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REVISION OF THE GENUS ROBINIA (LEGUMINOSAE: PAPILIONOIDEAE)

Iowa State University

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Revision of the genus Robinia (Leguminosae: Papilionoideae)

by

Frederick Joseph Peabody

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Department: Botany

Major: Botany (Taxonomy)

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For the Graduate College

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Ames, Iowa

1984

TABLE OF CONTENTS

	PAGE
INTRODUCTION	1
LITERATURE REVIEW	2
<u>Robinia</u> sensu lato	3
<u>Robinia</u> sensu stricto	4
Conservative view	4
Proliferation	4
Uncertainty	5
MATERIALS AND METHODS	9
Herbarium studies	9
Field studies	9
Chromosome numbers	10
Phenetics	14
RESULTS AND DISCUSSION	22
Chromosome numbers	22
Phenetics	28
Cluster analysis	28
Principal components analysis	38
TAXONOMIC TREATMENT	41
Introduction	41
ROBINIA	42
Key to species of <u>Robinia</u>	49
<u>Robinia pseudoacacia</u>	50
<u>Robinia hispida</u>	59
<u>Robinia viscosa</u>	90
<u>Robinia neomexicana</u>	103

Interspecific hybridization	115
LITERATURE CITED	134
ACKNOWLEDGMENTS	147
APPENDIX: SPECIMENS EXAMINED FOR PHENETIC ANALYSIS . .	148

LIST OF TABLES

	PAGE
TABLE 1. Species of <u>Robinia</u> (Rydberg 1924)	6
TABLE 2. Cytological findings in <u>Robinia</u> (Whitaker 1934)	7
TABLE 3. Taxonomic treatment of <u>Robinia</u> by Wilbur (1963, 1968)	8
TABLE 4. Field study documentation: Peabody accessions (ISC) of <u>Robinia</u>	11
TABLE 5. <u>Robinia</u> variables for phenetic analysis	16
TABLE 6. Chromosome counts in <u>Robinia</u>	23
TABLE 7. Left to right order of OTUs on the dendrograph	31
TABLE 8. Aberrant OTUs indicated on dendrograph	36
TABLE 9. Comparison of <u>Robinia</u> and <u>Olneya</u>	46
TABLE 10. Raw data for <u>Robinia</u> introgression (Bashor 1961)	125

LIST OF FIGURES

	PAGE
FIGURE 1. Chromosomes of <u>Robinia</u> , scale = 10 μ m	25
FIGURE 2. Microsporocyte meiosis in <u>Robinia hispida</u> L. var. <u>hispida</u> , Peabody 2203.	27
FIGURE 3. Dendrograph of 324 <u>Robinia</u> OTUs	30
FIGURE 4. Three-dimensional plot of 117 <u>Robinia</u> OTUs using principal components analysis	40
FIGURE 5. <u>Robinia pseudoacacia</u> L.	52
FIGURE 6. Distribution of <u>Robinia pseudoacacia</u> L.	55
FIGURE 7. <u>Robinia hispida</u> L. var. <u>fertilis</u> (Ashe) Clausen	65
FIGURE 8. Distribution of <u>Robinia hispida</u> L. var. <u>fertilis</u> (Ashe) Clausen	67
FIGURE 9. <u>Robinia hispida</u> L. var. <u>kelseyi</u> (Hutchins.) Isely	71
FIGURE 10. <u>Robinia hispida</u> L. var. <u>nana</u> (Ell.) DC.	77
FIGURE 11. Distribution of <u>Robinia hispida</u> L. var. <u>nana</u> (Ell.) DC.	79
FIGURE 12. <u>Robinia hispida</u> L. var. <u>hispida</u>	83
FIGURE 13. <u>Robinia hispida</u> L. var. <u>hispida</u>	85
FIGURE 14. Distribution of <u>Robinia hispida</u> L. var. <u>hispida</u>	87
FIGURE 15. <u>Robinia viscosa</u> Vent. var. <u>hartwigii</u> (Koehne) Ashe	95
FIGURE 16. Distribution of <u>Robinia viscosa</u> Vent. var. <u>hartwigii</u> (Koehne) Ashe	97
FIGURE 17. <u>Robinia viscosa</u> Vent. var. <u>viscosa</u>	100

FIGURE 18. Distribution of <u>Robinia viscosa</u> Vent. var. <u>viscosa</u>	102
FIGURE 19. Distribution of <u>Robinia neomexicana</u> Gray	105
FIGURE 20. <u>Robinia neomexicana</u> Gray var. <u>rusbyi</u> (Woot. & Standl.) Peabody	110
FIGURE 21. <u>Robinia neomexicana</u> Gray var. <u>neomexicana</u>	114
FIGURE 22. <u>Robinia</u> x <u>slavinii</u> Rehder (pro sp.)	123
FIGURE 23. Bashor (1961) introgression studies in <u>Robinia</u>	128
FIGURE 24. Dendrograph of Bashor (1961) <u>Robinia</u> data	131
FIGURE 25. Polygon comparisons of Bashor (1961) <u>Robinia</u> data	133

INTRODUCTION

Taxonomic agreement about the interpretation of the variability in the North American genus Robinia has never been achieved. The number of species recognized varies from four (Sargent 1892, Isely and Peabody ca. 1984) to eight (Wilbur 1963) to twenty (Rydberg 1924). Wilbur (1963) has stated:

A most baffling genus and one but little understood at the present time.... Critical study of the genus in the field, experimental garden and herbarium is obviously needed before anything approaching a satisfactory treatment can be presented. Previous accounts of the genus, when at all original, have differed widely in interpretation of characters and entities.

This study is an attempt to resolve some of the problems of inter- and infra-specific variation and to present a rationale for conclusions reached. Methods employed are traditional field and herbarium studies supplemented by cytological and phenetic investigations. Numerical methods include cluster analysis and principal components analysis.

LITERATURE REVIEW

Approximately 350 combinations have been made in the genus Robinia throughout its nomenclatural history. Almost half of these are horticultural trinomial cultivars, mostly selections of R. pseudoacacia and R. hispida. I have not passed nomenclatural judgement on names based on cultivated material since their species affinity is obvious and herbarium type material is usually lacking. Another large group of combinations consists of taxa which were eventually removed from the genus Robinia. Author citations for these can be found in the following section. A complete tabulation of generic transfers and names given to cultivated material, together with their currently accepted synonyms, is contained in a separate manuscript (Peabody 1981) deposited in the library at Iowa State University, Ames. Names referring to Robinia as herein circumscribed and known in North America can be found under their respective taxa in the taxonomic treatment.

The nomenclatural history of the genus Robinia can be divided into five stages: 1) an original and broad circumscription of the genus (Robinia sensu lato), 2) generic circumscription restricted to present day status (Robinia sensu stricto), 3) conservative view of the number of species within the genus, 4) proliferation of the number of species, and 5) uncertainty as to species

circumscriptions among current workers.

Robinia sensu lato

From before the publication of the Species Plantarum (Linnaeus 1753) to the middle of the nineteenth century, many taxa were named in the genus Robinia. During this period, many leguminous trees with odd-pinnately compound leaves, racemose inflorescences, and diadelphous stamens were placed in the genus Robinia, including plants of not only North, Central, and South American distribution, but also plants of the Eastern Hemisphere (Amman 1739, Breyne 1739, Commelin 1696, Cornuti 1635, Parkinson 1640, Plukenet 1696, Ray 1686-88, Rivinus 1699, Tournefort 1700, Linnaeus fil. 1781, 1787, Jacquin 1763, Crantz 1766, Miller 1768, Laxman 1771, Aublet 1775, Pallas 1796a, 1796b, 1800, L'Heritier de Brutelle 1785-91, West 1793, Loureiro 1790, Moench 1794, Vahl 1794, Salisbury 1796, Willdenow 1800-02, Poiret 1804, 1816, Persoon 1805-07, Desveaux 1813-14, Marschall von Bieberstein 1808-19, Du Mont de Courset 1811, Fischer 1812, Roxburgh 1814, 1820, Besser 1816, Sweet 1827, 1830, Humboldt, Bonpland, and Kunth 1823-26, Martius 1824, De Candolle 1825, Sprengel 1826, Schumacher 1827, Schlechtendal 1830, 1838, Presl 1830, Walpers 1842, 1848, Wight and Arnott 1834, Miquel 1860-61, Bentham 1860, Lavallee 1877, Handlos 1894).

Robinia sensu stricto

Monographic efforts of the 18th and 19th centuries, based on ample collections, clarified generic limits in the Leguminosae as a whole and restricted the circumscription of Robinia to its present North American distribution (De Candolle 1825, Sargent 1892).

Conservative view

North American floristic works of the late 19th and early 20th centuries (Watson and Coulter 1889, Chapman 1860, Sargent 1891, Small 1903) presented a more conservative view as to the number of species within the genus, recognizing four or five eastern and one western species. Included among the eastern species were the common black locust (Robinia pseudoacacia), the bristly locust (R. hispida), the clammy locust (R. viscosa), and in some cases recognition of one or two glabrate forms within R. hispida called R. boyntonii Ashe (1897) and/or R. elliottii (Chapman) Ashe (1903). The western species was the New Mexico locust (R. neomexicana).

Proliferation

In the first part of the 20th century, 13 new species of Robinia were described by W.W. Ashe, State Forester for North Carolina (Ashe 1897, 1903, 1922, 1923a, 1923b, 1923c).

He suggested an additional new species to Schallert (1923) who described it as R. ashei. Rehder (1915, 1922, 1940, 1949) published notes on Robinia, primarily descriptive of horticultural varieties and hybrids. Rydberg (1924) recognized twenty species of Robinia (Table 1). Eight of Ashe's species were maintained and three new ones described. Small (1933) recognized 14 species for the Southeastern United States, his taxonomy evidently following that of Rydberg (1924).

Uncertainty

In an attempt to unravel some of the confusion relating to this genus, Whitaker (1934) sampled various taxa (Table 2) and found a chromosome number of $2n=2x=20$. Among certain flowering but non-fruiting populations a chromosome number of $2n=3x=30$ was found which he interpreted as triploids. This was supported by correlation of the abnormal somatic number ($2n=3x=30$) with a high percentage of pollen sterility, indicating irregular meiotic behavior.

Studying Robinia hispida, Clausen (1940) examined the Linnaean specimen for that species and the type material of some of Ashe's species. He concluded that R. hispida contained two groups which he called variety typica (consisting of an aggregate of miscellaneous sterile forms) and variety fertilis (consisting of the fertile diploid

TABLE 1. Species of Robinia (Rydberg 1924)

Species	Synonyms (as listed by Rydberg)
<u>R. pseudoacacia</u> L.	<u>R. acacia</u> L. <u>Pseudoacacia odorata</u> Moench <u>R. fragilis</u> Salisb.
<u>R. pringlei</u> Rose	<u>R. rosea</u> Ell.
<u>R. elliottii</u> (Chapm.) Ashe	<u>R. hispida elliottii</u> Chapm. <u>R. hispida rosea</u> Ell. <u>R. hispida inermis</u> Petz. & Kirch.
<u>R. boyntonii</u> Ashe	<u>R. hispida rosea</u> Pursh <u>R. hispida macrophylla</u> DC. <u>R. macrophylla</u> G. Don <u>R. hispida nana</u> T. & G.
<u>R. nana</u> Ell.	
<u>R. kelseyi</u> Cowell	
<u>R. longiloba</u> Ashe	
<u>R. grandiflora</u> Ashe	
<u>R. speciosa</u> Ashe	
<u>R. pallida</u> Ashe	
<u>R. pedunculata</u> Ashe	
<u>R. hispida</u> L.	<u>R. rosea</u> Marsh. <u>Pseudoacacia hispida</u> Moench <u>R. hispida-rosea</u> Mirb. <u>R. montana</u> Bartr. <u>pro parte</u> <u>R. unakae</u> Ashe <u>R. hispida</u> Michx. <u>pro parte</u> <u>R. nana</u> Ashe <u>pro parte</u>
<u>R. fertilis</u> Ashe	
<u>R. rusbyi</u> Woot. & Standl.	<u>R. rusbyi</u> Woot. & Standl. <u>pro parte</u>
<u>R. neomexicana</u> Gray	<u>R. neomexicana</u> Gray <u>pro parte</u> <u>R. neomexicana luxurians</u> Dieck
<u>R. luxurians</u> (Dieck) Rydb.	
<u>R. breviloba</u> Rydb.	
<u>R. subvelutina</u> Rydb.	
<u>R. viscosa</u> Vent.	<u>R. echinata</u> Mill. <u>R. glutinosa</u> Sims <u>R. montana</u> Bartr. <u>pro parte</u> <u>R. viscosa hartwigii</u> (Koehne) Ashe
<u>R. hartwigii</u> Koehne	

TABLE 2. Cytological findings in Robinia (Whitaker 1934)

Species	n=	% pollen sterility
R. <u>pseudoacacia</u> L.	10	25
R. <u>holdtii</u> Beiss.	10	16
R. <u>fertilis</u> Ashe	10	19
R. <u>kelseyi</u> Hutchins.	10	10
R. <u>hispida</u> L.	15	88
R. <u>boyntonii</u> Ashe	15	72
R. <u>slavinii</u> Rehd.	10	48
R. <u>margaretta</u> Ashe	10	30
R. <u>luxurians</u> Schneid.	10	25
R. <u>viscosa</u> Vent.	10	45
R. <u>hartwigii</u> Koehne	10	10

forms). By implication most of Ashe's names were to be relegated to one or the other variety, but no synonymy was provided. In his meticulous work on the legumes of North Carolina, Wilbur (1963) emphasized the provisional nature of the taxonomy of the genus (see introduction) and recognized eight species (Table 3). For the flora of the Carolinas Wilbur (1968) stated:

The following is merely a preliminary approximation to the taxonomy of this genus - a satisfactory and meaningful treatment is impossible until the relationships of the genus are better understood.

For this study, extensive review of the nomenclatural literature of Robinia was undertaken, examining protologues of over 350 names. A complete name reference bibliography of the genus including assignment of Robinia binomials referred to other genera and other species within the genus,

is not included in this dissertation but constitutes a separate manuscript-tabulation (Peabody 1981) deposited in the library at Iowa State University, Ames.

TABLE 3. Taxonomic treatment of Robinia by Wilbur (1963, 1968)

Species	Synonyms (as listed by Wilbur)
<u>R. pseudoacacia</u> L.	
<u>R. viscosa</u> Vent.	
<u>R. hartwigii</u> Koehne	<u>R. viscosa</u> var. <u>hartwigii</u> (Koehne) Ashe
<u>R. hispida</u> L.	<u>R. fertilis</u> Ashe <u>R. hispida</u> var. <u>fertilis</u> (Ashe) Clausen
<u>R. elliotii</u> (Chapm.) Ashe in Small	<u>R. hispida</u> var. <u>elliotii</u> Chapm.
<u>R. nana</u> Ell.	<u>R. hispida</u> var. <u>nana</u> (Ell.) DC.
<u>R. boyntonii</u> Ashe	<u>R. hispida</u> var. <u>rosea</u> Pursh
<u>R. kelseyi</u> Hutchins.	

MATERIALS AND METHODS

Herbarium studies

This study was based, in large part, on herbarium material kindly lent by herbaria as follows: AAU, ASU, B, BM, COLO, G, GA, GH, K, NCU, NY, PH, RSA, TENN, UNM, and US (abbreviations from Holmgren and Keuken 1974). Herbarium material was studied to determine the nature and correlation of exomorphic characters with geographic distribution and ecological factors in an attempt to form a preliminary rational basis for the delimitation of taxa, and to provide a data base for subsequent computer analyses. Insofar as available, type material was also examined.

Field studies

Portions of three growing seasons (1979,1980,1981) were spent in the southeastern United States studying native populations of Robinia. The western United States populations were sampled in June of 1980 and 1981. Specific localities of study sites are listed in Table 4. Herbarium specimens of all populations were prepared and deposited in the Herbarium of Iowa State University (ISC). Bud material was collected and chemically fixed for meiotic chromosome number determinations. Living material in the form of rootstock was collected and planted in the Botany Department

Greenhouse at Iowa State University to provide material for further study and chromosome number determinations.

