The Wild Beans of Southwestern North America

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Beans, all previously considered to be in the genus *Phaseolus*, are an interesting group of southwestern legumes. Ranging from the lower Sonoran desert to the Ponderosa Pine forest, they are excellent subjects for the study of speciation and environmental adaptation. Many have potential for the improvement of cultivated beans, possessing tolerance to heat, frost, drought, flooding, insects (Buhrow, 1981) and diseases (Hubelling, 1957). Unfortunately, the relationships among many of the species have been poorly understood, and because of this, breeders have made very limited use of the characteristics found in this group. This study is an attempt to clarify these relationships, and to describe the environmental adaptation of each species.

An Overview

The Phaseolinae of the Southwest are now considered to form two natural genera, *Phaseolus* and *Macroptilium* (Marechal et al., 1978). The characteristics which distingush these genera are listed in Table 1.

Three *Macroptilium* species occur within southwestern North America. They are: *Macroptilium atropurpureum* (D.C.) Urban (*Phaseolus atropurpureus* D.C.); *Macroptilium gibbosifolium* (Ortega) A. Delgado (*Phaseolus heterophyllus* Willd.); and *Phaseolus supinus* Wiggins and Rollins (*P. supinus* is actually a *Macroptilium*, but the name has not been changed for reasons discussed later in this article). The *Phaseolus* species occurring in this region are *P. angustissimus* A. Gray; *P. acutifolius* A. Gray; *P. filiformis* Bentham; *P. grayanus* Woot. and Standley; *P. metcalfei* Woot. and Standley; *P. parvulus* Greene; *P. ritensis* Jones; and *P. wrightii* A. Gray.

A diagram has been constructed indicating relationships between the species discussed in this article and other domesticated species. Placement of *P. metcalfei* and *P. ritensis* follows Le Marchand et al. (1976). *P. grayanus* is associated with the lunatus branch by seed and fruit characters. The filiformis group of Piper (1926) is placed in the lunatus branch, based on seed and fruit similarities, although this group's status has not yet been satisfactorily resolved. Le Marchand et al. (1976) placed it closer to *P. acutifolius* by pollen characteristics. The sterile hybrid *P. vulgaris* × *P. filiformis* (Marechal and Baudet, 1978) and an unpublished report of *P. acutifolius* × *P. wrightii* with abnormal plantlets (Pratt, 1982) lend support to affinity with *P. vulgaris*. Relationships of *P. coccineus*, *P. vulgaris*, and *P. acutifolius* are based on chemotaxonomic studies by Kloz, Klozova, and Turkova (1966) and interspecific hybridization studies of Honma (1956), Ibrahim and Coyne (1975), and others. Placement of *Macroptilium* spp. follows that of Marechal et al. (1978).

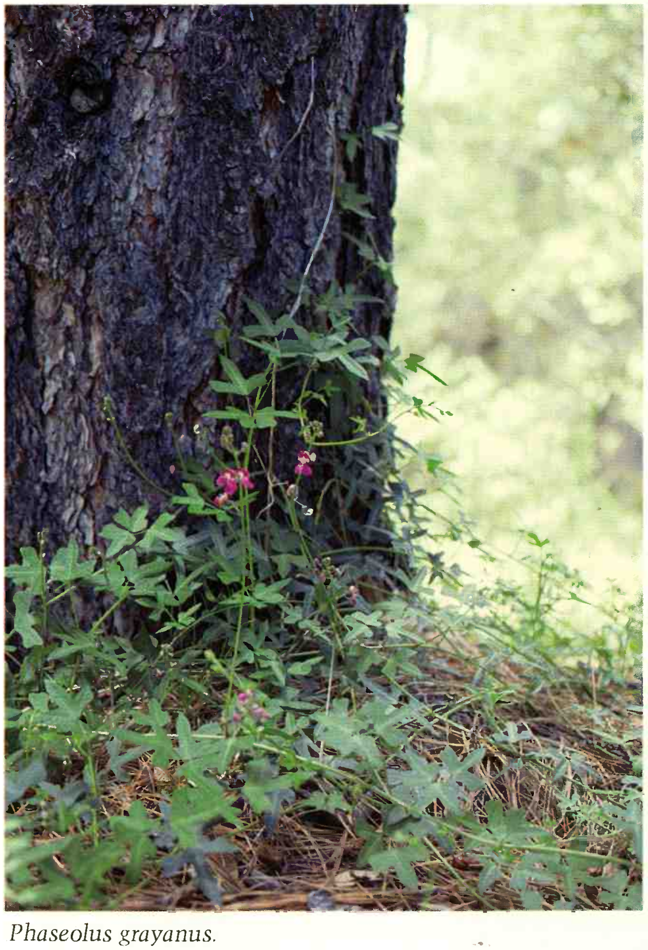
Macroptilium

Macroptilium atropurpureum, found throughout the American tropics, ranges from Peru (Marechal et al, 1978) northward to southern Arizona and Texas. This plant is being domesticated in Australia as a forage crop under the name Siratro. *Macroptilium atropurpureum* is a large plant, with vines up to 6 meters in length produced from seedling plants in one season. The plant is a perennial, returning from drought or winter from stem buds and from the somewhat fleshy root. Germination is barely epigeal, with cordate primary leaves. Found in the Baboquivari and Coyote Mountains in the 1930's and 1940's, *M. atropurpureum* is apparently rather rare at these

Macroptilium gibbosifolium.

Phaseolus ritensis.

