 or less of carpel face, lacunae transparent (Fig. 5); attaching thread long, persistent; seeds
2.


Distribution: Southern Utah to south-central Arizona. In Utah, rare, but from the Dixie Corridor and Canyonlands sections of the Colorado Plateau (Fig. 23).

Discussion: *S. rusbyi* is uncommon in the state of Utah. Although the presence of *S. rusbyi* in Utah is doubtful, the six specimens which are deposited in Utah herbaria and are not typical of the species have been assigned to *S. rusbyi* on the basis of similar vegetative characteristics. Our specimens are more pubescent, have smaller calyxes and the carpels have larger reticulate portions with less transparent lacunae than the more typical Arizona specimens. Kearney (l. c.) concluded that the specimens he observed from Washington Co. were probable *S. rusbyi* x *S. grossulariaefolia* hybrids. Figure 22 is an illustration of one of these putative hybrids. Recent collections have extended the range of this form into San Juan and Garfield Counties.

Excluded Species


Fig. 22. Illustration of *Sphaeralcea rusbyi* A. Gray

This specimen is typical of the *S. rusbyi* growing in Utah and is probably an intermediate between *S. rusbyi* and *S. grossulariaefolia*. 
Fig. 23. Distribution Map - *Sphaeralcea rusbyi* A. Gray
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