Chromosome numbers

Plant material for chromosome study consisted of 1) root tips for mitotic figures and 2) microsporocytes for meiotic figures. Root tips were obtained from seeds using the method outlined by Palmer and Heer (1973). Seeds were pretreated by chipping off small portions of the seed coat at opposite ends. They were then placed between three thicknesses of germination paper about 1 cm from the edge. The germination paper was rolled and fastened with a rubber band, placed on end in a one quart plastic container (with the seed bearing end out) to which had been added about 50 ml of distilled water. A plastic bag was inverted over the container and fastened with rubber bands. Seeds were allowed to incubate in a growth chamber at 30 degrees C for 18 hours, illuminated with 300 foot candles, and at 6 hours at 22 degrees C in the dark. Root tips were harvested on the third or fourth day after three hours of the 30 degree C period by excising 1 cm from the tip and slitting the apical one third with a razor blade. Excised tips were pretreated for two hours at 12.5 degrees C in covered vials filled with a saturated solution of paradichlorobenzene. They were then washed with distilled water and placed in freshly prepared

TABLE 4. Field study documentation: Peabody accessions
(ISC) of Robinia

State	County	Locality
North Carolina	Macon	Southeast slope of Whiteside Mountain on summit near granite bald, 4,100 feet
North Carolina	Macon	0.1 miles south of Highlands town limit on State Rt. 28, 3,800 feet
North Carolina	Macon	Summits of Little and Big Fodderstack Mountains
North Carolina	Macon	Summit of Satulah Mountain
North Carolina	Macon	Cowee Gap
North Carolina	Macon	Eye-brow Cliffs, Buzzard Ridge, and Wildcat Ridge, 4,000-4,500 feet
North Carolina	Alleghany	Blue Ridge Parkway 200-300 feet south of mile post 234, 3,900 feet
North Carolina	Wilkes	Blue Ridge Parkway between mile posts 267 & 268, 3,700 feet
North Carolina	Caldwell	4 miles south of Blowing Rock on Globe Road
North Carolina	Yancy	Blue Ridge Parkway 0.6 miles east of Jct. of State Rt. 80, between mile posts 343 & 344, 3,900 feet
North Carolina	Yancy	Blue Ridge Parkway 0.8-1.0 miles east of Jct. of State Rt. 80, between mile posts 342 & 343, 3,900 feet
North Carolina	Brunswick	In Southport near intersection of Willis Drive and Longleaf Ave., 60 feet
North Carolina	Bladen	5-6 miles north of Elizabethtown along State Rt. 53
North Carolina	Burke	1 mile off State Rt. 183 on Wiseman's View Road
North Carolina	Yancy	Blue Ridge Parkway between mile posts 348 & 349, 4,800 feet
North Carolina	Ashe	Blue Ridge Parkway between mile posts 256 & 257, 3,100 feet
North Carolina	Ashe	Blue Ridge Parkway between mile posts 259 & 260, 3,100 feet
North Carolina	Yancy	Blue Ridge Parkway between mile posts 347 & 351 at Green Knob

TABLE 4. (continued)

State	County	Locality
		Overlook, 4,700 feet
North Carolina	Burke	Summit of Table Rock Mountain
North Carolina	Mitchell	Summit of Grandfather Mountain
North Carolina	Yancy	Trail to summit of Mt. Mitchell
North Carolina	Madison	Summit of Round Top, north of Hot Springs
North Carolina	Buncombe	Swananoa Gap Mountains
North Carolina	Avery	Near Linville
North Carolina	Madison	Right bank of French Broad River 1 mile northwest of Hot Springs
South Carolina	Oconee	Stumphouse Mountain
Georgia	Rabun	Tallulah Falls, Chatahoochee National Forest
Georgia	Harris	Sliding Rock Road, Pine Mountain F.D.R. State Park
Arkansas	Yell	3 miles south of Rover
Tennessee	Unicoi	North Bussiness Mountain
Tennessee	Blount	Foothills Parkway 4 miles north of junction of State Rt. 129
Tennessee	Blount	Intersection of Montvale Springs Road and Foothills Parkway
Iowa	Story	City of Ames, intersection of 8th Street and Burnett
Iowa	Story	City of Ames, near intersection of Hickory and Westbrook Drives
Iowa	Mahaska	2 miles west of Oskaloosa on State Rt. 92 at Hull Mine Site
Iowa	Boone	Ledges State Park along Des Moines River bank
Colorado	El Paso	Garden of the Gods National Mon. near Ridge Road and back entrance
Colorado	Las Animas	6 miles north of New Mexico State line along west side of Interstate 25 between Trinidad and Raton
New Mexico	Bernalillo	Just inside boundary of Cibola National Forest along Route 44 near Sulphur Canyon Picnic Ground, Sandia Mountains
New Mexico	Sierra	10.8 miles west of Hillsboro along State Rt. 90, 2.1 miles west of Gila National Forest boundary, Mimbres Mountains
New Mexico	Catron	Along roadside 2 miles west of Mogollon

fixative (3 parts 95% ethanol to 1 part glacial acetic acid) for 48 hours in covered vials at 35-40 degrees C. Tips were again washed and then hydrolized in 1N hydrochloric acid for 8 minutes at 60 degrees C. Staining was done by placing tips in leuco-basic fuchsin in covered vials for 1.5 hours at room temperature. Staining was followed by an ice-cold water bath for 45 minutes. Tips were then placed in pectinase on spot plates at 30 degrees C for 1 hour. They could then be stored in 70% ethanol in covered vials at 4 degrees C, or slides could be made immediately. Slides were prepared by removing the unstained root cap and placing 1 mm or less of the root tip on a slide to which had been added a drop of propiocarmine stain. Tips were tapped gently but thoroughly with a blunt glass rod. A cover slip was applied and the slide was squashed using a pellet press.

Reagents used were prepared as follows: 1) Saturated paradichlorobenzene - 750 mg paradichlorobenzene added to 50 ml distilled water, incubated overnight at 60 degrees C and shaken vigorously while cooling to at least room temperature. 2) Pectinase - 100 mg bacto-peptone plus 500 mg pectinase plus 10 ml distilled water, pH adjusted to 6.0, incubated 30 minutes at 30 degrees C, filtered, and frozen in small aliquots until ready to use.

Microsporocytes were obtained from flower buds which were 2-3 mm in length. Entire buds were chemically fixed in

a 3:1 solution (95% ethanol : propionic acid) for at least 48 hours. Buds were then transferred to a 70% solution of ethanol and stored at 4 degrees C. Slides were prepared by dissecting the buds and removing anther sacs at the same stage of development for the preparation of each slide. Anther sacs were placed on a glass slide in a drop of propiocarmine stain and macerated with a blunt glass rod using a tapping motion. The broken pieces of anther sac were removed, cover slip added, and the slide was examined to determine the stage of microspore development. If pollen grains had already formed, younger buds were used in preparing subsequent slides; or older buds were used if there was no evidence of meiosis. Examination of a series of slides of Robinia microsporocytes harvested at different times of the day has shown that meiosis occurs between 4:30 and 6:00 P.M.

Phenetics

From available herbarium material (see Herbarium Studies), 324 individual herbarium sheets were selected for numerical analysis. These are listed in the Appendix. The selection was based on the adequacy of material on the herbarium sheet as related to the variables to be measured (Table 5). Many specimens obtained on loan were entirely vegetative and were of no use in this analysis. Insofar as

possible, specimens selected had complete inflorescences with flowers at and past anthesis. Complete inflorescences were required because of the character "number of flowers per inflorescence" (Table 5). Inflorescences with both young and old flowers were required because of the character "evidence of ovary expansion" (Table 5). Older flowers of normally fruiting individuals often show ovary expansion beyond the staminal filament sheath, while those of non-fruitle flowers show no such expansion. Based on judgment derived from field and herbarium studies, supplemented by the taxonomic literature, 30 characters were chosen for inclusion in the analysis (Table 5).

Floral measurements (characters 12 through 15) were made by removing an entire flower from each herbarium sheet and placing it in a labeled compartment of an ice cube tray which had 4 or 5 one mm holes drilled in the bottom of each compartment. Trays containing flowers were placed in a pan to which had been added a sufficient amount of a 5% solution of Contrad 70 (Schmid and Turner 1977), to immerse the flowers. The flowers were then soaked for eight to ten hours at 50 to 60 degrees C. Trays were then lifted out of the Contrad 70 allowing the solution to drain from the now softened flowers. Trays containing flowers were then placed in a 10% acetic acid solution and lightly agitated for 5 minutes. This effectively neutralized the strongly alkaline

TABLE 5. Robinia variables for phenetic analysis

Variable no.	Variable	Scoring
1	Flowers dark pink	yes/no ^a
2	Rachis hispid	yes/no
3	Twig hispid	yes/no
4	Branch hispid	yes/no
5	Glandular-viscid	yes/no
6	Stalked viscid glands	yes/no
7	Number of leaflet pairs	N ^b
8	Leaflet length	cm
9	Leaflet width	cm
10	Leaflet tip width	cm
11	Leaflet base width	cm
12	Calyx lobe length	mm
13	Calyx lobe width	mm
14	Calyx tube length	cm
15	Keel length	cm
16	Number flowers per raceme	N
17	Evidence of ovary expansion	yes/no
18	Mogollon Rim distribution	yes/no
19	Coastal Plain distribution	yes/no
20	Fruit hispid	yes/no
21	No evidence of ovary expansion	yes/no
22	Below 3,000 ft. elevation	yes/no
23	Legume winged	yes/no
24	West of 100th Meridian	yes/no
25	Leaflet length/leaflet width	r ^c
26	Leaflet tip width/leaflet length	r
27	Leaflet base width/leaflet length	r
28	Leaflet tip width/lflt. base width	r
29	Calyx lobe length/calyx lobe width	r
30	Calyx tube length/clx. lobe length	r

^a Yes=1, no=0.

^b A pure number.

^c Ratio of variables.

Contrad 70. This was followed by a wash in distilled water, still with the flowers in the labeled compartments. Flowers could then be measured immediately or stored in individual vials to which had been added 70% aqueous ethanol. Softened

flowers were examined under a dissecting binocular microscope with a magnification of 17 to 30 diameters. Other characters (1-11 and 16-22) were measured by direct observation of each herbarium sheet with the aid of a clear plastic ruler and a tape recorder. This allowed the information recorded on tape to be played back and key-punched directly into the computer terminal. Care was taken to select representative leaves and leaflets that were fully mature and expanded. Inflorescence and branch pubescence remains on the plant, even after pressing for herbarium preservation, and especially can be seen in leaf and branch axils and parallel to the plane of the herbarium sheet. The raw data were first standardized across objects using the formula:

$$Z = \frac{x_i - \bar{x}_i}{s_x}$$

where: Z = the standardized score of x

x_i = the raw value of x

\bar{x}_i = the mean of the raw values of x

s_x = the standard deviation of the values of x

The measure of similarity chosen was the correlation coefficient since it is capable of handling a mixed data set

composed of discrete and continuous values. The correlation coefficient is computed with the formula:

$$r_{x,y} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\left[\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2 \right]^{1/2}}$$

where: $r_{x,y}$ = correlation coefficient between objects x and y

x_i = standardized score of x

\bar{x} = mean standardized score of x

y_i = standardized score of y

\bar{y} = mean standardized score of y

This computation results in a matrix of N by N dimensions where N equals the number of objects or OTUs in the analysis (i.e. each of the 324 specimens examined). The elements of the matrix represent the correlation coefficients of the pairwise comparison between all OTUs. The standardization of the raw data and the computation of the correlation coefficients were accomplished with Fortran computer programs and executed on an Advanced Systems 6 computer at the Iowa State University Computation Center. The matrix of correlation coefficients contains all of the

information needed to describe the similarity between all OTUs and groups of OTUs. Because of the complex nature of the data, it is presented in more easily comprehensible dendrograph form using cluster analysis (Mc Cammon and Wenninger 1970). The Cal Comp Plotter was used to draw the dendrograph.

The dendrograph is a graphic representation designed to arrange a set of objects whose pairwise similarity coefficients, in this case correlation coefficients, are given into mutually exclusive homogeneous subgroups, or clusters, and to display the results in the form of a minimum spanning tree. The procedure employed for clustering was the unweighted pair-group method using centroid linkage.

The dendrograph is constructed in the following manner:

- 1) the similarity matrix is scanned for the highest measure of similarity between a pair of OTUs, 2) these two OTUs are placed in the same cluster, i.e. treated as a single OTU, and the pairwise similarity values are recomputed between this new cluster and all other OTUs, 3) this process is continued, decreasing the similarity matrix by one row and one column at each step, until all of the OTUs are in one of two subgroups resulting in a matrix of 2 by 2 dimensions, 4) the highest similarity value at each step of the clustering process becomes the plotting value for producing the

dendrograph.

Some OTUs show a low level of similarity (below about 0.6) to the cluster in which they are placed by cluster analysis. These OTUs need further analysis since their affinity might be better described within another cluster. Because of the manner in which the dendrograph is constructed it loses resolution at the lower levels of similarity. The most widely accepted method for subsequent analysis is some form of ordination technique, usually principal components analysis (PCA) (Sneath and Sokal 1973). This involves a regression technique computing the least squares distance of all OTUs from their projected image on a fitted line. Whereas regression analysis plots OTUs in terms of the variables, PCA plots OTUs in terms of principal components. The computation of principal components involves extracting the eigenvalues and eigenvectors from a square matrix of similarity values for all variables. The relationship of eigenvalues and eigenvectors to a square matrix follows the formula:

$$A U = \lambda U$$

where: A = a square matrix of similarity values

U = a vector (the eigenvector)

λ = a scalar (the eigenvalue)

The number of eigenvalues and eigenvectors which can be described for a given square matrix equals the number of OTUs which also equals the dimensionality of the matrix. The first eigenvalue and eigenvector project a line through the long axis of the cloud of data points describing the largest amount of variance. The second eigenvalue and eigenvector project a line at right angles to the first line such that it describes the second largest amount of variance. This process continues until all of the eigenvalues and eigenvectors have been computed and virtually all of the variance of the data set has been explained. It is customary to extract only enough eigenvalues and eigenvectors to remove the majority, say 75%, of the total variance of the data matrix. Quite often as few as three principal axes will be sufficient to explain most of the variance. It is then possible to produce a series of three two-dimensional plots or one three-dimensional plot to depict graphically the relationship of all OTUs to each other. The scaling for the plotting axes consists of the values of the principal components.

RESULTS AND DISCUSSION

Chromosome numbers

As far as I can determine, on the basis of limited chromosome counts (Table 6), plants which have a chromosome number of $2n=3x=30$ are sterile. Since the base chromosome number of the genus appears to be $x=10$, plants exhibiting a $2n=2x=20$ chromosome number should be fertile, but some of these fruit infrequently (e.g. Robinia viscosa var. viscosa and R. hispida var. nana). If indeed these low fruit set types are normal diploids ($2n=2x=20$) the reason for their low fruit set may lie in self-incompatibility mechanisms to insure crossing; but I have no experimental evidence to support this suggestion.

Figure 1 shows mitotic chromosomes in some Robinia taxa. Table 6 presents chromosome counts I have obtained as compared to Whitaker (1934). The fruiting frequency of each taxon as observed on herbarium sheets and in the field is also tabulated. Figure 2 shows irregular meiosis in an unbalanced genome, characteristic of triploid populations of Robinia hispida. A chromosomal bridge connecting the nuclear areas of two of the four daughter nuclei is also apparent.

If all or most of the sterile populations in nature are indeed triploid and unable to set fruit successfully, how is

TABLE 6. Chromosome counts in Robinia

Taxon	Whitaker (1934) <u>n</u> =	-----Present study-----			
		fruiting frequency	<u>2n</u> =	Number of counts	Voucher specimens
<u>pseudoacacia</u>	10	abundant	20	3	2140, 2119 2169
<u>viscosa</u>	10	infrequent	20	5	2157, 2158 2160, 2166 2197
<u>hartwigii</u>	10	abundant	20	3	2199, 2207 2208
<u>hispida</u>	15	nonfruiting	30	5	2097, 2203 2155, 2156 2154
<u>boyntonii</u>	15	nonfruiting	30	3	2142, 2163 2200
<u>fertilis</u>	10	abundant	20	4	2145, 2194 2198, 2206
<u>nana</u>	--	infrequent	20	3	2170, 2172 2193
<u>neomexicana</u>	--	abundant	20	2	2192, 2189
<u>rusbyi</u>	--	abundant	20	1	2204

it that they are able to achieve long distance dispersal? Plainly sterile populations far outnumber fertile ones (at least for Robinia hispida) in both numbers of individuals, ecological niches occupied, and total range. Possibly the union of 2n gametes (Souter, Dawe, and Peloquin 1980), which may be produced at low frequency, with n gametes could produce triploid seed, thereby establishing triploid populations. However, I have no field or chromosome evidence to support this hypothesis. The reason for the comparative abundance of the triploid populations as

FIGURE 1. Chromosomes of Robinia, scale = 10 μ m

- A. R. hispida L. var. fertilis (Ashe)
Clausen $2n = 2x = 20$, Peabody 2194
- B. R. viscosa Vent. var. hartwigii (Koehne)
Ashe $2n = 2x = 20$, Peabody 2199
- C. R. neomexicana Gray var. rusbyi (Woot. &
Standl.) Isely & Peabody $2n=2x=20$,
Peabody 2204
- D. R. hispida L. var. nana (Ell.) DC.
 $2n = 2x = 20$, Peabody 2170

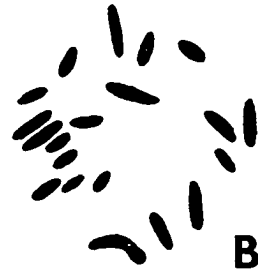
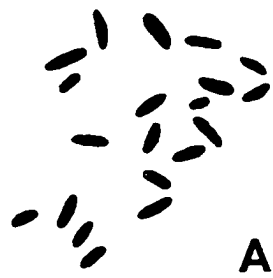
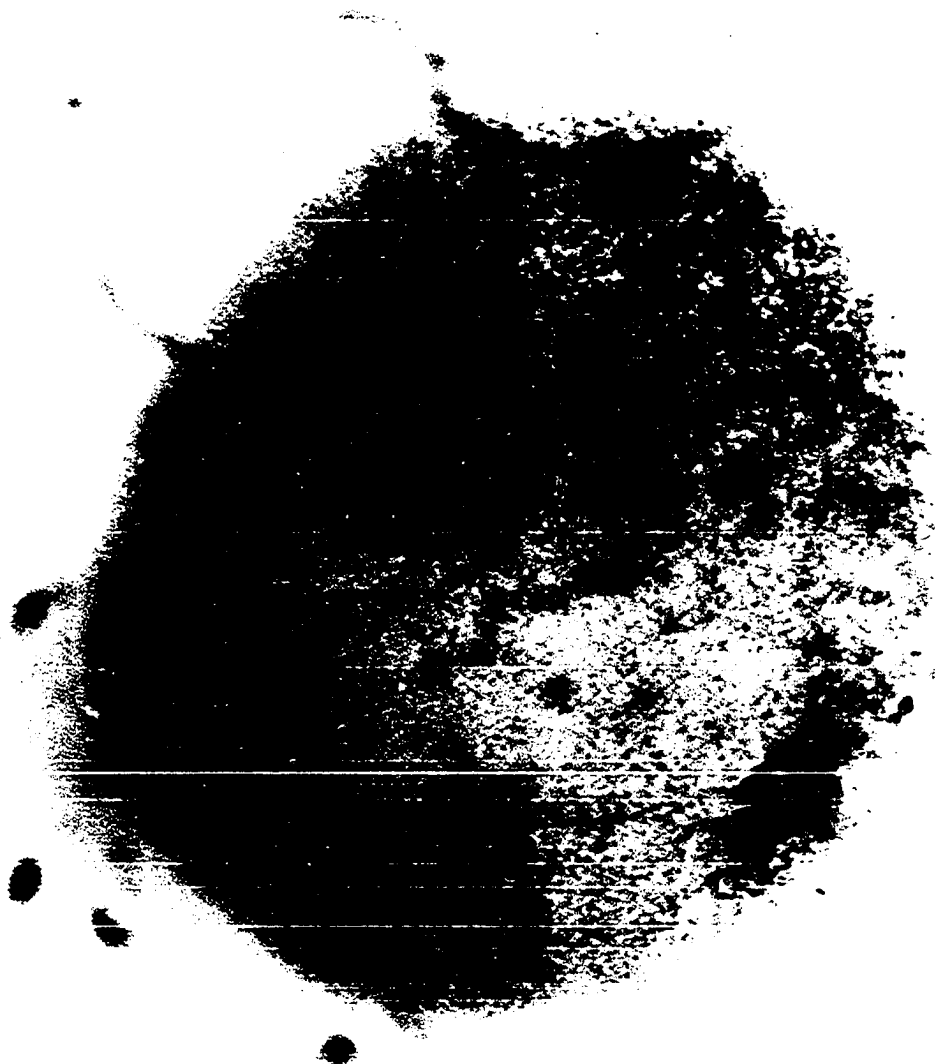


FIGURE 2. Microsporocyte meiosis in Robinia hispida L.
var. hispida, Peabody 2203



compared to the diploid populations is speculative. It is possible that the lack of sexual reproduction and subsequent vigorous vegetative reproduction may have led to the fixing of adaptive genotypes to particular niches similar to apomictic, clonal, or cleistogamous strategies.