Phaseolus angustissimus.



Phaseolus grayanus.

Macroptilium atropurpureum *at the University of Arizona Campbell Avenue Farm.*

localities, or has disappeared, as the author has searched the area for three seasons without success.

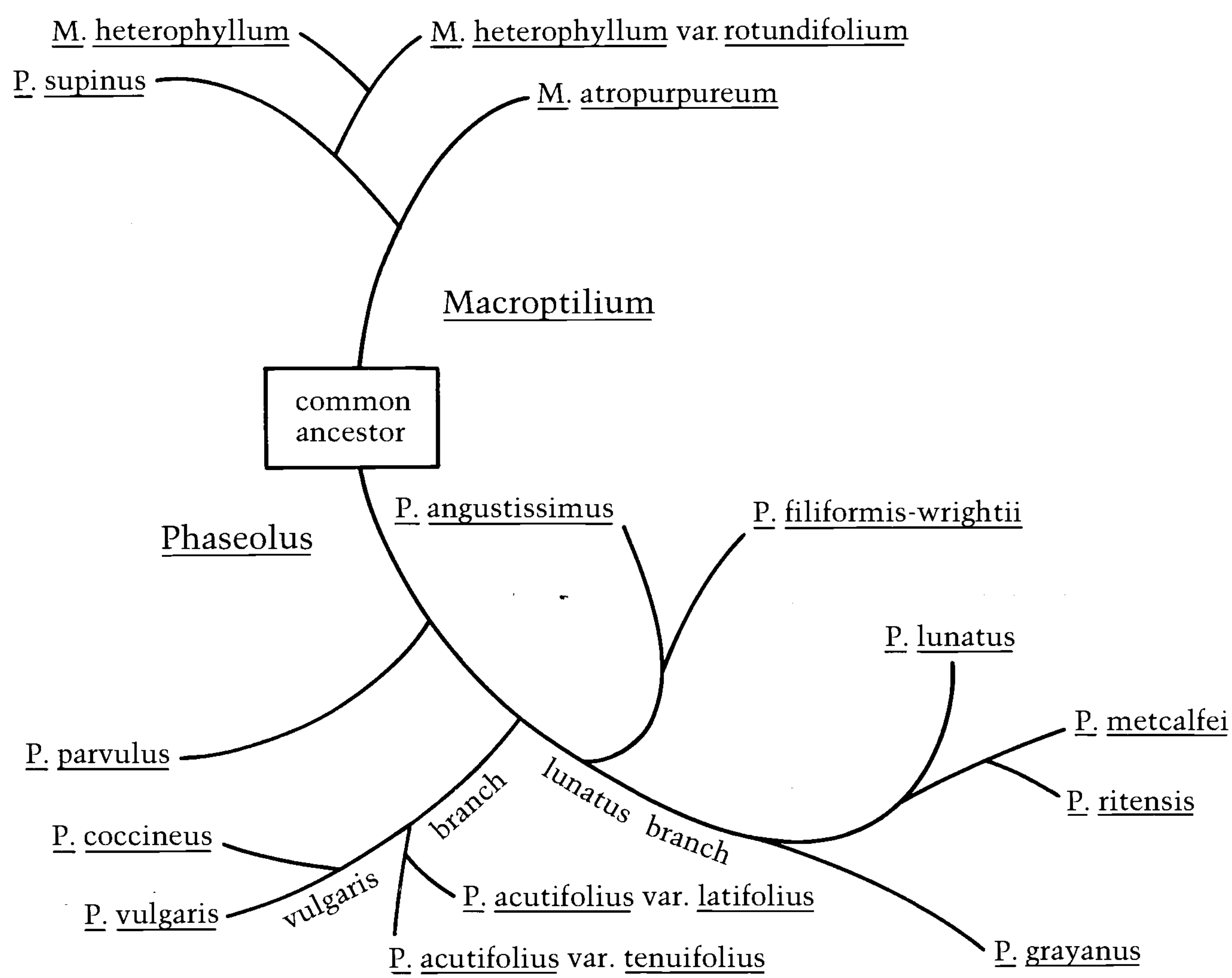
Macroptilium gibbosifolium has the widest distribution of any species in the American Phaseolinae, from Argentina, Paraguay, and Bolivia (Marechal et al., 1978) to central Arizona and New Mexico. A relatively small plant, *M. gibbosifolium* is thin-stemmed and rarely exceeds 2 meters vine length. Plants are perennial from a fusiform or linear lignescent root. Germination is hypogeal, with ovate or cordate primary leaves.

Macroptilium pedatum? Phaseolus supinus is included here based on characters of Marechal et al. (1978). Marechal (1979) considered this taxon to be merely a variant of *M. pedatum* (Rose) Marechal and Baudet. A change in taxonomic status at this time seems inappropriate, pending clarification of the relationship between *M. pedatum* and *P. supinus*. Based upon the type descriptions, these taxa differ primarily in leaflet shape, a very weak character for Phaseolinae. *P. supinus* also is reported to have larger peduncles than *M. pedatum*. Both *M.*

Table 1. Characters distinguishing between *Phaseolus* and *Macroptilium*[1].