Phenetics

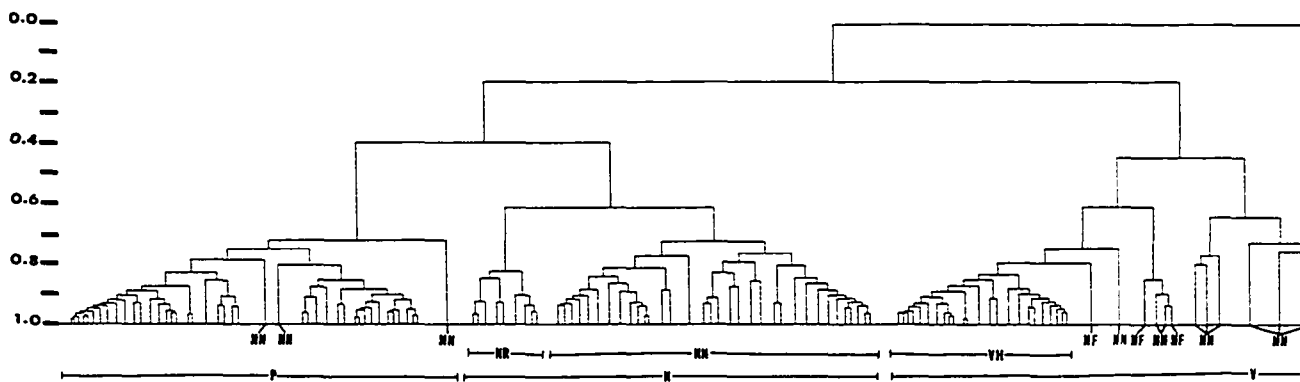
Cluster analysis

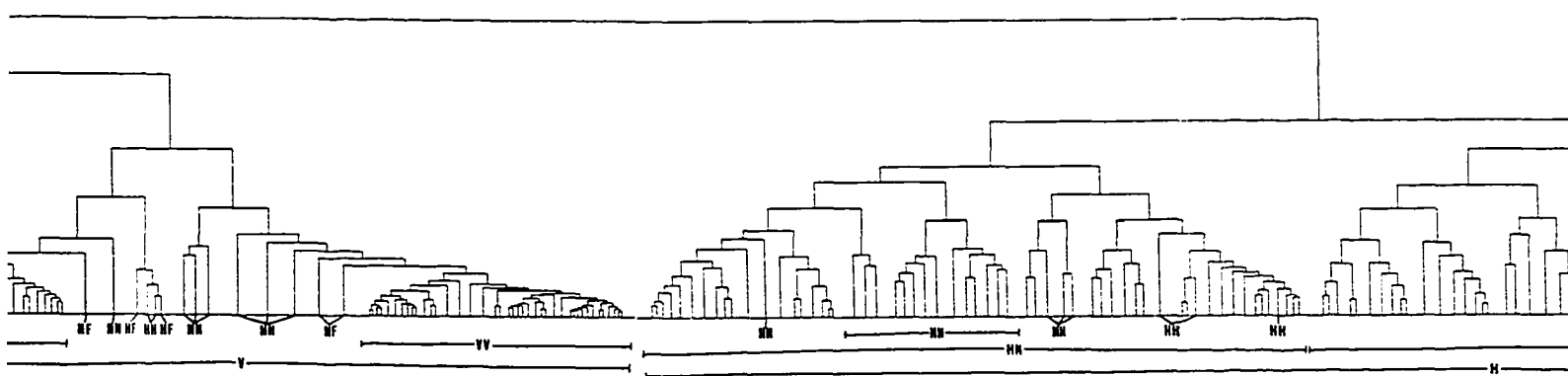
The dendrograph of 324 Robinia OTUs is presented in Figure 3. Four major clusters are evident and labeled "P" for R. pseudoacacia, "N" for R. neomexicana, "V" for R. viscosa, and "H" for R. hispida. Clusters N, V, and H can each be subdivided into two groups as indicated by the labeling: N(NR and NN), V(VH and VV), and H(HN and HH). The left to right order of OTUs on the dendrograph is given in Table 7. Similarity values are labeled on the y axis on the left portion of the dendrograph. As one moves away from the baseline, similarity decreases. The left portion of the dendrograph, containing clusters P, N, and V, shows high within-cluster similarity. This maximizes separation and allows for relatively easy circumscription of clusters. The right-hand portion of the dendrograph, however, shows low within-cluster similarity and the circumscription of subclusters becomes more difficult.

On the basis of overall morphology some OTUs contained

FIGURE 3. Dendrograph of 324 Robinia OTUs

The scale on the left is degree of similarity
(1.0 = identical, 0.0 = distinct).





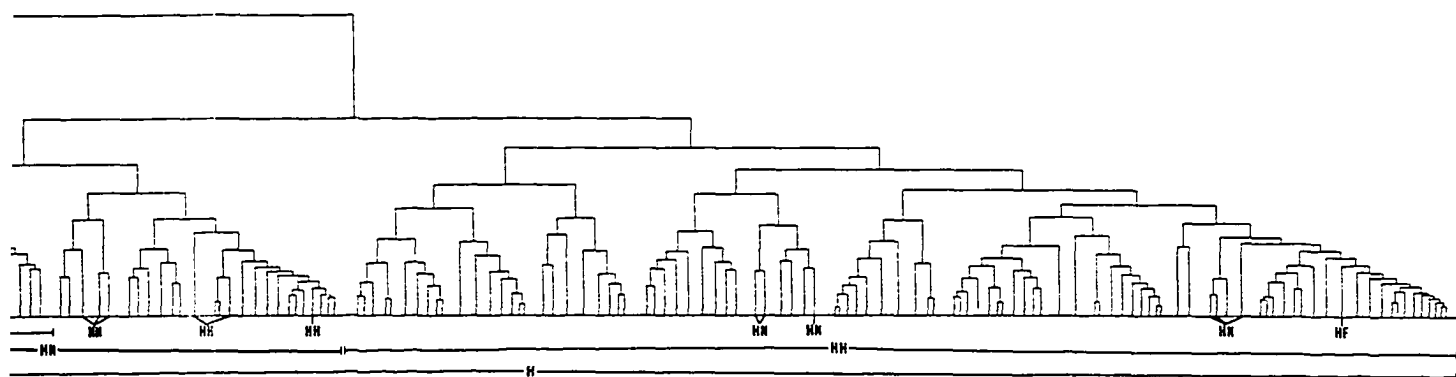


TABLE 7. Left to right order of OTUs on the dendrograph

Cluster	Sequence	OTU no.	Cluster	Sequence	OTU no.
P ^a	1 ^b	263 ^c	P	41	264
P	2	277	P	42	287
P	3	298	P	43	276
P	4	274	P	44	104
P	5	279	NR	1	36
P	6	286	NR	2	293
P	7	272	NR	3	34
P	8	290	NR	4	24
P	9	268	NR	5	33
P	10	283	NR	6	37
P	11	256	NR	7	253
P	12	259	NR	8	252
P	13	275	NR	9	251
P	14	297	NN	1	19
P	15	260	NN	2	294
P	16	292	NN	3	5
P	17	271	NN	4	9
P	18	258	NN	5	22
P	19	262	NN	6	295
P	20	255	NN	7	35
P	21	284	NN	8	14
P	22	273	NN	9	8
P	23	285	NN	10	13
P	24	254	NN	11	29
P	25	142	NN	12	28
P	26	150	NN	13	10
P	27	257	NN	14	30
P	28	267	NN	15	21
P	29	266	NN	16	1
P	30	261	NN	17	4
P	31	270	NN	18	11
P	32	269	NN	19	2
P	33	278	NN	20	3
P	34	280	NN	21	6
P	35	265	NN	22	23
P	36	291	NN	23	25
P	37	288	NN	24	20
P	38	281	NN	25	15
P	39	282	NN	26	17
P	40	289	NN	27	26

^a Cluster designation code (see Figure 3).

^b Within-cluster sequence number (see Figure 3).

^c OTU number designation (see Appendix).

Table 7. (continued)

Cluster	Sequence	OTU no.	Cluster	Sequence	OTU no.
NN	28	16	VV	8	232
NN	29	31	VV	9	218
NN	30	12	VV	10	314
NN	31	7	VV	11	315
NN	32	32	VV	12	320
NN	33	27	VV	13	247
NN	34	18	VV	14	230
VH	1	207	VV	15	316
VH	2	209	VV	16	321
VH	3	210	VV	17	322
VH	4	195	VV	18	317
VH	5	202	VV	19	323
VH	6	197	VV	20	243
VH	7	5	VV	21	229
VH	8	296	VV	22	217
VH	9	208	VV	23	227
VH	10	206	VV	24	250
VH	11	212	VV	25	228
VH	12	213	VV	26	222
VH	13	214	VV	27	219
VH	14	204	VV	28	239
VH	15	211	VV	29	244
VH	16	235	VV	30	237
VH	17	203	VV	31	249
VH	18	205	VV	32	236
VH	19	196	VV	33	225
VH	20	201	VV	34	324
VH	21	199	VV	35	318
VH	22	198	VV	36	216
VH	23	234	VV	37	319
VH	24	200	VV	38	240
VH	25	310	VV	39	245
VH	26	129	VV	40	248
VH	27	231	VV	41	241
VH	28	309	VV	42	238
VH	29	312	VV	43	246
VH	30	311	VV	44	224
VV	1	151	VV	45	220
VV	2	153	VV	46	220
VV	3	147	VV	47	223
VV	4	71	VV	48	242
VV	5	40	VV	49	221
VV	6	38	HN	1	124
VV	7	233	HN	2	136

TABLE 7. (continued)

Cluster	Sequence	OTU no.	Cluster	Sequence	OTU no.
HN	3	135	HN	47	143
HN	4	121	HN	48	167
HN	5	120	HN	49	116
HN	6	122	HN	50	123
HN	7	101	HN	51	141
HN	8	125	HN	52	108
HN	9	134	HN	53	106
HN	10	133	HN	54	117
HN	11	105	HN	55	138
HN	12	154	HN	56	171
HN	13	126	HN	57	107
HN	14	120	HN	58	139
HN	15	119	HN	59	103
HN	16	127	HH	1	165
HN	17	144	HH	2	191
HN	18	137	HH	3	193
HN	19	111	HH	4	148
HN	20	146	HH	5	164
HN	21	183	HH	6	158
HN	22	182	HH	7	307
HN	23	39	HH	8	184
HN	24	83	HH	9	308
HN	25	53	HH	10	306
HN	26	76	HH	11	177
HN	27	84	HH	12	176
HN	28	47	HH	13	168
HN	29	75	HH	14	169
HN	30	54	HH	15	162
HN	31	74	HH	16	161
HN	32	73	HH	17	160
HN	33	66	HH	18	166
HN	34	110	HH	19	178
HN	35	115	HH	20	170
HN	36	157	HH	21	179
HN	37	181	HH	22	188
HN	38	300	HH	23	185
HN	39	99	HH	24	174
HN	40	140	HH	25	163
HN	41	118	HH	26	152
HN	42	109	HH	27	186
HN	43	131	HH	28	180
HN	44	102	HH	29	192
HN	45	194	HH	30	145
HN	46	128	HH	31	175

TABLE 7. (continued)

Cluster	Sequence	OTU no.	Cluster	Sequence	OTU no.
HH	32	172	HH	66	57
HH	33	173	HH	67	59
HH	34	149	HH	68	89
HH	35	113	HH	69	43
HH	36	112	HH	70	42
HH	37	190	HH	71	79
HH	38	187	HH	72	64
HH	39	189	HH	73	156
HH	40	100	HH	74	155
HH	41	80	HH	75	98
HH	42	85	HH	76	132
HH	43	86	HH	77	65
HH	44	82	HH	78	130
HH	45	78	HH	79	61
HH	46	50	HH	80	69
HH	47	46	HH	81	49
HH	48	55	HH	82	58
HH	49	301	HH	83	44
HH	50	299	HH	84	45
HH	51	68	HH	85	159
HH	52	92	HH	86	94
HH	53	51	HH	87	313
HH	54	63	HH	88	62
HH	55	41	HH	89	97
HH	56	72	HH	90	304
HH	57	48	HH	91	91
HH	58	60	HH	92	303
HH	59	70	HH	93	81
HH	60	96	HH	94	56
HH	61	90	HH	95	302
HH	62	67	HH	96	95
HH	63	88	HH	97	93
HH	64	77	HH	98	305
HH	65	52	HH	99	87

in each cluster do not appear to agree with the cluster analysis placement. These OTUs are labeled on the dendrograph with a letter code indicating their obvious relation-

ship. Table 8 lists these OTUs accompanied by possible explanations for this disparity. The three OTUs labeled "HN" or "HH" within pseudoacacia ("P") represent hispida OTUs. Introgressive hybridization between pseudoacacia and hispida has been studied (Bashor 1961) and these OTUs may represent hybrids. Indeed, examination of the OTUs in question corroborated their affinity to pseudoacacia (see section on Interspecific hybridization in the Taxonomic Treatment).

The fourteen OTUs labeled "HF," "HN," or "HH" within viscosa ("V") also represent hispida OTUs. The five labeled "HF" represent fruit-bearing specimens, the eight labeled "HH" represent the hispida cluster, and the one labeled "HN" represents the nana cluster. The dendrograph as a whole is divided into two major clusters: those on the left representing fertile fruit-bearing material, and those on the right representing sterile material. The five fertile hispida OTUs probably clustered with the viscosa OTUs rather than with the other hispida OTUs primarily due to the presence of fruit. The choice of variables and the subsequent construction of the dendrograph may have overemphasized the fruiting characters causing this aberration. The other hispida OTUs within viscosa may have more slender leaflet shapes similar to the viscosa pattern causing them to cluster abnormally. Apparently, the single

TABLE 8. Aberrant OTUs indicated on dendrograph

Cluster	Label	OTU no.	Possible explanation
P ^a	HN ^b	142 ^c	introgression with <u>hispida</u>
P	HH	150	introgression with <u>hispida</u>
P	HN	104	introgression with <u>hispida</u>
VH	HF	310	weighted fruit characters
VH	HN	129	aberrant leaf type
VH	HF	231	weighted fruit characters
VH	HH	309	immature fruiting form
VH	HH	312	immature fruiting form
VH	HF	311	weighted fruit characters
VV	HH	151	immature fruiting form
VV	HH	153	immature fruiting form
VV	HH	147	immature fruiting form
VV	HH	71	immature fruiting form
VV	HH	40	immature fruiting form
VV	HH	38	immature fruiting form
VV	HF	233	weighted fruit characters
VV	HF	232	weighted fruit characters
HN	HH	154	gene flow
HN	HH	146	gene flow
HN	HH	183	gene flow
HN	HH	182	gene flow
HN	HH	39	gene flow
HN	HH	83	gene flow
HN	HH	53	gene flow
HN	HH	76	gene flow
HN	HH	84	gene flow
HN	HH	47	gene flow
HN	HH	75	gene flow
HN	HH	54	gene flow
HN	HH	74	gene flow
HN	HH	73	gene flow
HN	HH	66	gene flow
HN	HH	157	gene flow
HN	HH	181	gene flow
HN	HH	300	gene flow
HN	HH	194	gene flow
HN	HH	167	gene flow
HN	HH	171	gene flow
HH	HN	113	gene flow
HH	HN	112	gene flow

^a Cluster designation code (see Figure 3).

^b OTU designation code (see Figure 3).

^c OTU number designation (see Appendix).

Table 8. (continued)

Cluster	Label	OTU no.	Possible explanation
HH	HN	100	gene flow
HH	HN	98	gene flow
HH	HN	132	gene flow
HH	HN	130	gene flow
HH	HN	313	gene flow

OTU labeled "HN" has been placed here due to its leaflet shape and number which more closely correspond to the typical viscosa pattern. The fourth major cluster contains only hispida OTUs, but distinction into subgroups is less exact. If we attempt division of this cluster into two mutually exclusive subgroups (Figure 3) we find some correlation with morphology and geographical distribution. Generally, the OTUs in the left subgroup are native to the Coastal Plain Province and are the dwarf nana types. The OTUs in the right subgroup are distributed throughout the Piedmont and Mountain Provinces with only a few located in the Coastal Plain. They represent the hispida types. Again, apparent morphological discrepancies are indicated by the code "HN" in the right subgroup and "HH" in the left subgroup. One OTU labeled "HF" in the right subgroup represents a fruit-bearing specimen.

Principal components analysis

Principal components analysis was performed using the correlation coefficient matrix of variables. A Statistical Analysis Systems (SAS 1976) computer program was used for the computation of the eigenvalue, eigenvectors, and the principal component values for all OTUs. Figure 4 presents a three-dimensional plot of 117 of the OTUs using the first three principal components. The middle-right portion of the plot contains OTUs representing both Robinia pseudoacacia and R. neomexicana. Those of the latter tend to occupy the upper-middle portion of the plot, but there is considerable overlap between the two. For these two species, separation is more evident in the dendrograph produced by cluster analysis. R. viscosa is located toward the lower right portion of the plot. R. hispida extends the full length of the plot. Its two forms: hispida and nana, also overlap but nana is located primarily in the right two-thirds of the plot, and hispida in the left two-thirds.

In summary, the phenetic analysis indicates reasonably clear distinction among four species of Robinia. The circumscription of two subgroups each in R. neomexicana and R. viscosa is suggested. The circumscription of subgroups within R. hispida is more subjective as indicated by the lower similarity values on the dendrograph and the overlapping of regions on the principal components analysis plot.

Figure 4. Three-dimensional plot of 117 Robinia OTUs using principal components analysis

Axes I, II, and III are scaled with values for the first, second, and third principal components, respectively.

Symbol legend:

○ = R. pseudoacacia L.

□ = R. neomexicana Gray var. neomexicana

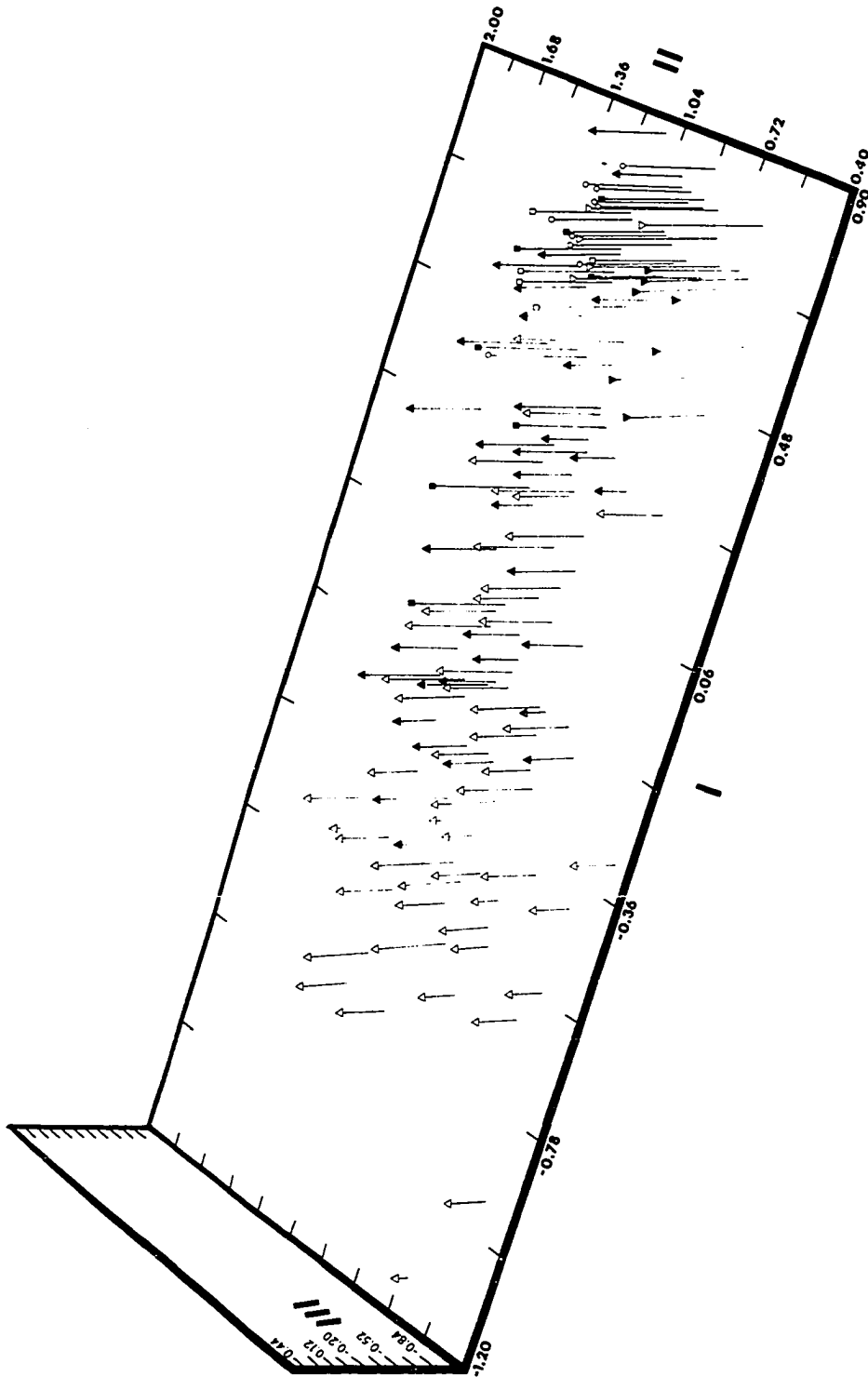
■ = R. neomexicana Gray var. rusbyi
(Woot. & Standl.) Isely & Peabody

▽ = R. viscosa Vent. var. viscosa

▼ = R. viscosa Vent. var. hartwigii
(Koehne) Ashe

△ = R. hispida L. var. hispida

▲ = R. hispida L. var. nana (Ell.) DC.



TAXONOMIC TREATMENT

Introduction

Taxonomic descriptions of the genus, species, and varieties are presented. Keys to varieties, when recognized, are included within the species treatments followed by taxonomic reference of synonyms. Nomenclatural validation for names taken up in the list of synonyms has been drawn from various sources: from protologue descriptions (indicated by the letter "P"), from type material when available (indicated by the letter "T"), and from representative specimens (indicated by the letter "S").

It is difficult to assess the status of much of the W. W. Ashe material since he described clones which may have appeared distinctive in the field, but not so on herbarium sheets. It is possible that he failed to appreciate the distinctive nature of clones and that he possibly reported a number of hybrid types. When the placement of synonyms is uncertain, this is indicated by a question mark ("?").

ROBINIA

Robinia L., Gen. Pl. 220. 1754. Type: R. pseudoacacia L.

Hort. Cliff. 354.

Pseudo-acacia Medicus, Vorl. Churpf. Phys. Ges. 2:364.

1787. P

Pseudo-acacia Moench, Meth. Pl. 145. 1794. P

Deciduous trees, shrubs, or subshrubs from 0.5-18.0 m tall with suckering roots. Trunk 0.01-0.5(1.2) m in diameter. Branches often armed with paired stipular spines, glabrous or sparsely to densely bristly-hispid, or glandular-viscid and sticky to the touch. Leaves alternate, petioled, imparipinnately compound with 3-9 pairs of leaflets, 10-35 cm long. Leaflets petioluled, 1.5-3.5(5.0) cm long, 0.8-2.5(3.0) cm wide, ovate to elliptic in outline, usually entire but sometimes apiculate by means of a brief mucro, or slightly obcordate at the tip, often with a pair of slender caducous stipels. Inflorescences 4-40 flowered, pendulous, axillary, peduncled racemes. Calyx 5-lobed with upper (adaxial) two lobes shorter than the others due to longer connation, sometimes appearing only 4-lobed due to complete or nearly complete connation, upper sinus of the calyx then 0-5 mm long. Corolla papilionaceous. Standard longitudinally reflexed beyond the calyx, 1.0-2.5 cm long, 1.0-1.5 cm wide, shortly clawed, white, light, or dark pink,

sometimes with a central yellow spot. Wings 1.5-2.2 cm long, 0.7-1.2 cm wide, shortly clawed, white, light or dark pink. Keel petals fused along half to three-quarters of their length forming an envelope which is open along the adaxial edge, enclosing the androecium and gynoecium, 1.5-2.2 cm long, 0.5-1.5 cm wide, white, light or dark pink. Androecium of 10 stamens, diadelphous, the vexillary stamen entirely free, filaments 0.5-1.2 cm long, the free portion 0.4-0.8 cm long, anthers uniform, 1-2 mm long, opening by lateral splitting. Gynoecium unicarpellate. Ovary 0.5-1.2 cm long, 2-3 mm wide, 0.5-1.0 mm thick, laterally compressed, stipe bent abaxially. Style 0.5-1.5 cm long, base expanded and dorsi-ventrally compressed perpendicular to the lateral compression of the ovary, attached toward the abaxial side of the ovary apex, curved adaxially and contained within the end of the keel, bearing a line of pubescence on the adaxial side for one-quarter to one-third its length directly below the stigma. Stigma inconspicuous or very slightly capitate. Ovules 10-25 per ovary, placentation marginal. Fruit a follicle, oblong, 3-12 cm long, 0.7-1.5 cm wide, distinctly laterally compressed, flat or turgid, valves papery or somewhat coriaceous, eventually splitting along both sutures and twisting in opposed directions or remaining flat, surface glabrous or with stalked and/or sessile viscid glands or dense to sparse

stiff bristles. Seeds 2-10(12) in each fruit, 2-4 mm long, 1-3 mm wide, reniform, uniformly dark brown to black or variously mottled dark to light brown and green.

Traditionally, the legumes have been divided into three subfamilies: Caesalpinioideae, Mimosoideae, and Papilionoideae, based primarily upon flower morphology (De Candolle 1825, Bentham and Hooker 1865, Taubert 1894, Cronquist 1981). Some authors (Cronquist 1968, Takhtajan 1980) have noted the distinctness of these three units and chose to recognize three separate families: Caesalpinaceae, Mimosaceae, and Papilionaceae (Fabaceae). Bentham and Hooker (1865) placed the genus Robinia in a heterogeneous tribe called the Galegeae. Authors contributing to the reports of The International Legume Conference reports (Polhill and Raven 1981) have divided the traditional Galegeae into several tribes, of which the Robinieae is one.

As defined by Polhill and Raven (1981), the Robinieae is a New World group of South America and the American tropics, with the exception of the pantropical genus Sesbania. Robinia and Olneya are of temperate North America. Because I have no knowledge of the other alleged members of this tribe, it is fruitless for me to speculate concerning their presumed affinity to Robinia. I believe Robinia and Olneya to be closely related as briefly compared as follows.

Both Robinia and Olneya (Table 9) have imparipinnately compound leaves, racemose inflorescences in leaf axils, caducous flower bracts, short-clawed petals with a reflexed standard, fused keel petals, diadelphous stamens, uniform filaments and anthers, flat linear pods, and a woody habit. Olneya, a monotypic Sonoran Desert genus, is usually evergreen with somewhat coriaceous leaves that lack stipels. The standard has two callosities on the abaxial surface. The ovary is sessile and the stigma is capitate. The pods are large and moniliform, their valves thick and leathery, containing one or two large seeds. It has a chromosome number of $2n=18$.

On the basis of both morphology and past distribution (next section) Robinia is probably most closely related to Olneya. The differences between the two genera are not fundamental: Olneya perhaps mostly adapted for a xeric habit. Unlike Robinia, its calyx lobes are rounded and imbricate and it has a different chromosome number.

The fossil record suggests that Robinia was once more widespread in the western United States than at present. Alleged Tertiary records (ca. 65-1 million years before present) include leaf and pod impressions and fossil wood. The identification of fossil leaf impressions, based on comparisons with modern leaf shapes and venation patterns, is commonly speculative. Fossil wood identifications of

TABLE 9. Comparison of Robinia and Olneya

Character	<u>Robinia</u>	<u>Olneya</u>
No. species	4	1 ^b
2n=	20(30) ^a	18
Habit	deciduous trees or shrubs	evergreen trees or shrubs
Stipular spines	present	on older growth
Leaves	imparipinnate thin, alternate	pari- or impari- pinnate, somewhat corriaceous alternate
Leaflets	entire, opposite	entire, irregu- larly arranged
Stipels/stipules	present	absent
Inflorescence	raceme	raceme
Floral bracts	small or large, caducous	small, caducous
Calyx	large, campanulate	short, campanulate
Standard	broad-orbicular, short-clawed, without callosities, reflexed	broad-orbicular, short-clawed, with two callosities, reflexed
Wings	oblong, falcate, free	oblong, falcate, free
Keel petals	obtusely obovate, inner margin incurved, free only basally	obtusely obovate, inner margin incurved, free only basally
Stamens	diadelphous, vexil- lary stamen free	diadelphous, vexil- lary stamen free
Anthers	uniform or alternate ones smaller	uniform
Ovary	stalked	sessile
Style	bearded abaxially	bearded abaxially
Stigma	inconspicuous	thick, capitate
Pods	linear flat	linear moniliform
Seeds	continuous within usually more than 2, reniform	continuous within 1 or 2, broad, ellipsoid

^a Whitaker 1934, Clausen 1940.^b Allen and Allen 1981.

Table 9. (continued)

Character	<u>Robinia</u>	<u>Olneya</u>
Locality	North America	southern Arizona California and northwestern Mexico
Habitat	wooded edges along forests, highways, rivers, and in disturbed sites	deserts

genera with modern representatives are, on the other hand, often reasonably definitive (Core and Cote 1979; Brown, Panshin, and Forsaith 1949).

The oldest known records consist of leaf impressions assigned to Robinia from the Oligocene (36-22 mybp) located in Colorado (Cockerell 1908, Knowlton 1916). The Miocene Epoch (22-7 mybp) provides fossil leaf records from Colorado (Mac Ginitie 1953), California (Axelrod 1916, Condit 1944), Idaho (Ashlee 1932), and Nebraska (Mac Ginitie 1962). Miocene fossil woods include records from Montana (Prakash, Barghoorn, and Scott 1962) and Washington (Prakash 1968). Pliocene records (7-1 mybp) include leaf impressions from Oklahoma, Kansas, and Nebraska (Brown 1940) and wood from California (Webber 1933, Axelrod 1944). Leaf impressions from the Pleistocene (ca. 1 mybp) are restricted to eastern North America: Ontario (Penhallow 1899, 1907) and Maryland (Hollick 1906).

If we assume the origin of the group to be the American tropics as postulated by Polhill and Raven (1981), and if we also assume the correct identification of at least some of the fossils assigned to Robinia, migration of proto-Robinia-Olneya types would have occurred into the southwestern United States during the late Eocene and early Oligocene (40-33 mybp). Differential habitat selection, especially xeric versus mesic or high versus low elevation, may have provided the appropriate niches for segregation between Robinia and Olneya.

Migration would have continued into eastern North America with the establishment of the diverse populations of Robinia in the Appalachian Mountains. Pleistocene glaciation with its attendant climatic modifications may have accounted for the apparant extinction of Robinia from much of the northern portions of the middle and western United States.

Key to species of Robinia

1. Flowers white; upper two lobes of calyx united throughout or forming a shallow adaxial sinus 0.3-0.6 mm deep; pod bearing a 1-3 mm wide wing along the adaxial suture; branches and pods glabrous.....R. pseudoacacia
1. Flowers light or dark pink; upper two lobes of calyx only basally united forming a distinct adaxial sinus 1.5-4.5 mm deep; pod wing lacking; branches and pods glabrous or bristly.....2
2. Branches and pods sticky with stalked and/or sessile viscid glands.....R. viscosa
2. Branches and pods bristly-hispid to glabrous, never sticky-viscid.....3
3. Flowers 14-18 per raceme; upper lobes of calyx 1.7-2.0 mm long; pods bristly or, in local populations, glabrous; native to the southwestern United States.....R. neomexicana
3. Flowers 4-9 per raceme; upper lobes of calyx 2.5-4.5 mm long; pods lacking or, in local fruiting populations, often densely bristly-hispid; native to the southeastern United States.....R. hispida

Robinia pseudoacacia

- Robinia pseudoacacia L., Sp. Pl. 722. 1753. Specimen at LINN (913.1 labeled by Linnaeus as "pseudoacacia" microfiche !)
Hort. Cliff. 354. Presumed types at BM (not seen).
Pseudo-acacia odorata Moench, Meth. Pl. 145. 1794. P
R. pringlei Rose, Contr. U. S. Nat. Herb. 12:274. 1909.
PT
R. pseudoacacia L. var. rectissima Raber, U. S. Dept. Agric. Circ. 379:7. 1936. P
R. pseudoacacia L. fma. oswaldiae Oswald, Phytologia 22:139. 1971. PT

Deciduous trees 8-10(18) m tall. Trunk 0.1-0.5(1.2) m in diameter. Branches glabrous and often appearing fluted when young by means of decurrent leaf ridges. Leaves with 6-9 pairs of leaflets. Inflorescence (10)18-40 flowered, pendulous; bracts shorter than flower buds and quickly caducous. Calyx appearing four-lobed due to complete or nearly complete connation of the upper two (adaxial) lobes. Flowers white. Standard 1.0-1.5 cm long, usually with a conspicuous greenish-yellow spot on the abaxial surface. Ovules 17-22 per ovary. Fruit valves glabrous and papery, not elastic, with a 1-3 mm wide wing along the adaxial suture. Seeds dark brown to black. (Figure 5)

The black locust is widely distributed throughout the

FIGURE 5. Robinia pseudoacacia L.

a. Habit, scale = 3 cm; b. fruiting branch, scale = 3 cm; c. calyx dissection, scale = 3 mm, showing complete union of adaxial calyx lobes indicated by arrows; d. small branch at nodal region, scale = 2 mm, l - leaf petiole base, i - inflorescence peduncle base (based on Peabody 2119.)