Phaseolus	*Macroptilium*
Uncinate hairs present	Uncinate hairs absent
Pedicels longer than the calyx	Pedicel length less than or equal to that of the calyx
Floral bracts persistent to anthesis	Floral brackets caducous
Knots of the rachis not swollen	Rachis of inflorescence somewhat knotty at the insertion of the pedicels
Style closely coiled 1.5-2 turns	Keel and style closely curved at the tip
Standard with a small marginal indentation and a diffuse central thickening	

1. Translated after Marechal et al. (1978).



Evolutionary relationships of wild southwestern and cultivated Phaseolinae.

pedatum and *P. supinus* possess above-ground and subterranean flowers and fruits. Flowers were reported by Rose (1903) as purple for *M. pedatum*, and flowers of *P. supinus* are orange. Flowers of both *M. gibbosifolium* and *P. supinus* dry to a purple color, and it could be that Rose reported the color from dried materials, since the type specimen was collected by Pringle. Plants of *P. supinus* typically grow with grasses and due to the fine stems and creeping habit, are nearly invisible in habitat unless in bloom. Vine length may reach 1 meter, but half that length is more usual. Plants are perennial from a fusiform root. Germination is hypogeal, with ovate-lanceolate primary leaves. The plants are apparently rare, known only from 3 localities: Sycamore Canyon, Atascosa Mountains, Arizona; between Mazatan and Colorado, Sonora; and Los Ruiz, Nayarit (Delgado, 1979). The type locality of *M. pedatum* is Iguala, Guerrero, Mexico.

Phaseolus

Phaseolus acutifolius, the only southwestern member of Phaseolinae which has been domesticated, is also known as the tepary bean. Four forms are known: domesticated variety *latifolius*, wild variety *latifolius*, the nominate variety *acutifolius*, and variety *tenuifolius*. Variety *latifolius* can be distinguished from variety *tenuifolius* as having ovate or ovate-lanceolate, rather than linear, lanceolate, or lance-ovate leaves; primary leaves deltoid or deltoid-saggitate, rather than deltoid-lanceolate or lance-ovate; heavier stems and larger seeds. Domesticated variety *latifolius* has lost most of its twining ability, has larger seeds of a more uniform color, and is less hard seeded than wild variety *latifolius* (Nabhan, 1978). Wild variety *latifolius* is basically an understory plant of canyon bottoms and floodplains, habitats where runoff from adjacent uplands accumulates, creating a more mesic environment than the surrounding area. In good years, this allows the plants to become quite large, climbing into the canopy up to 4 meters (Freeman, 1918). Variety *tenuifolius* is generally found in canyon bottoms and on rocky slopes, rarely exceeding 2 m vine length. There is also an elevational separation of these varieties. The nominate variety is found near El Paso, Texas, but plants with leaf shape similar to the type specimen have been found at Sycamore Canyon,

Phaseolus supinus *removed to show plant form, Sycamore Canyon, Atascosa Mountains, Arizona, 1160 m (3800 ft.).*

Atascosa Mountains (Nabhan, 1978), and in the Coyote Mountains, Arizona.

Variety *acutifolius* is essentially an unusually broad-leaf var. *tenuifolius*, having similar growth form and seed size. Considerable leaf variation exists within var. *tenuifolius*, from very narrow leaves to leaves similar to the nominate type. The following synonymy is proposed:

> *Phaseolus acutifolius* Gray 1852. var. *acutifolius* =
> *Phaseolus acutifolius* var. *tenuifolius* Gray 1853.

Germination of *P. acutifolius* is epigeal and the plants are annual.

P. angustissimus ranges farthest north of the southwestern Phaseolinae, reaching northern Arizona. The plants are perennial, with vines to 2 m long, and are often found in association with Ponderosa Pine. Plants are also found at lower elevations in riparian habitats. Leaflet shape varies from linear to orbicular and from entire to lobed. Germination is hypogeal, with cordate based, ovate-lanceolate primary leaves.

Sometimes misidentified as *P. acutifolius* var. *tenuifolius*, *P. angustissimus* may be distinguished by its perennial habit, waxy leaves, 2-4 seeded pods, rather than the 4-10 seeded for *P. acutifolius*, rugose seeds, heavier, more glabrous stems, and magenta or pink, rather than light lavender flowers.

Confusion exists regarding *P. filiformis* and *P. wrightii.* In Gray's (1852) original description of *P. wrightii*, he states that it may be a variety of *P. filiformis.* His later description of Wright 952 (1853) adds confusion to the literature which persists today. The later specimen was *P. grayanus*, a perennial. This error was cited by Wooton and Standley (1913). Specimens from the type locality of *P. wrightii* (El Paso, Texas) fall within the normal range of variability seen throughout the range of *P. filiformis.* Kearny and Peebles (1960) and Shreve and Wiggins (1964) all state that there seems little justification for maintenance of *P. wrightii* as a species. The following synonymy is proposed:

> *Phaseolus filiformis* Benth. 1844. =
> *P. wrightii* A. Gray 1852.