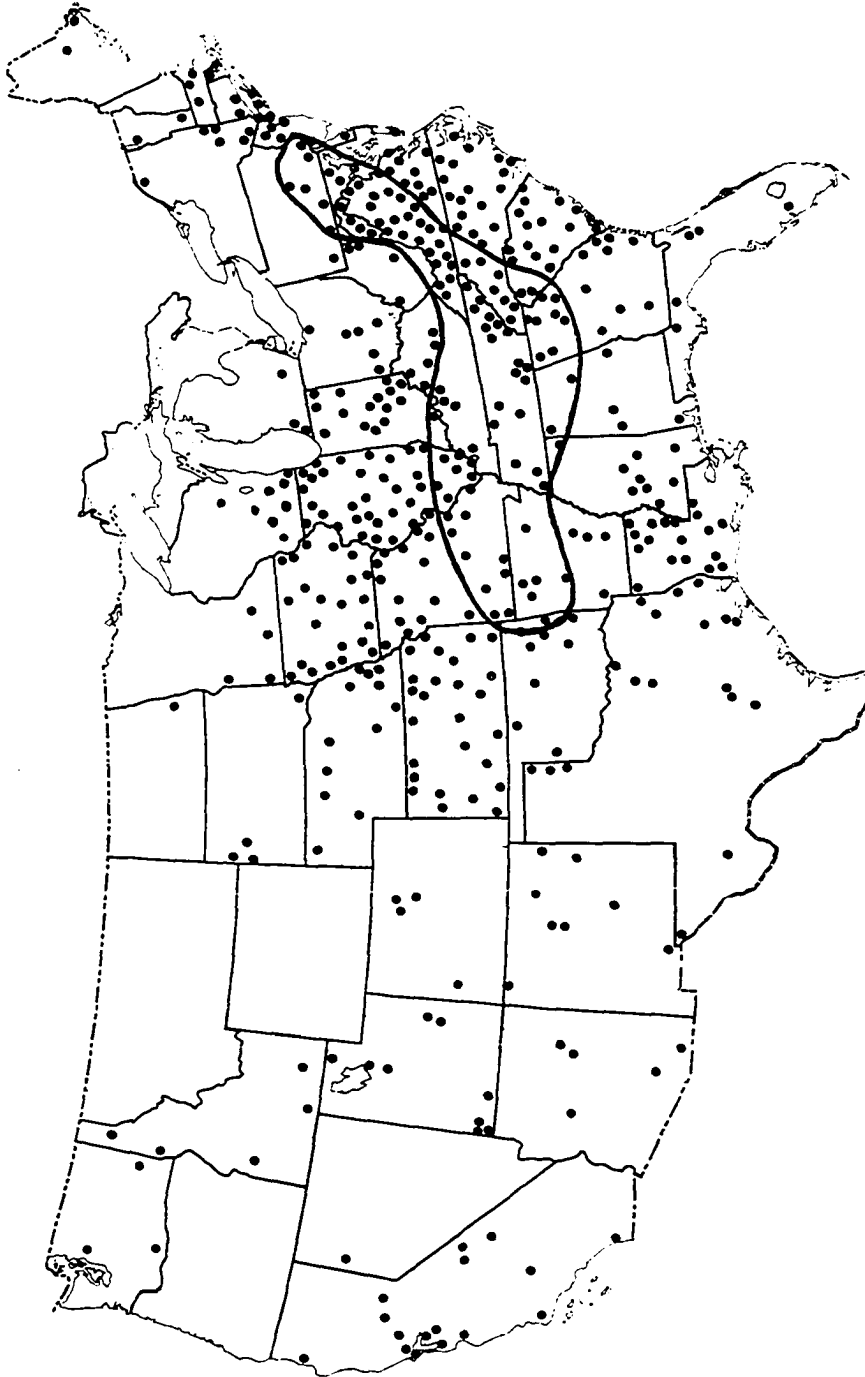
eastern United States (Figure 6). It is probably native to the Appalachian and Ozark Mountains connected by the Ohio and Mississippi River courses. The most common habitats are woodland borders, roadsides, riverbanks, and disturbed sites. As a native this species probably rapidly invaded small openings in the forest canopy following the fall of larger trees, or occupied larger areas following fire or other large-scale catastrophies. With the destruction of most of the native forests and the many inroads into formerly dense virgin stands, numerous suitable habitats have been created. Consequently, this species is probably more abundant today than in earlier times.

As a consequence of introductions, the black locust has escaped and become established from southern Quebec and Ontario through southern Minnesota and South Dakota to eastern Wyoming and Colorado to northeastern Texas (Figure 6). It is found less commonly in western North America, except in the central valley of California, where it has become locally established.

Herbarium and field studies indicate that the black locust is rather consistent morphologically throughout its wide range. There appear to be no geographical or ecological varieties. Some authors (Oswald 1971, Detwiler 1937, Raber 1936) indicate morphological variation consisting of variable coloration of calices and fruits and

Figure 6. Distribution of Robinia pseudoacacia L.

Solid line encloses the presumed native range. Data courtesy of Duane Isely (ms) Wisconsin data (Fassett 1939)



straightness of trunk and bark patterns. Most of this appears to be phenotypic variation induced by various site parameters (Hanover, Department of Forestry, Michigan State University, personal communication). The wide distribution of black locust probably consists of a mosaic of smaller populations which may show some genetic and/or phenotypic variation. Starch gel electrophoresis of allozymes might uncover some of this diversity, but it is doubtful that any such information would have nomenclatural significance.

Economic uses have been of historical importance in both the Old and New World. The earliest of nodulation studies on leguminous trees (Tsirich 1887, Schneider 1892) were conducted using black locust. Studies on growth and yield in black locust and its relationship to the growth of species associated with it were carried out in the early twentieth century (Cooper 1950, Kapel 1939, Phinney 1939, Barger 1942). Some attempt at planting for soil stabilization was made during the 1930s (Cooper 1950) but the problem of the insect stem borer (Cyllene robinae Forst.) undermined its potential usefulness.

Resistance of the wood to rotting has been attributed (Freudenberg and Hartman 1953, Allen and Allen 1981) to the presence of about 4% taxifolin, an isomer of dihydroquercetin or dihydrorobinetin which functions as a growth inhibitor of wood destroying fungi. Historically,

black locust has been used for fence posts, construction, and specialty pieces requiring a high density, low shrinkage wood (Hicks 1883, Withers 1842). About 2.8 million board-feet (7,000 cubic meters) of black locust wood were used in all manufacturing industries in the United States in 1960 (Allen and Allen 1981).

The potential of using black locust as a rapidly growing source of high density fuel has been studied by forest researchers in Korea (Kim and Lee 1969) and in Japan (Kodama 1977). Large areas of forest land have now been planted in black locust in Korea (Haden-Guest, Wright, and Teclaff 1956) where it seems to be free from the insect pests which plague it within in its native range. Recent escalations in fuel costs have made "energy plantations" more popular (Wray 1979). Prestemon (1980) evaluated various hardwoods for their relative fuel capacity. Black locust has a high B.T.U. rating: about 400,000 B.T.U.s per cord as compared to 170,000 to 240,000 for other hardwoods tested including such well-known kinds as oak, hickory, and maple.

Apiculture has recognized the usefulness of black locust in honey production, primarily in Europe (Withers 1842, Allen 1937, Porcher 1869). Black locust honey is especially prized in eastern Europe where it is valued over other types (Porcher 1869).

A poisonous principle called "robin" or "robitin" has been reported (Kingsbury 1964, Harshberger 1920, Lewis and Elvin-Lewis 1977). Poisoning of humans and animals has resulted from eating the bark, seeds, or fresh leaves (Barnes 1921, Emery 1887).

Robinia hispida

Usually non-fruiting shrubs, subshrubs, occasionally trees 0.5-3.0 m tall. Trunk 0.1-0.5(1.0) dm in diameter. Branches glabrous or sparsely to densely bristly-hispid. Leaves with 3-6 pairs of leaflets. Inflorescence of 4-9 flowers; bracts shorter than flower buds, quickly caducous. Calyx distinctly 5-lobed, adaxial calyx sinus 2.5-4.5 mm deep. Flowers dark pink fading to light pink. Standard 1.5-2.5 cm long, sometimes with a conspicuous yellow spot on the abaxial surface. Ovules 18-24 per ovary. Fruit valves (in local fertile populations) bristly-hispid and coriaceous, splitting along both sutures and twisting in opposed directions, wingless. Seeds light to dark brown.

The bristly locust is the common pink-flowered locust of the southeastern United States. Its native range includes the Mountain, Piedmont, and Coastal Plain Provinces of Virginia, the Carolinas, Tennessee, Georgia, Florida, and Alabama. It also extends eastward on the Cumberland Plateau into West Virginia, Kentucky, and central and eastern Tennessee (Figure 14). It has been widely cultivated as an ornamental and soil stabilizer and can be found established in New England and the Midwest. It is also planted in the western states but apparently little established.

Robinia hispida is the most variable taxon in the genus. Though primarily constituted of sterile populations

it also includes fertile forms which consist of local natural and established populations as described in subsequent text. It ranges in height from 0.5-4.0 m and from entirely glabrous (Figure 13) to very densely bristly-hispid (Figure 12). The vestiture may be restricted to the inflorescence or it may extend to younger growth on leaf rachises, or to older growth on stems and branches (Figure 12). It sometimes persists on branches 3 to 4 years old. Variation in the amount and location of this vestiture has been one of the chief criteria for the description of taxa within this complex by some authors. Correlation between this morphological variation and geographical distribution is very low. The only general tendency is for the populations in the Coastal Plain, especially in the Sand Hills (Figure 11), to be somewhat more glabrous than those of the Piedmont and Mountain Provinces (Figure 10). There is also a tendency for these Coastal Plain forms to be smaller than the others, with the exception of the high elevation types. This dwarf coastal form, seldom surpassing 1 m in height, has been called R. nana (Elliott 1822) and R. elliottii (Chapman 1860, Small 1903, Rydberg 1924, Wilbur 1963, 1968). In addition, some authors (Elliott 1822, Ashe 1897, Rydberg 1924, Wilbur 1963, 1968) have recognized a glabrate, taller form in the Piedmont and Mountain Provinces under the name R. rosea or R. boyntonii (Figure 13).

While the field and herbarium worker can easily distinguish between the end points in the morphological continuum of this taxon, the range of intermediates obviates the practicality of the recognition of a suite of species or numerous closely allied varieties. Instead, I have chosen to recognize only four varieties within this polymorphic taxon.

Key to varieties of *Robinia hispida*

1. Plants setting abundant fruit.....2
1. Plants rarely fruiting or not known to fruit.....3
 2. Plants moderately to densely bristly-hispid, especially on young growth and pods; leaves about 1.5 times as long as wide, ovate-elliptic; native to the mountains of western North Carolina and eastern Tennessee, but widely cultivated.....R. hispida var. fertilis
 2. Plants sparsely bristly-hispid to glabrous throughout; leaves 2-3 times longer than wide, acuminate; known only from horticulture.....R. hispida var. kelseyi
3. Plants less than 1 m tall; sparingly branched; of Coastal Plain distribution; confluent with the following.....R. hispida var. nana
3. Plants over 1 m tall; branched; primarily of Mountain and Piedmont distribution but occasionally found in the Coastal Plain.....R. hispida var. hispida

Robinia hispida* var. *fertilis

Robinia hispida L. var. *fertilis* (Ashe) Clausen, Gent. Herb.

4:291. 1940. *R. fertilis* Ashe, Rhodora 24:182. 1923.

(Ashe specimen at NCU !).

R. michauxii Sarg., J. Arn. Arb. 8:32. 1922. P

?*R. unakae* Ashe, J. Elisha Mitchell Sci. Soc. 39:111.

1923. PS

R. grandiflora Ashe, J. Elisha Mitchell Sci. Soc. 37:

176. 1922. PS

?*R. pedunculata* Ashe, J. Elisha Mitchell Sci. Soc. 39:

111. 1923. PS

Robinia hispida var. *fertilis* is native to the higher elevations (3,000-4,000 ft.) of western North Carolina and adjacent eastern Tennessee (Figure 8). It is easily distinguished from var. *nana* in its abundant fruiting habit, larger growth form, more dense bristly indumentum, and disjunct native distribution. Other than the fact that it is a fertile diploid, it is seemingly indistinguishable from var. *hispida*. It differs from var. *kelseyi*, which also sets fruit, in that its leaflets are only one and a half to two times longer than wide, and is usually distinctly bristly-hispid (Figure 7).

Because of uncertainty whether some of the pink-flowered locusts of Ashe are fruiting types, their correct

FIGURE 7. Robinia hispida L. var. fertilis (Ashe)
Clausen

a. Habit, scale = 3 cm (based on Peabody 2194), b. immature fruiting branch, scale = 7 mm (based on Peabody 2145), c. small branch with immature fruit, scale = 9 mm, showing bristly-hispid indumentum restricted to the inflorescence (based on Peabody 2206) d. small branch at nodal region, scale = 3 mm, showing bristly-hispid indumentum on branches and leaf petiole (1) (based on Peabody 2194), e. calyx dissection, scale = 2 mm, arrows indicate adaxial calyx lobes (based on Peabody 2145.)

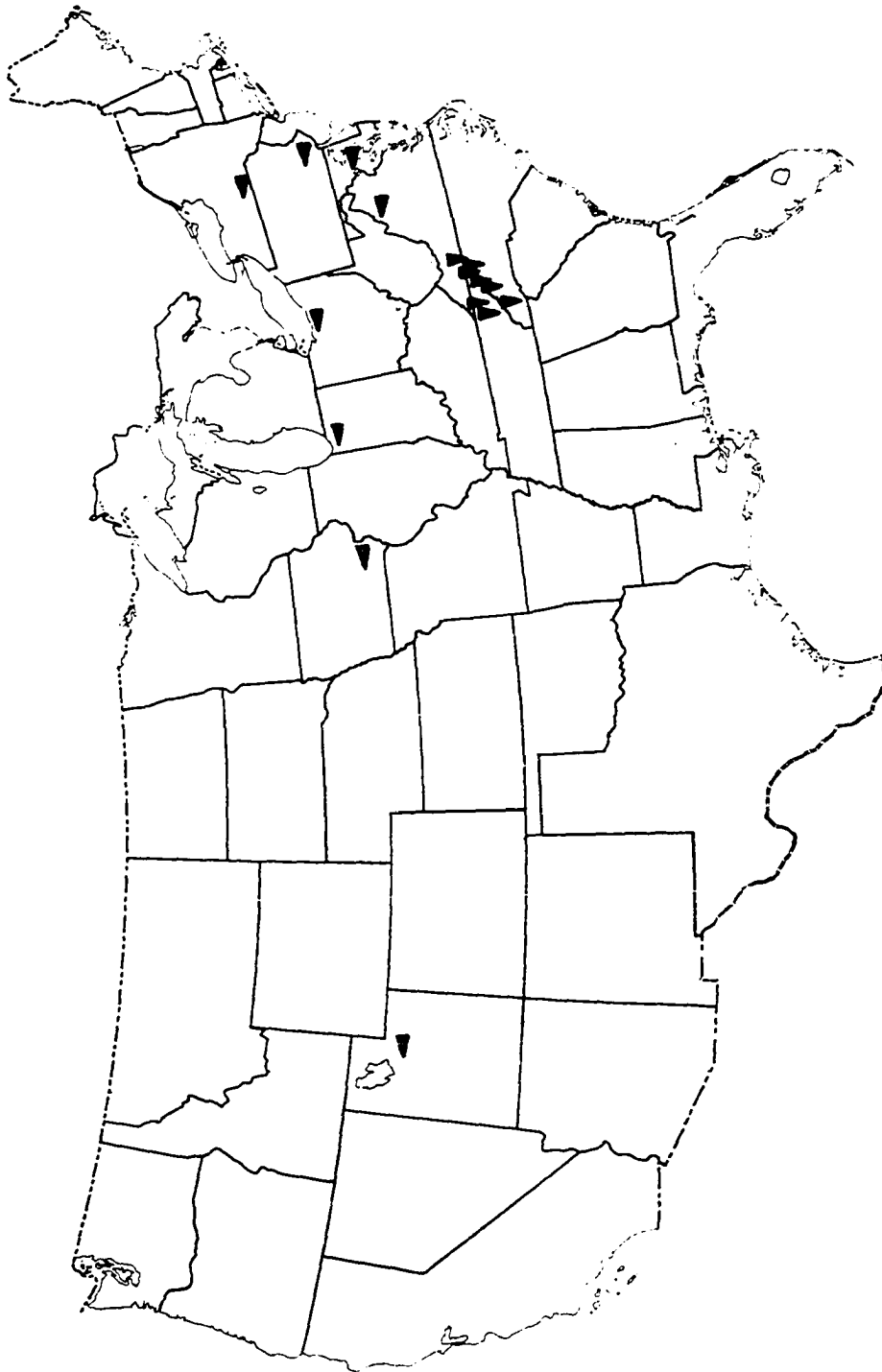


Figure 8. Distribution of Robinia hispida L. var.
fertilis (Ashe) Clausen

Symbol legend:

▼ = native populations

◄ = cultivated and established populations



assignment in synonymy is in doubt. He originally described the fruit of Robinia boyntonii (Ashe 1897) and of R. longiloba (Ashe 1918) but later retracted his descriptions (Ashe 1923c) indicating that these two species had been described, not from a single specimen bearing fruit, but from at least two specimens: one with fruit, which later he interpreted as a different species. This leads one to wonder if his other fertile species, especially R. unakae and R. pedunculata, are also composed of disparate elements.