Phaseolus filiformis is the only species of *Phaseolus* adapted to extremely arid conditions. Its range includes some of the most xeric environments in North America. Perhaps the most interesting of all the southwestern Phaseolinae, *P. filiformis* is able to withstand drought, extreme heat, and frost. These adaptations permit *P. filiformis* to grow essentially independent of the temperatures which normally occur in its habitats, allowing utilization of any available moisture. Plants have been observed flowering and fruiting both in the summer (46° C) and in mid-winter (-6.7° C). This desert bean is an annual, although some plants will grow in the winter, go semi-dormant, and regrow in the summer before dying. People of the Pinacate region of northwest Sonora and southwest Arizona are

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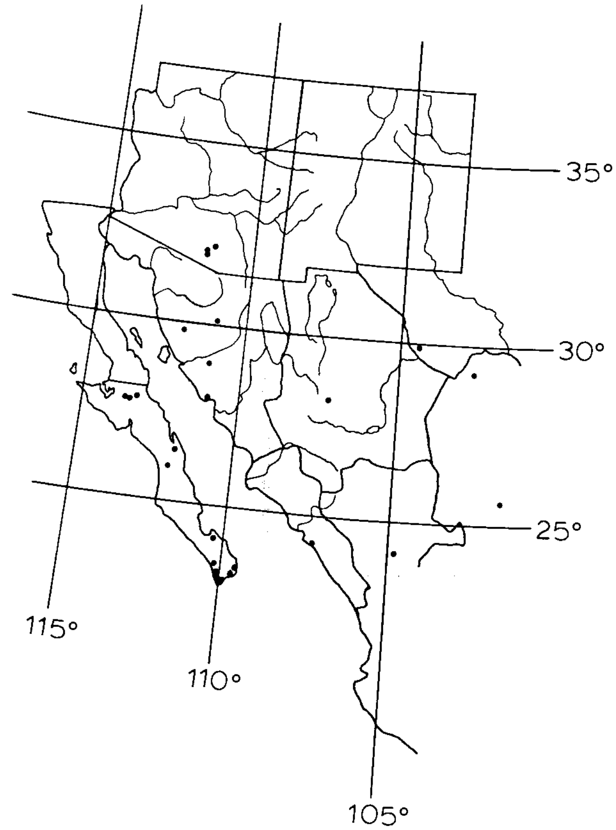
reported to eat both immature pods and mature seeds of *P. filiformis* (Nabhan, 1982). Germination is epigeal, and primary leaves are cordate. Mature plants have vines up to 1 m length.

As previously mentioned, *P. grayanus* has been confused with *P. filiformis (P. wrightii)*. This is due to the similarity of leaf shape of certain *P. filiformis* and *P. grayanus* plants. The similarity ends at that point. *P. grayanus* is a plant of oak woodlands and pine forests, a perennial from a lignescent thickened root, a much larger plant with fruits and seeds very different from *P. filiformis*.

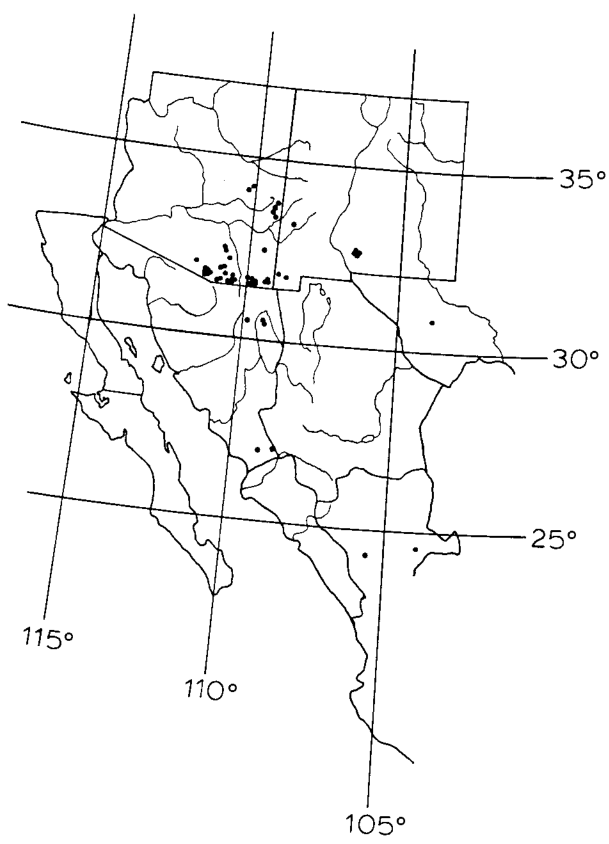
Phaseolus metcalfei and *P. ritensis* are two sibling species of a group which includes at least four members (Piper, 1926). Although difficult to distinguish in flower, fruited specimens are easily separated (Nabhan et al., 1980). Useful characters are listed in Table 2.

Both species are found in oak savannas, oak woodland, and chapparal, but *P. metcalfei* has a broader range, including Chihuahuan grasslands. Germination of both species is hypogeal. Both species are perennial from rather large, lignescent roots. Vines reach lengths of up to 5 m. They have been sporadically used as forage crops, sometimes under the name *P. retusus*, and are the only wild southwestern *Phaseolinae* whose products (medicinal roots) are currently marketed (Nabhan et al., 1980).

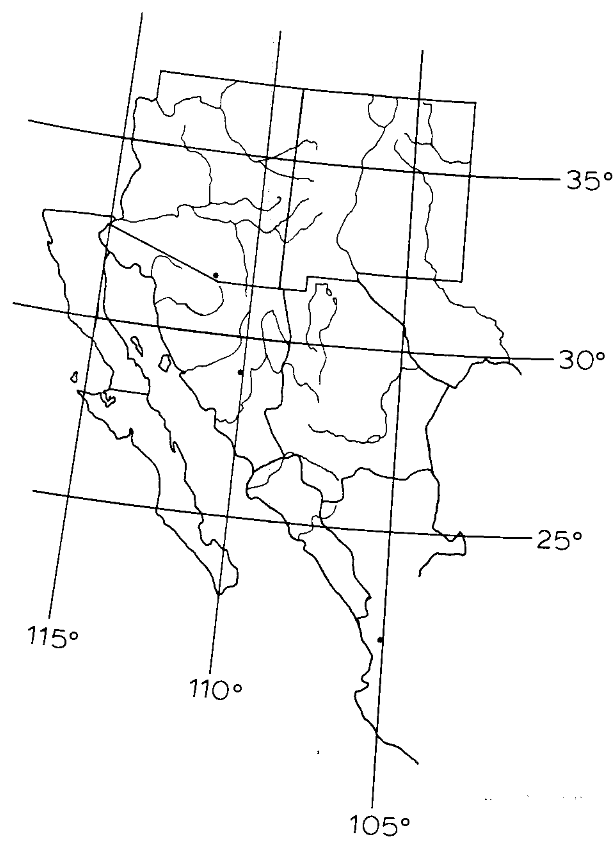
Phaseolus parvulus, a species of pine forests, is the smallest



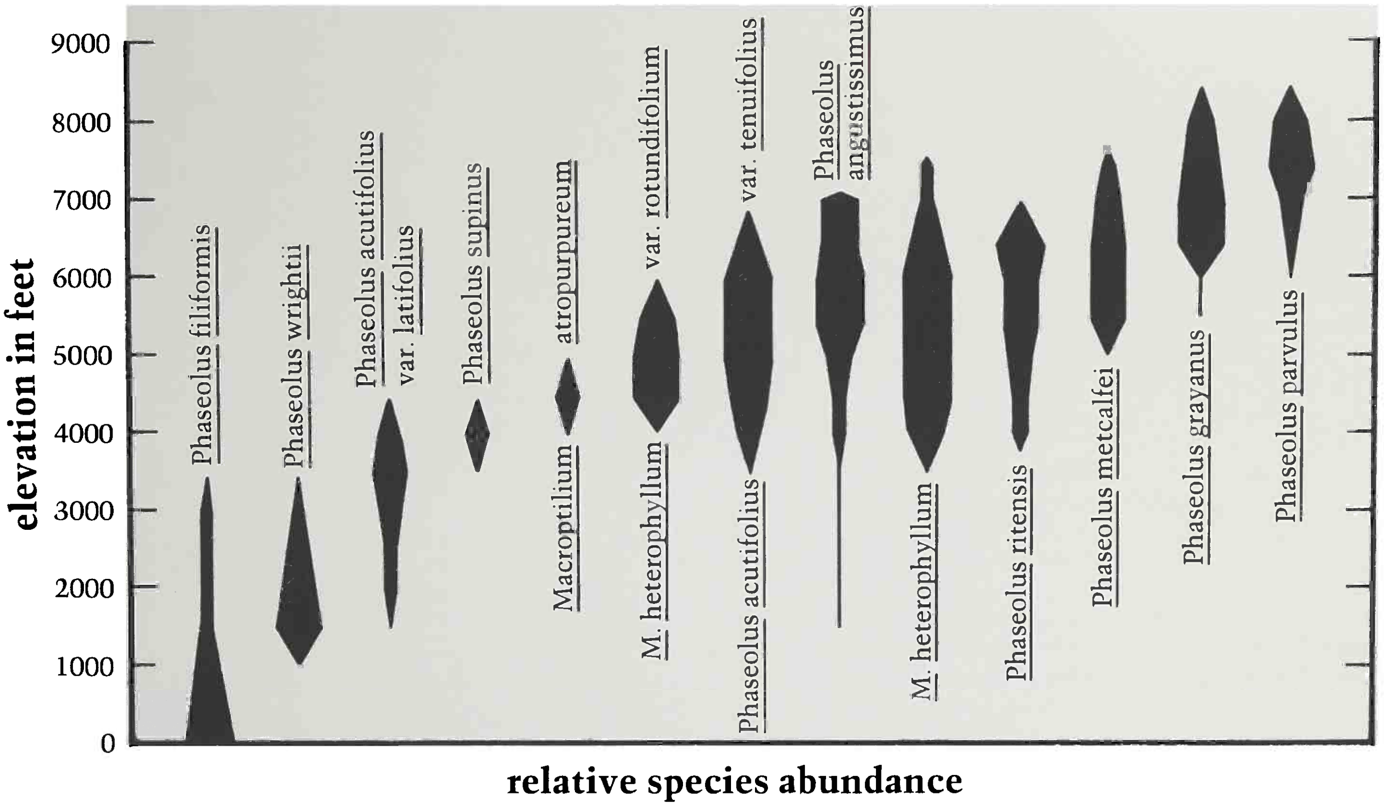
Macroptilium atropurpureum.



Macroptilium gibbosifolium.