Certain fertile forms of the bristly locust have been found useful in the reclamation of strip mine spoils (Mc Williams 1969, 1970). Characteristics which make these (as Arnot bristly locust) suited for this purpose include their ability: 1) to grow in extremely low pH soils (4.2- 7.5), 2) to reproduce and spread by root-suckering, and 3) to grow in nutrient-poor and dry soils (Mc Williams 1970, Helgerson and Gordon 1978).

Robinia hispida* var. *kelseyi

Robinia hispida L. var. *kelseyi* (Hutchins.) Isely.

R. kelseyi Hutchins., Curt. Bot. Mag. 134. 1908.

Lectotype designated by Isely (Brittonia 34:340. 1982. K!)

Robinia hispida var. *kelseyi*, as herein defined, is not known in the wild. The only collections that I have seen are of cultivated material. It is distinguished from the other varieties of *R. hispida* in having long, acuminate leaflets which are two to three times longer than wide (Figure 9). Like variety *fertilis* it sets abundant fruit but lacks the bristly-hispid indumentum.

Mr. Kelsey, a nurseryman from Salem, Massachusetts, first introduced this plant into horticulture in his catalogues of 1900-1902 (Kelsey 1900-01, 1901-02). It appears to be distinct from the other pink-flowered taxa in having entirely glabrous branches, branchlets, and pedicels. It appears to be fully fertile, producing pods that are beset with bristles. Henry (1912) mentioned that Kelsey first reported to Kew Gardens, that "It came up spontaneously" in his nursery; but supposes that it may have come into his collection with seed of other plants from the southern Allegheny Mountains. Subsequently, in correspondence with George Nash (Nash 1916) Kelsey stated:

Robinia kelseyi was found growing on the Blue Ridge Range south of Pineola, North Carolina. Its

FIGURE 9. Robinia hispida L. var. kelseyi (Hutchins.)
Isely

a. Habit, scale = 3 cm; b. fruiting branch,
scale = 3 cm; c. calyx dissection, scale =
2 mm, arrows indicate adaxial calyx lobes;
d. small branch at nodal region, scale =
2 mm, l - leaf petiole base, i - inflor-
escence peduncle base (based on Hutchinson
1908.)



range so far as I know is not wide, although very possibly it might be found in other places....
The altitude is about 3700-3900 feet elevation.

In correspondence with Dayton (1943), Kelsey was even more specific:

The type locality where I discovered Robinia kelseyi was in Mitchell County on Rough Ridge, perhaps three miles from Pineola, North Carolina. The plants from which the description was made were, I believe, sent by me to the New York Botanical Garden. All of my material of this species, which I have an abundance of, came from the same locality and may be called true type specimens.

Dayton (1943) provided his interpretation of the precise type locality for Robinia kelseyi:

It seems clear that the type locality of Robinia kelseyi is not Mr. Kelsey's former nursery in Salem, Mass., but Rough Ridge, Mitchell County, N.C., about 3 miles or so east and south of Pineola, Avery County.

However, Dayton's (and probably Kelsey's) local geography was confused. Pineola, which is in Avery County, is east of Mitchell County. Traveling three miles southeast of Pineola puts one in either Avery or Burke County, Mitchell County being located at least ten miles to the west. Additionally, Rough Ridge is not three miles southeast of Pineola but eight miles northeast of Pineola near the Avery-Caldwell County lines.

All herbarium specimens of Robinia hispida var. kelseyi that I have seen are horticultural in origin. All material collected from the wild and labeled as R. kelseyi has been

misidentified. Some Ashe sheets of cultivated material contain geographical data for two additional localities of supposed wild populations, Table Rock Mountain in Burke County, North Carolina, and the Doe River Gorge in Carter County, Tennessee. My visits to all three of these localities produced no plants resembling R. kelseyi. All are the sterile form of R. hispida except for a Doe River Gorge population bearing bristly pods. These latter plants are R. hispida var. fertilis.

Robinia hispida var. kelseyi may represent a hybrid between R. hispida var. fertilis and R. pseudoacacia with R. hispida serving as the ovulate parent. The original hybridization may have occurred in Kelsey's garden where the putative parental types may have been growing relatively close together. Seed might have been produced resulting in a hybrid plant that was subsequently selected and distributed. Possibly some of Ashe's species, described from cultivated material, had a similar origin.

Robinia hispida* var. *nana

Robinia hispida L. var. *nana* (Ell.) DC., Prod. 2:262. 1825.

R. nana Ell., Sk. Bot. 2:243. 1822. (photograph from Elliott Herbarium NCU !)

R. rosea Ell., Sk. Bot. 2:243. 1822. non Mill. (1768) nec Marsh (1785). P

R. elliotii (Chapm.) Ashe ex Small, Man. S.E. Fl. 613. 1903. *R. hispida* L. var. *elliotii* Chapm. Fl. S.E. U.S. 94. 1860. P

Robinia hispida var. *nana* is almost restricted to the Coastal Plain Province in North and South Carolina and Georgia (Figure 11). Local populations can be found which appear to grade imperceptibly with var. *hispida* in that they exhibit a greater amount of bristly-hispid indumentum and depart from the otherwise characteristic habit and form of var. *nana* (Figure 10). Like var. *hispida*, var. *nana* sets fruit very rarely, but unlike var. *hispida*, var. *nana* has a chromosome number of $2n=2x=20$ indicating that it is a diploid whereas var. *hispida* is a triploid ($2n=3x=30$). This difference in chromosome numbers together with the geographical and morphological data indicate its maintenance as a variety.

Elliott (1822) indicated that "*rosea*" is "Scarcely a variety of *R. hispida*." Chapman (1860) placed Elliott's

(1822) "rosea" and "nana" together. The non-hispid condition and the similarity in distribution indicate that Elliott's (1822) "rosea" is probably best placed under R. hispida var. nana.

FIGURE 10. Robinia hispida L. var. nana (Ell.) DC.

a. Habit, scale = 3 cm; b. small branch at nodal region, scale = 2 mm; c. calyx dissection, scale = 3 mm, arrows indicate adaxial calyx lobes (based on Peabody 2170.)

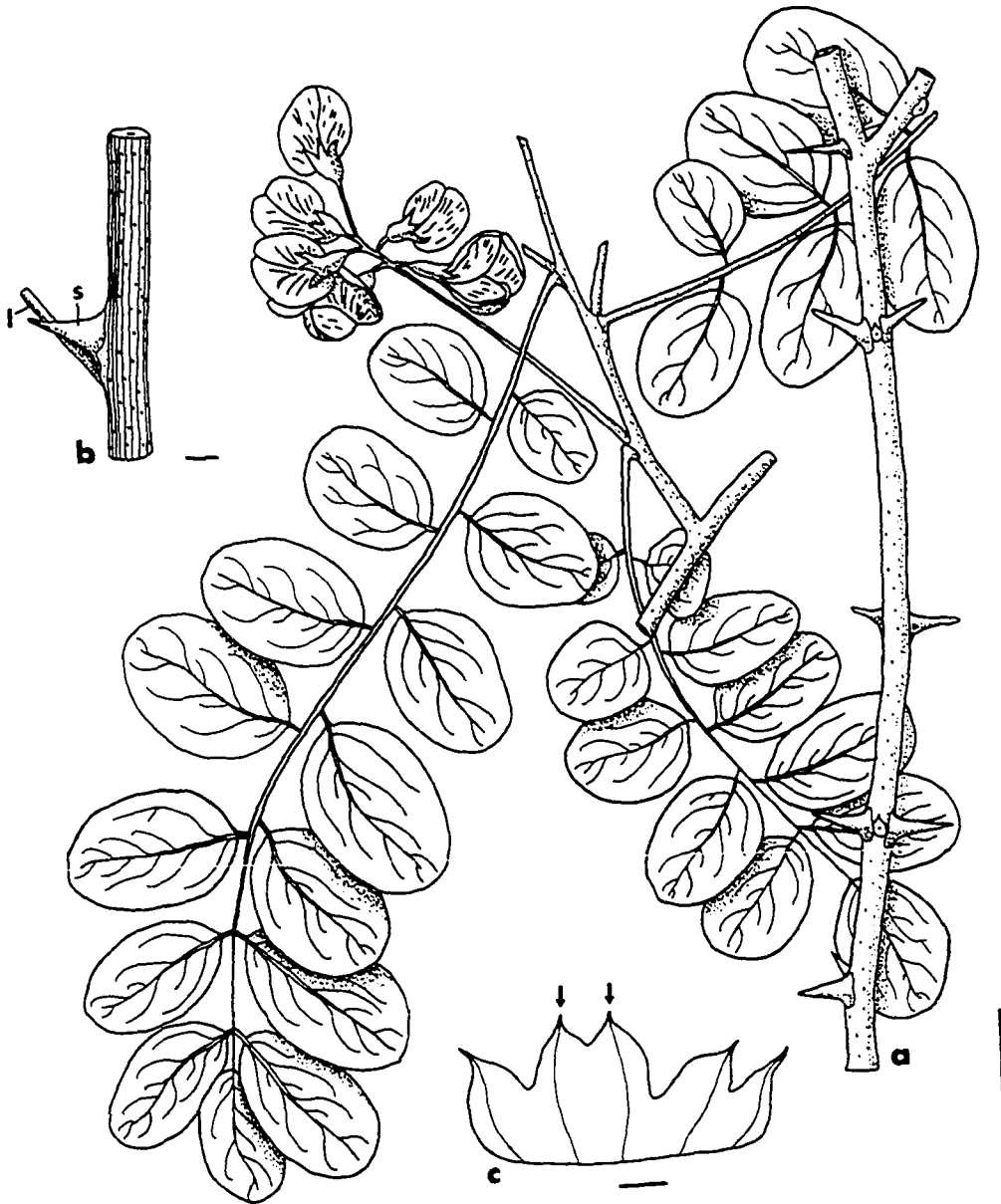


FIGURE 11. Distribution of Robinia hispida L. var.
nana (Ell.) DC.

All are native populations.



Robinia hispida var. hispida

Robinia hispida L., Sp. Pl. 722. 1753. Specimen at LINN

designated as type by Clausen (1940) (913.2 labeled by Linnaeus as "hispida" microfiche !).

R. echinata Mill., Gard. Dict. 1768. P

R. rosea Marsh., Arbust. Am. 134. 1785. P

Pseudo-acacia hispida (L.) Moench, Meth. Pl. 145. 1794. P

R. hispida-rosea Pursh, Fl. Am. Sept. 488. 1814. P

R. macrophylla (Schrad. ex DC.) Don, Gen. Hist. Dichl. Pl.

238. 1832. R. hispida L. var. macrophylla Schrad.

ex DC., Prod. 2:262. 1825. P

R. boyntonii Ashe, J. Elisha Mitchell Sci. Soc. 14:51.

1897. PS

?R. grandiflora Ashe, J. Elisha Mitchell Sci. Soc. 37:176.

1922. non L. (1753) nec Schneid. (1907) PS

R. pauciflora Ashe, Bull. Torrey Bot. Club 50:362. 1923. PS

R. albicans Ashe, Bull. Torrey Bot. Club 50:362. 1923. PS

R. speciosa Ashe, Rhodora 25:181. 1923. PS

R. pallida Ashe, Rhodora 25:182. 1923. PS

R. leucantha Rehder, J. Arn. Arb. 26:479. 1945. P

Robinia hispida var. hispida covers almost the entire range of the species throughout the southeastern United States (Figure 14). It is somewhat replaced in the Coastal Plain by var. nana (Figure 11). The lower elevation forms

contrast with var. nana in bearing more abundant hispid bristles on the young, and in some instances even the old, branches (Figure 12). However, higher elevation forms of var. hispida approach var. nana in lacking this dense indumentum (Figure 13). However, var. hispida attains a greater height (up to 3 m) than the low growth of nana (1 m or less). It differs from vars. fertilis and kelseyi in setting fruit very rarely due to its triploid condition (I have not observed any fruit whatsoever). Vegetatively, it can be distinguished from var. kelseyi by having ovate-elliptic leaflets only 1.5 to 2.0 times as long as wide (Figures 12 and 13). On the basis of vegetative characters alone, it cannot be distinguished from var. fertilis (Figure 7).

The taxon hispida has proven to be the most confusing within the genus Robinia due to its remarkable morphological diversity. It consists of sterile, triploid populations ($2n=3x=30$) which reproduce vigorously by root suckering.

Some authors (Ashe 1897, 1922, 1923a, 1923b, 1923c, Sargent 1922a, Rydberg 1924, Clausen 1940, Wilbur 1963, 1968) have attempted to name some of this morphological diversity by the recognition of a number of species of pink-flowered locusts. Unfortunately, this has led to large scale subjectivity and confusion when attempting precise identification. The maintenance of varietal and specific

FIGURE 12. Robinia hispida L. var. hispida

a-c. Hispid form:

a. Habit, scale = 3 cm, showing bristly-hispid indumentum on small branches and leaf rachises as well as inflorescence branches; b. small branch at nodal region, scale = 2 mm, l - leaf petiole base, i - inflorescence peduncle base; c. calyx dissection, scale = 2 mm, arrows indicate adaxial calyx lobes (a-c based on Peabody 2120.)

d-f. Less-hispid form:

d. Habit, scale = 3 cm, showing bristly-hispid indumentum restricted to inflorescence; e. calyx dissection, scale = 3 mm, arrows indicate adaxial calyx lobes; f. small branch at nodal region, scale = 2 mm, l - leaf petiole base, i - inflorescence peduncle base (d-f based on Peabody 2155.)

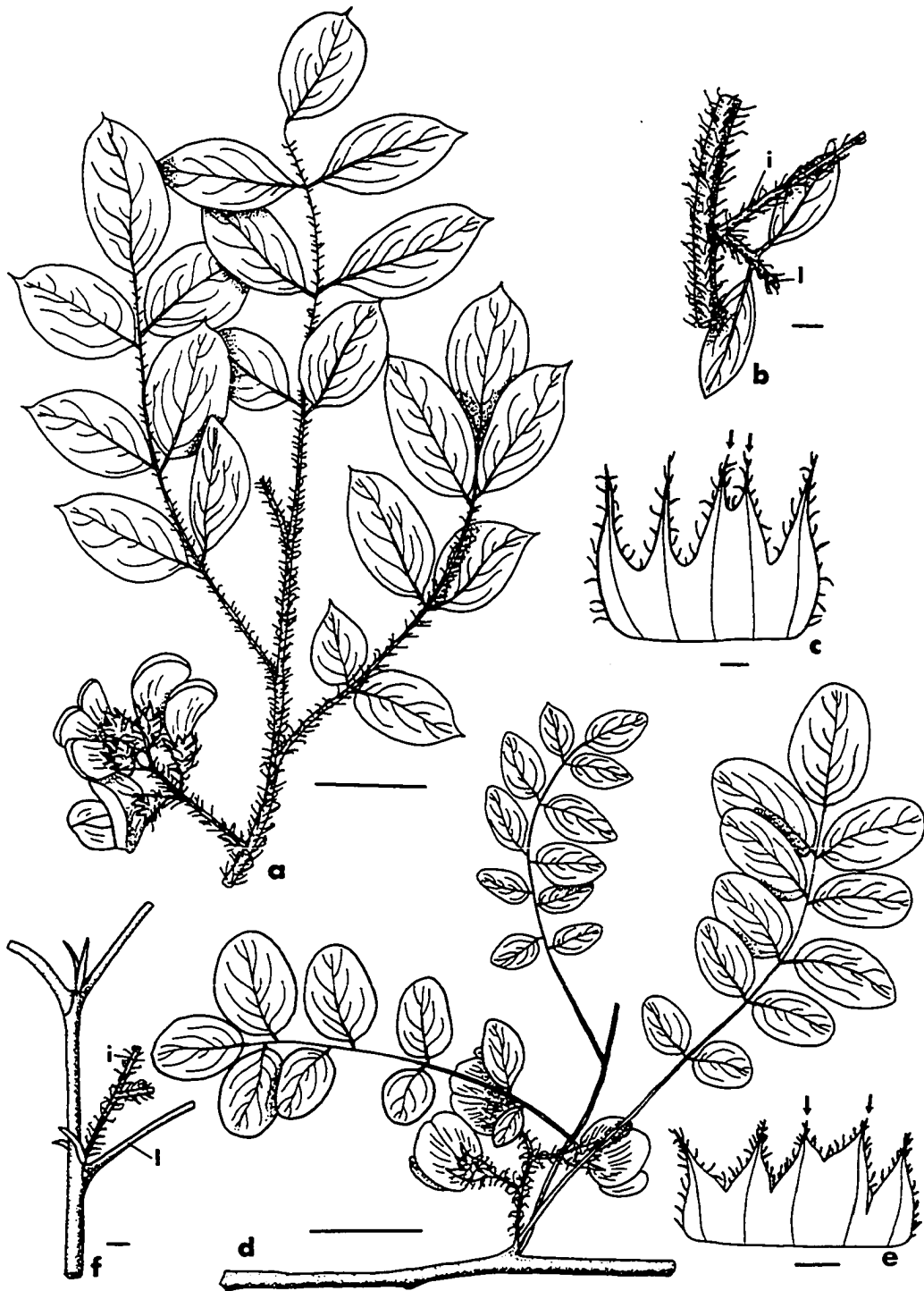


FIGURE 13. Robinia hispida L. var. hispida

a-c. Glabrate form:

a. Habit, scale = 3 cm, showing lack of
bristly-hispid indumentum; b. small
branch at nodal region, scale = 2 mm,
l - leaf petiole base, s - nodal spine;
c. calyx dissection, scale = 3 mm,
arrows indicate adaxial calyx lobes
(a-c based on Peabody 2164.)