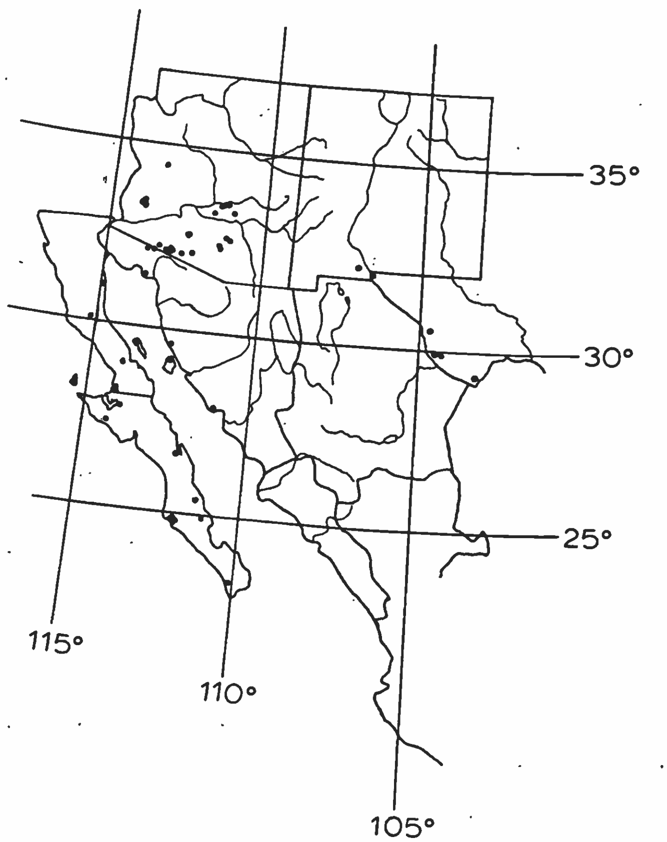


Phaseolus supinus.

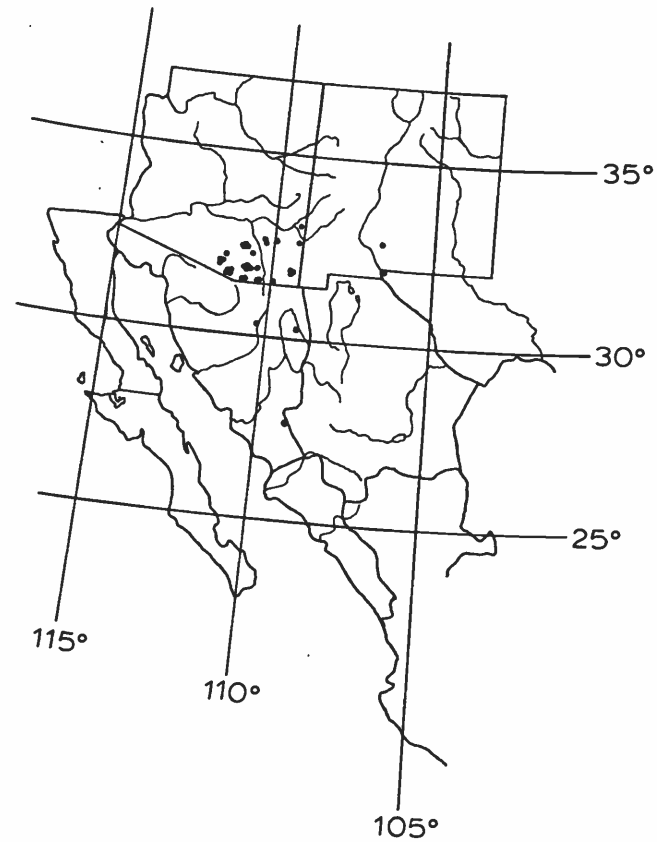


Elevational distributions of Southwestern Phaseolinae.

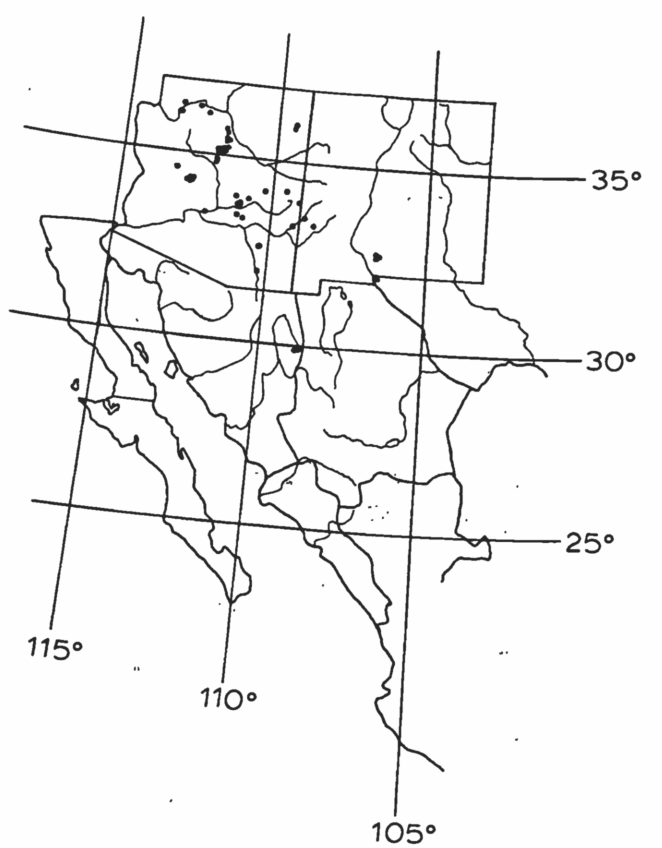
Phaseolus filiformis *at the University of Arizona Campbell Avenue Farm.*



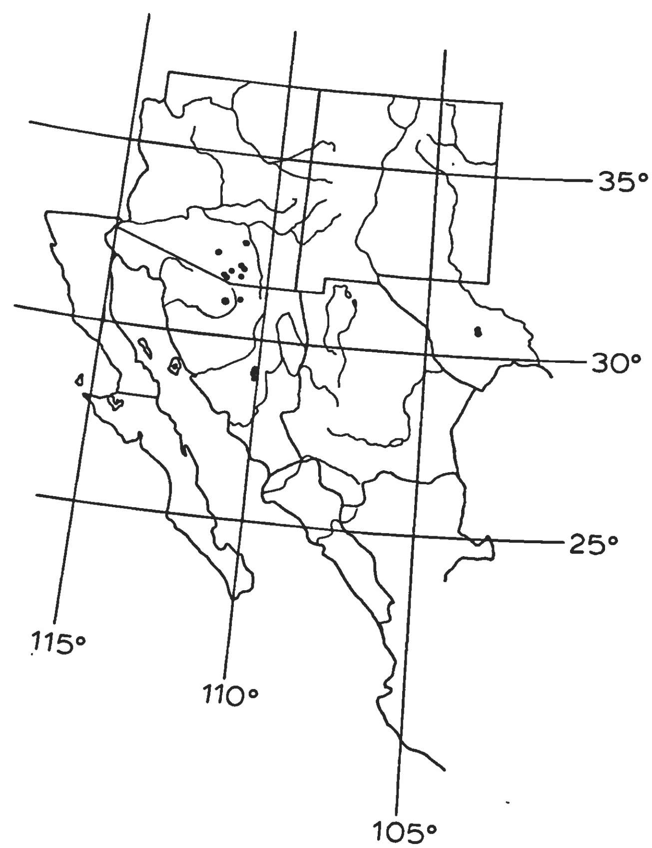
Phaseolus filiformis.



Phaseolus acutifolius var. *acutifolius.*



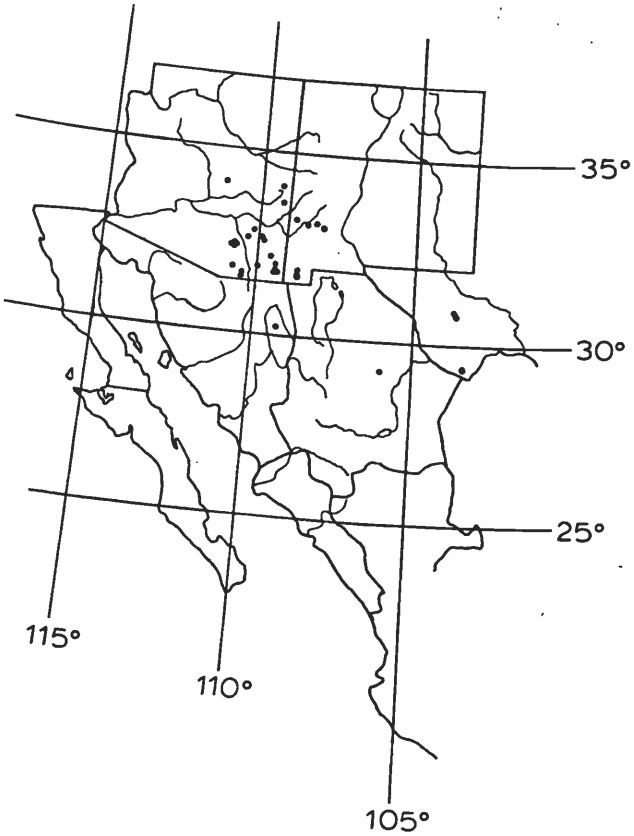
Phaseolus angustissimus.



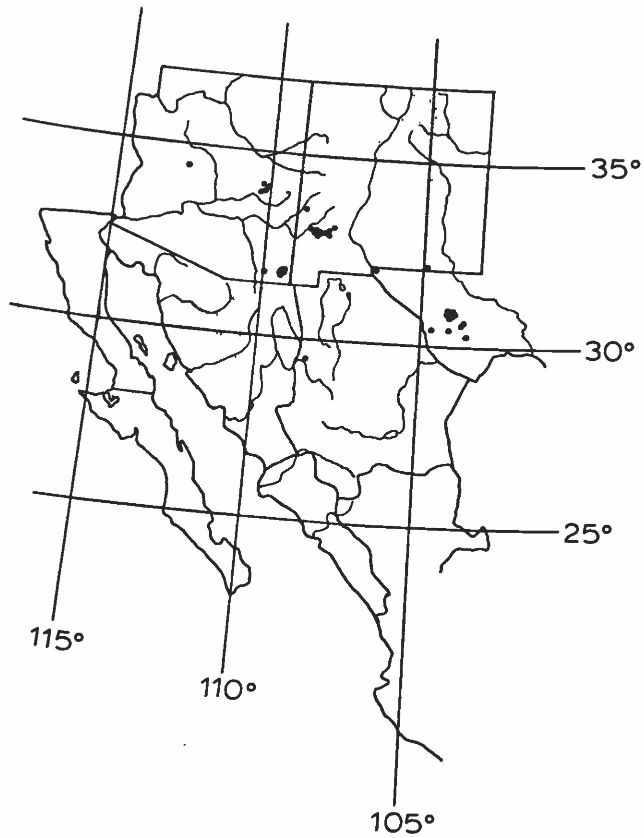
Phaseolus acutifolius var. *latifolius.*

Phaseolus acutifolius *var.* acutifolius *at the University of Arizona Campbell Avenue Farm.*