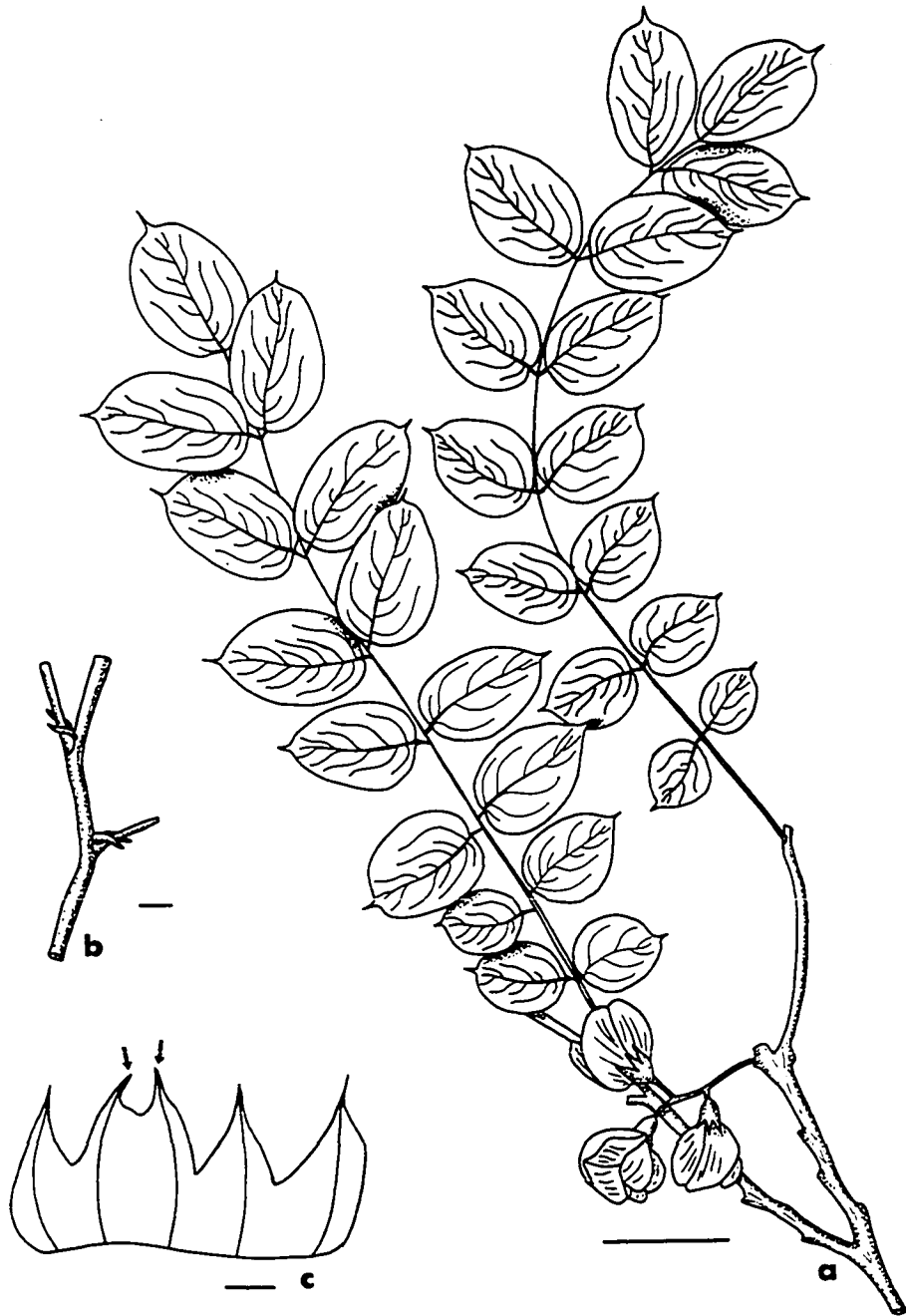
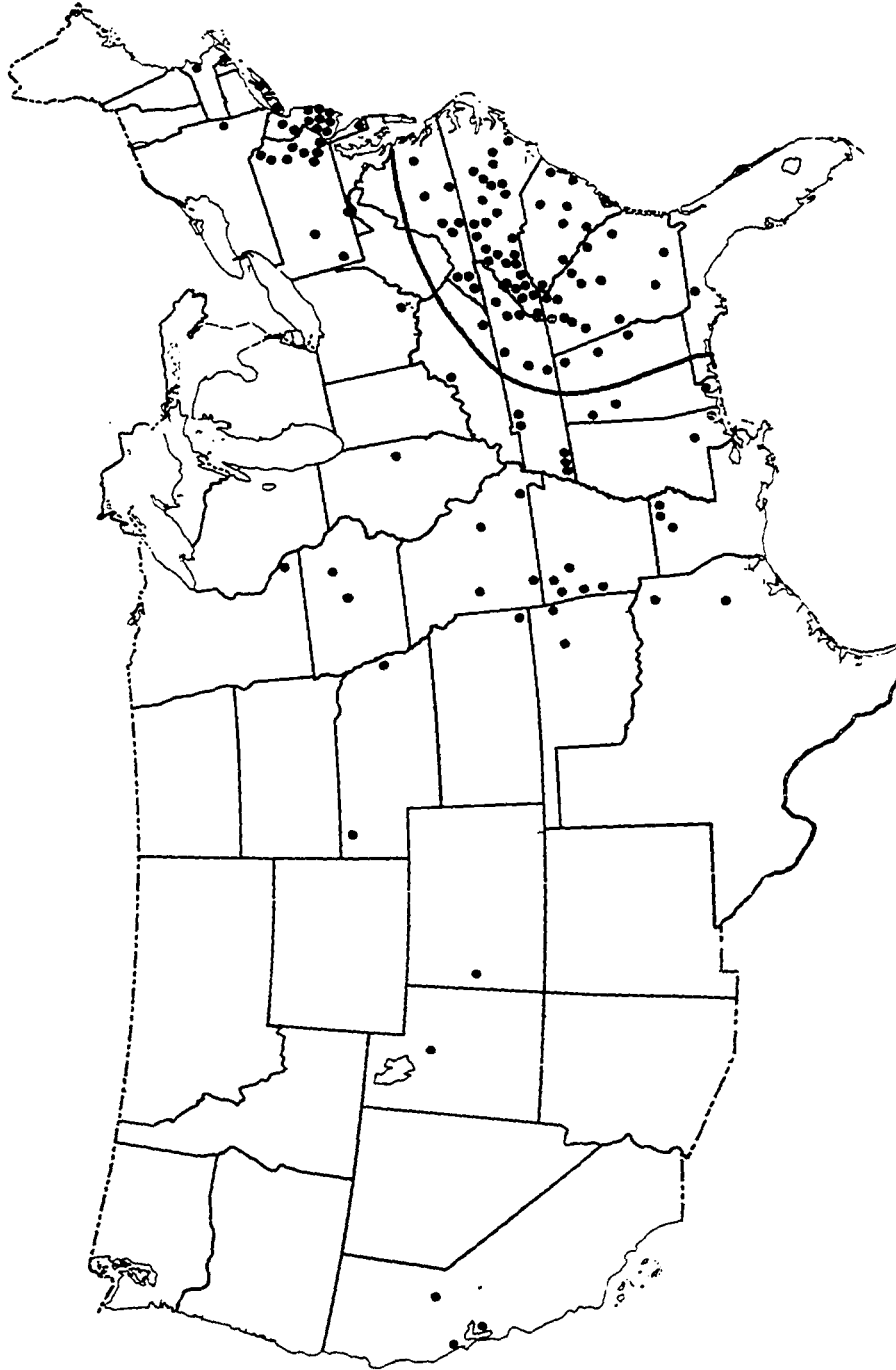


Figure 14. Distribution of Robinia hispida L. var.
hispida

Solid line encloses the presumed native range.



names describing levels of pubescence and growth habit can be broken down quite easily upon examination of larger samples of herbarium and field material. The reason for this may be phenotypic variation in response to site parameters, large scale mixing of incompletely segregated gene pools, or the variable expression of heterozygous genotypes.

The glabrate forms (Figure 13) of the Piedmont and Mountain Provinces (Robinia boyntonii and R. rosea of previous authors) have been separated from the more densely hispid forms (Ashe 1897, Rydberg 1924, Wilbur 1963, 1968). On the basis of field, herbarium, and numerical analyses I can scarcely distinguish these glabrate forms from the distinctly hispid types due to clinal intergradation. The number of intermediates between the two extremes presents ample evidence for treatment as a single polymorphic taxon. One exception to this is the tendency, admittedly weak, for the Coastal Plain forms to be much smaller (seldom exceeding 1 m in height) and to be glabrate to glabrous. Also, unlike the other sterile forms of var. hispida which are triploids ($2n=3x=30$), this dwarf form is a diploid ($2n=2x=20$). This has escaped general attention, however, due to its very low fruit set; former authors included it with the other sterile forms of var. hispida. Intermediates between typical var. hispida and var. nana can be found which would obscure

strict delimitation, but the frequency of this type and its correlation to Coastal Plain distribution (Figure 11) indicate its maintenance as a variety within R. hispida (i.e. Robinia hispida var. nana).

Identification of Ashe's material becomes subjective (see discussion under Robinia hispida var. fertilis). Primary characters used by him for distinction of pink-flowered locust species are height of the plant and relative abundance of twig, rachis, peduncle, and pedicel indumentum. Plant height ranges from 2-4 dm (R. pauciflora) to 1.5-2.5 m (R. boyntonii). Indumentum ranges from entirely glabrous (R. boyntonii) to somewhat hispid (R. grandiflora, R. albicans, R. pallida) to distinctly hispid (R. pauciflora, R. speciosa).

Robinia viscosa

Shrubs or small trees 1-10 m tall. Trunk 0.2-1.0(4.0) dm in diameter. Branches sticky to the touch by means of sessile and/or stalked viscid glands. Leaves with 6-10 pairs of leaflets. Inflorescence of 14-25 flowers, aristate bracts larger than the flower buds, overlapping each other, giving the immature inflorescence a hops-like appearance, bracts early caducous. Calyx distinctly 5-lobed with the upper (adaxial) two lobes shorter than the others due to longer connation; adaxial calyx sinus 1-2 mm deep. Flowers light pink. Standard 1-2 cm long. Ovules 15-22 per ovary. Fruit valves 3-12 cm long, sticky to the touch with stalked and/or sessile viscid glands, somewhat coriaceous in variety viscosa, and papery in variety hartwigii, splitting along both sutures at maturity, wingless. Seeds light brown or mottled green and light brown.

The native range of the clammy locust is restricted to the Appalachian Mountains of western North Carolina at elevations of 3,000 to 4,500 feet (Figures 16 and 18). Variety viscosa (see following text) has been widely planted and locally established in New England and Europe.

Robinia viscosa is easily distinguishable from other species by the sticky branches. Variety viscosa rarely sets fruit and may be self-sterile, while variety hartwigii sets abundant fruit. Field observation indicates that these two

forms are easily distinguishable from each other and, unlike R. hispida, show less mixing of characters. This has led some workers (Koehne 1913, Rydberg 1924, Wilbur 1963, 1968, Small 1903) to treat them as separate species. I maintain a varietal classification for these forms because they share the characteristic sticky-viscid secretions and the caducous flower bracts. They are quite different, however, in growth form and pod morphology. Variety viscosa is characterized by its tree-like habit and low fruit set, but fruit valves when produced are short (3-5 cm long) and rather coriaceous as in R. hispida. Variety hartwigii is shrubby in habit and sets abundant fruit which is up to 12 cm long and the valves are quite thin and papery.

Key to varieties of *Robinia viscosa*

1. Branches and branchlets bearing viscid glands elevated on short (1-2 mm long) trichomes; small shrubs under 2 m tall; native to Macon and Jackson Counties, North Carolina on high elevation (4,000 feet) south-facing slopes; rarely cultivated.....R. viscosa var. hartwigii
1. Branches bearing sessile viscid glands; infrequently fruiting; larger trees from 4-6 m tall; native to the mountains of western North Carolina at 3,000-4,000 feet; elsewhere in cultivation and locally established.....R. viscosa var. viscosa

Robinia viscosa* var. *hartwigii

Robinia viscosa Vent. var. *hartwigii* (Koehne) Ashe, J. Elisha Mitchell Sci. Soc. 37:175. 1922. *R. hartwigii* Koehne, Mitt. Deut. Dendrol. Ges. 1913:1. 1913. No protologue-based specimens seen.

Robinia viscosa var. *hartwigii* is endemic to higher elevation (ca. 4,000 feet) south facing-slopes in Macon and Jackson Counties in western North Carolina (Figure 16). The stalked viscid glands, papery fruit valves (Figure 15), lower growth form, and unique narrow distribution provide good characters for separation of this variety from variety *viscosa*. The specific habitat requirements and narrow distribution, combined with the encroachment of building operations on Whiteside Mountain (where the best developed population is located) warrant special consideration for the protection of this variety.

Some authors (Hartwig in Koehne 1913, Ashe 1922, Wilbur 1963, 1968) suggest the possibility that this variety might be a hybrid or a hybrid derivative of *Robinia hispida* and *R. viscosa*. Their hypothesis is that the combination of the bristles of *R. hispida* and the sessile glands of *R. viscosa* produced stalked viscid glands. Further investigation into this hypothesis is necessary before any judgment could be made.

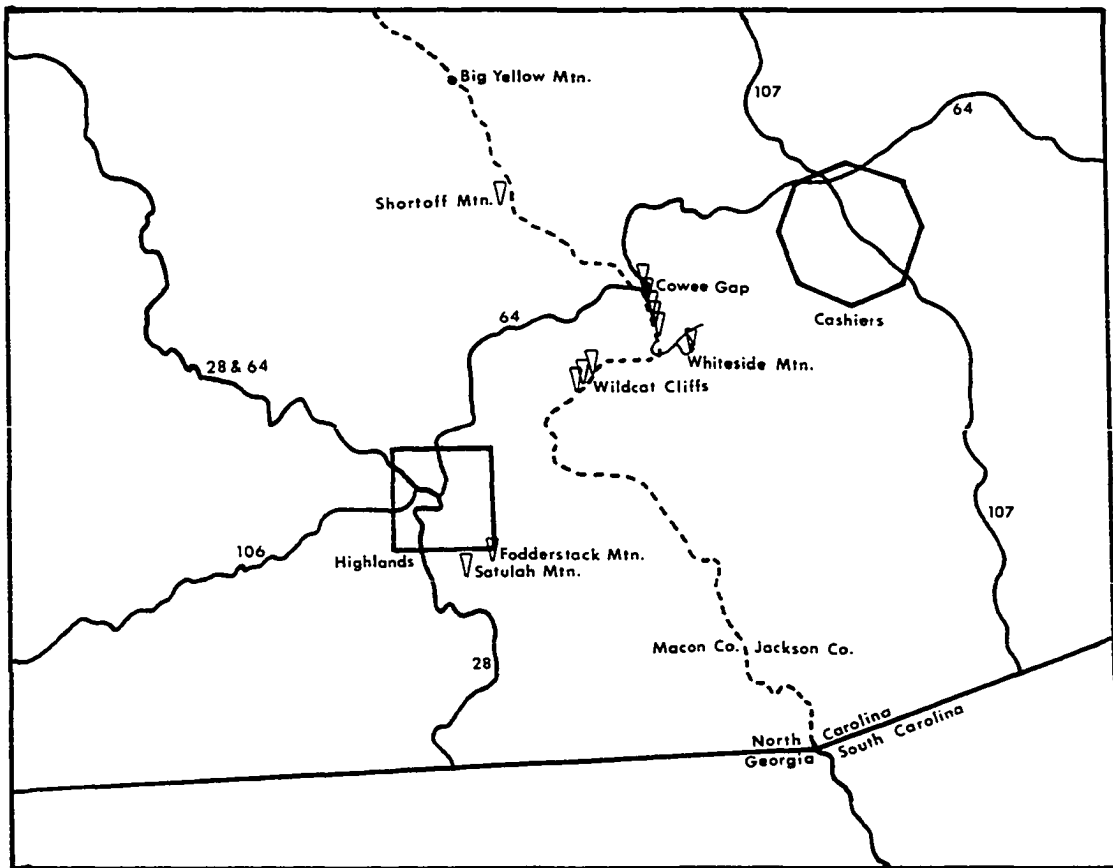
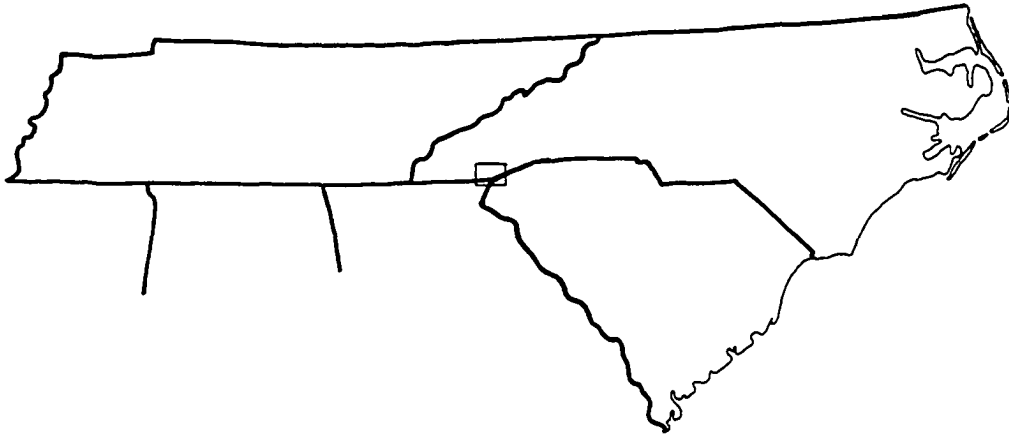
FIGURE 15. Robinia viscosa Vent. var. hartwigii
(Koehne) Ashe

a. Habit, scale = 3 cm; b. small branch at nodal region, scale = 2 mm, l - leaf petiole base, i - inflorescence peduncle base; c. section of stem internode, scale = 2 mm, showing stalked glands; d. fruiting branch, scale = 3 cm; e. calyx dissection, scale = 2 mm, arrows indicate adaxial calyx lobes (based on Peabody 2199.)