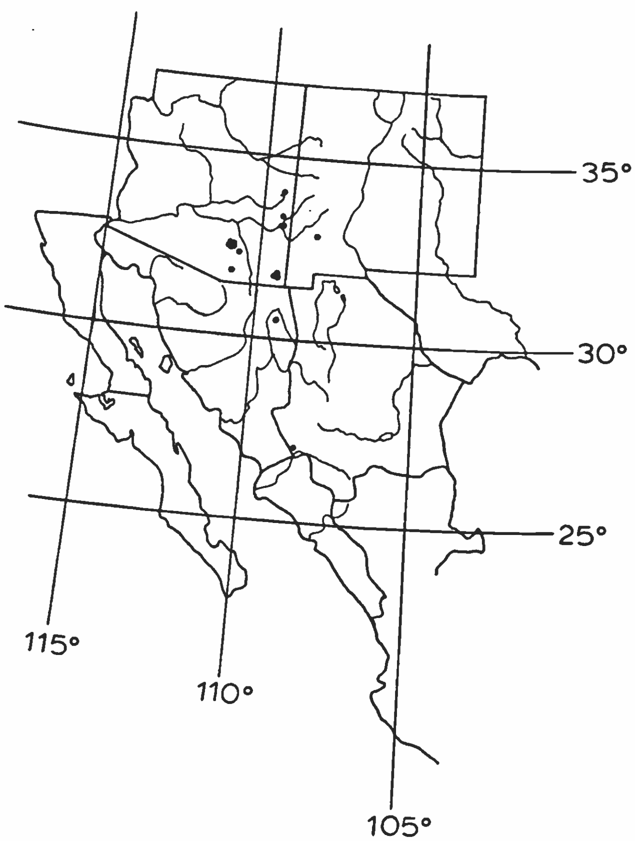
Phaseolus acutifolius *var.* latifolius *growing on volcanic talus, Sycamore Canyon, Atascosa Mountains, Arizona, 1160 m (3800 ft.).*



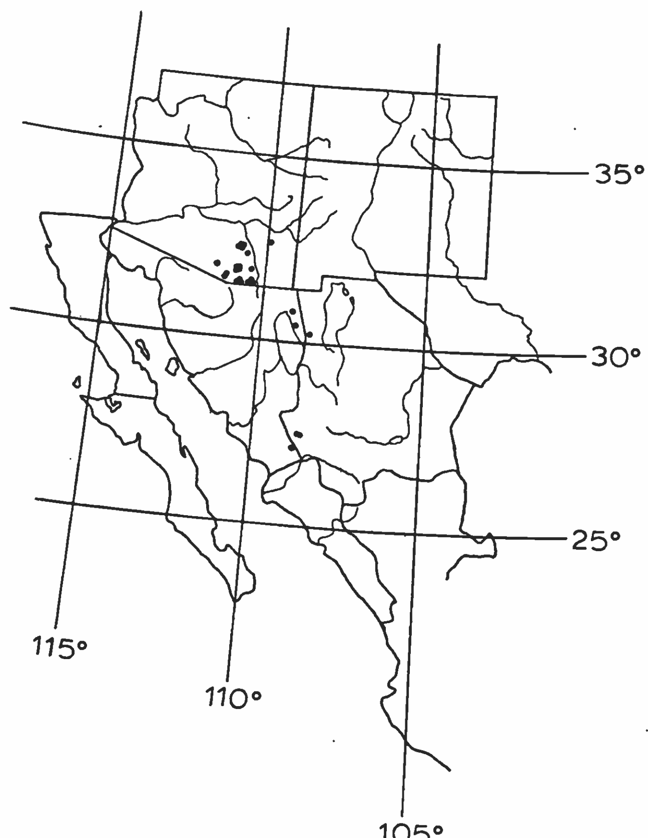
Phaseolus grayanus.



Phaseolus metcalfei.



Phaseolus parvulus.



Phaseolus ritensis.

Phaseolus metcalfei *growing from a roadcut along the Tombstone-Pierce road, Dragoon Mountains, Arizona, 1830m (6000 ft.).*

plant of the group, rarely reaching sizes greater than 40 cm. Growing from a small, round tuber, the plants usually emerge in late July or early August and have gone dormant by October.

Domesticated *Phaseolus* species are major contributors to the world food supply. Valuable characters unknown within domesticated species are found in the wild Phaseolinae of the Southwest. Unfortunately, many populations are in danger of extinction or have already been lost. Protection of threatened populations and species is imperative if the full potential for utilization of this group is to be achieved. This would not be protection in the conventional sense, since the group is most successful as disturbance indicators or colonizer species. Overgrazing and fire suppression are probably the most harmful factors for the group's survival. Successful populations are found on landslides, roadcuts, unstable soils, and recently-burned areas. Preservation of this group of wild plants merits the attention of those concerned with the continuation of a stable, long-term food supply.

Table 2. Characteristics that Distinguish *P. metcalfei* and *P. ritensis.*

	P. metcalfei	*P. ritensis*
Seed Weight	.2 - .3 g	.04 - .06 g
Pod Width	9-18 mm	6-10 mm
Pod	Constricted Between Seeds	Nearly Smooth
Peduncle Length	Not over 30 cm	Up to 1 m
Leaf Color	Blue green	Dark green
Primary leaf	Deltoid, petiolate	Lance-ovate, lanceolate subsessile
Node 3 leaf	Trifoliate	Unifoliate

Phaseolus parvulvus, *in mixed* Pinus ponderosa, Robina neomexicana *forest, Oracle Ridge, Santa Catalina Mountains, Arizona, 2400 m (7900 ft.). Seedlings are visible in the right foreground.*

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