FIGURE 16. Distribution of Robinia viscosa Vent.
var. hartwigii (Koehne) Ashe.

All are native populations.



Robinia viscosa* var. *viscosa

Robinia viscosa Vent., Des. Pl. Nouv. 4 1880. (No protologue-based specimens seen (excellent illustration in protologue))

?*R. montana* Bartr., Trav. 335. 1791. nom. nud. P

R. glutinosa Sims, Curt. Bot. Mag. 1802:560. 1802. P

R. bella-rosea (Hartwig) Nichols. & Mottet, Dict. Prat. Hort. Jard. 515. 1896. *R. viscosa* Vent. var.

bella-rosea Hartwig, Ill. Geholz. 333. 1892. P

Robinia viscosa var. *viscosa* covers the entire native range of the species (Figure 18) at elevations between 3,000- 4,000 ft. It is much more abundant and more widely distributed than the local variety *hartwigii*. Following cultivation it has become established in other localities, especially New England and Europe. Variety *viscosa* (Figure 17) contrasts with variety *hartwigii* as tabulated in the key to varieties. Larger plants of this variety are very attractive, bearing an abundance of light pink flowers amid a lacy foliage.

FIGURE 17. Robinia viscosa Vent. var. viscosa

a. Habit, scale = 3 cm; b. section of stem internode, scale = 2 mm, showing sessile glands; c. small branch at nodal region, scale = 2 mm, l - leaf petiole base, i - inflorescence peduncle base; d. calyx dissection, scale = 2 mm, arrows indicate adaxial calyx lobes; e. caducous bract subtending each flower, scale = 2 mm (based on Peabody 2160.)

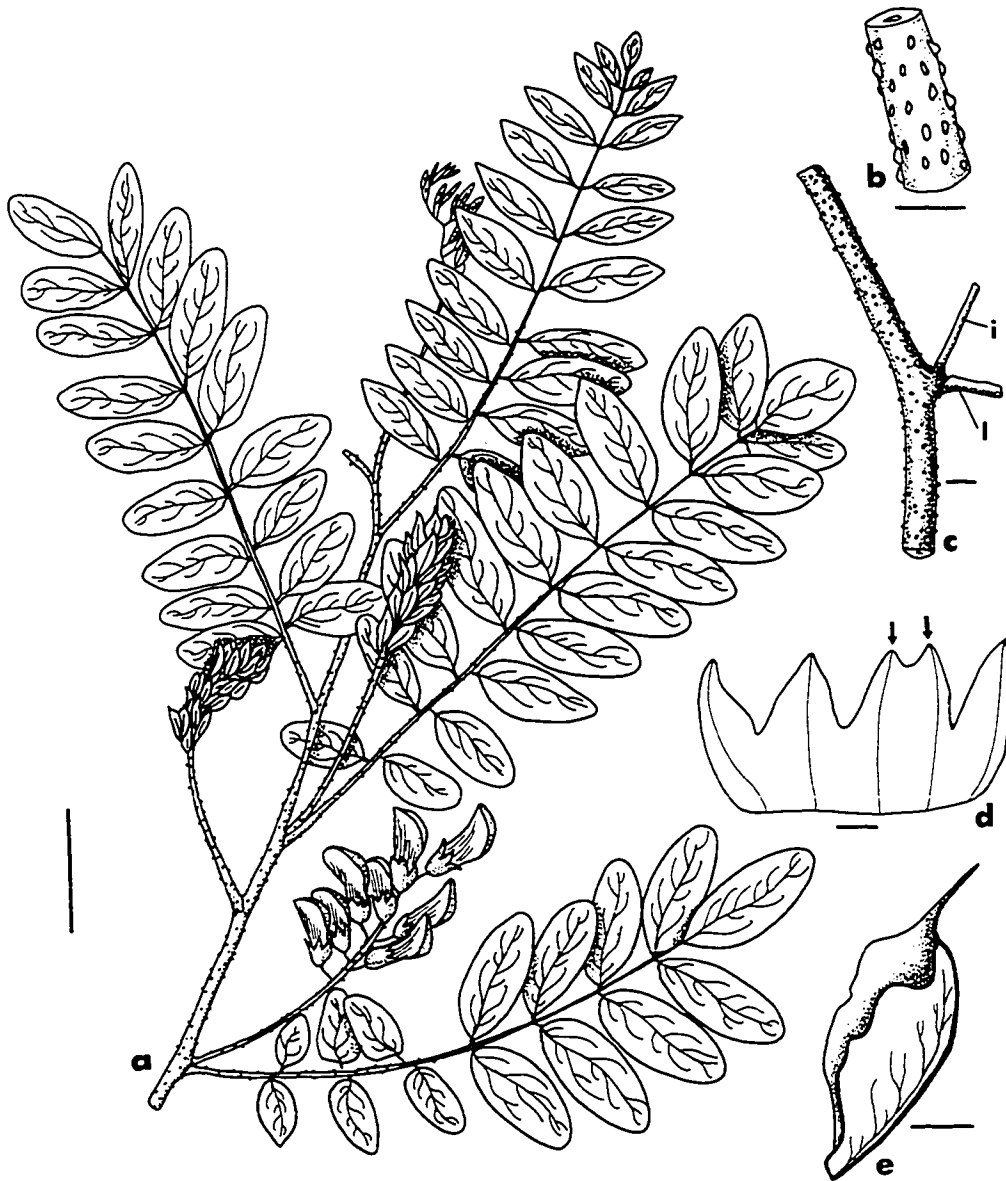
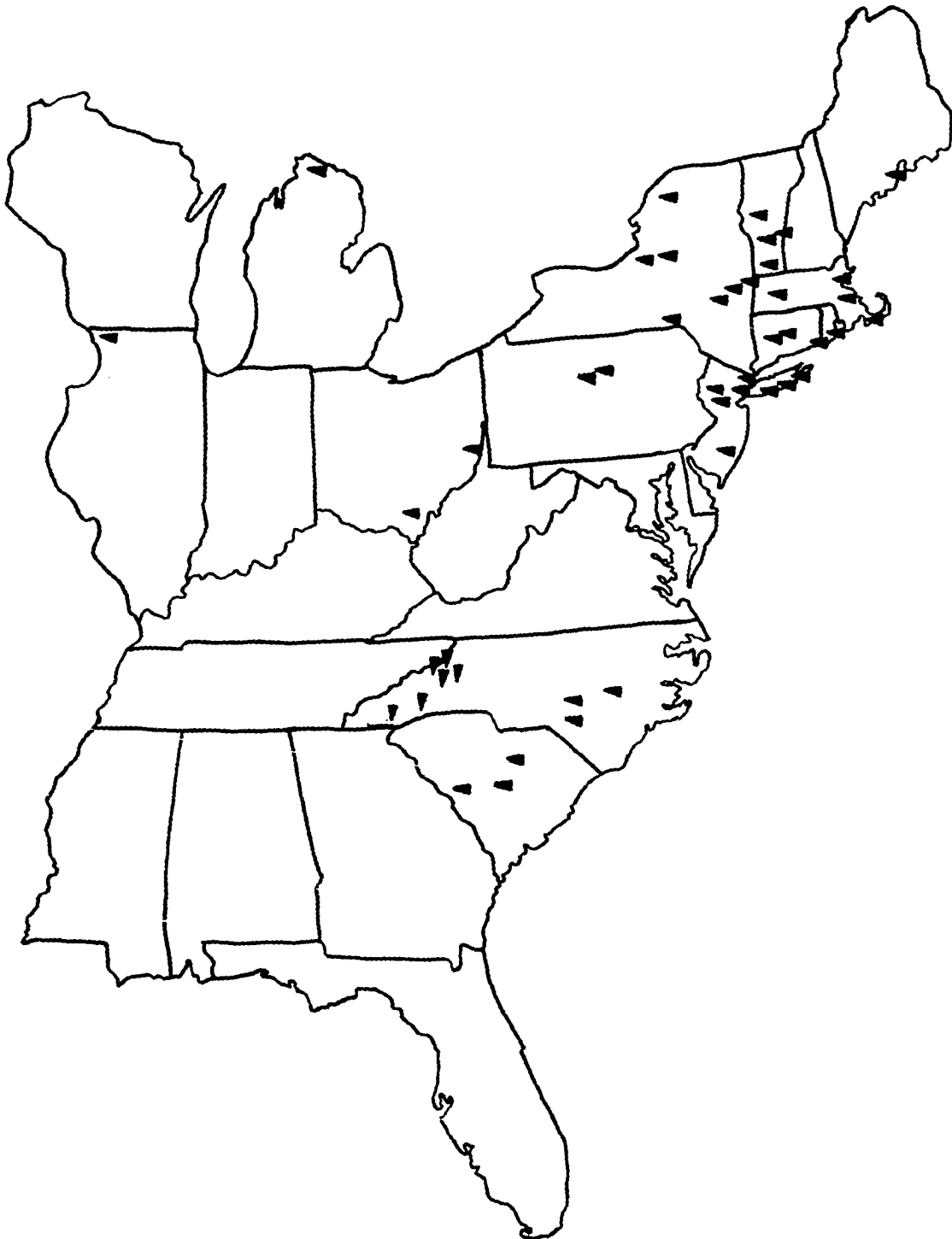


FIGURE 18. Distribution of Robinia viscosa Vent.
var. viscosa

Symbol legend:

▼ = native populations

◄ = cultivated and established populations



Robinia neomexicana

Shrubs or small trees 1-3(6) m tall. Trunk 0.2-1.0 dm in diameter. Branches glabrous except in the inflorescence where they are densely bristly-hispid or merely puberulent. Leaves with 7-10 pairs of leaflets. Inflorescence of 15-20 flowers; bracts longer than flower buds and quickly caducous. Calyx distinctly 5-lobed with the upper (adaxial) two lobes shorter than the others due to longer connation; adaxial calyx sinus 1.7-2.0 mm deep. Flowers dark pink fading to light pink. Standard 1.7-2.5 cm long. Ovules 12-17 per ovary. Fruit valves papery, bristly-hispid (glabrous in local populations), eventually splitting along both sutures, wingless. Seeds light to dark brown.

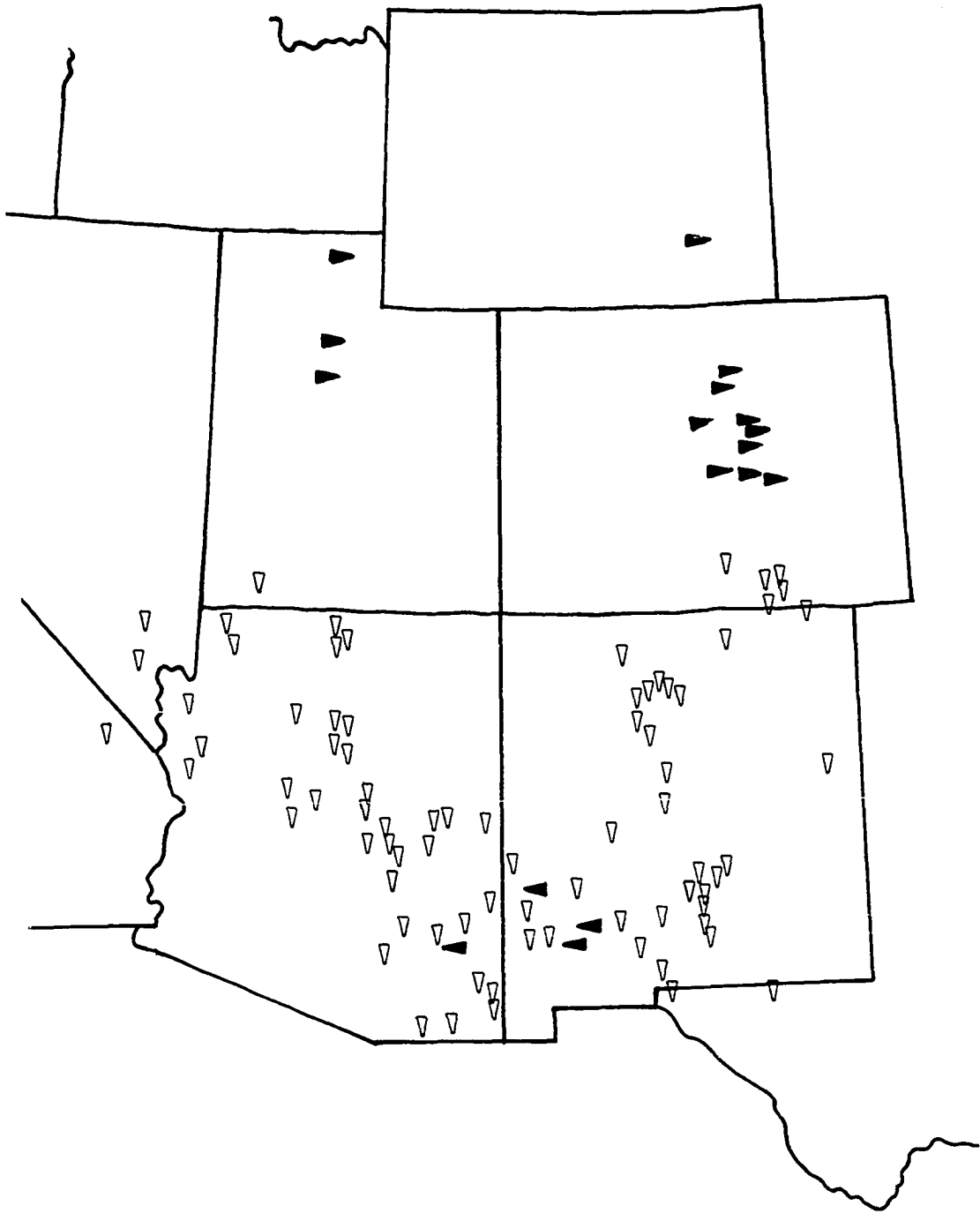
Robinia neomexicana is distributed from central and south-central Colorado along the eastern slopes of the Rocky Mountains, south through New Mexico, and into the Guadalupe Mountains of Texas, west through Arizona, extreme southwestern Utah (Zion Canyon), and adjacent southern Nevada and southeastern California (Figure 19). It grows in full sun along roadsides and steep slopes at middle elevations (3000-5000 feet) and in some localities (e.g. Raton Pass on the Colorado-New Mexico border) may be the dominant species.

It is locally cultivated and established in southeastern Wyoming and central Colorado and north-central Utah (Figure 19). It is also cultivated in Europe.

FIGURE 19. Distribution of Robinia neomexicana Gray

Symbol legend:

- ∇ = R. neomexicana Gray var. neomexicana
native populations
- ▶ = R. neomexicana Gray var. neomexicana
cultivated and established populations
- ◀ = R. neomexicana Gray var. rusbyi
(Woot. & Standl.) Isely & Peabody



Robinia neomexicana exhibits variation in the amount of vestiture on branchlets, pedicels, and pods. The widespread typical kind has abundant bristles in the inflorescence and on the pods (Figure 21). A local form, restricted to the Mogollon Rim of New Mexico and adjacent Arizona (Figure 19), hitherto known as R. rusbyi, has glabrous pods (Figure 20). Pubescence is otherwise limited to the inflorescence and commonly reduced in amount. Both kinds are fully fertile and set abundant fruit.

Key to varieties of *Robinia neomexicana*

1. Inflorescence rachis pubescent or with scattered bristles; upper calyx lobes wider than long; pods glabrous; native to the Mogollon Rim in southwestern New Mexico and adjacent southeastern Arizona.....
.....R. neomexicana var. rusbyi
1. Inflorescence rachis densely bristly-hispid; upper calyx lobes as wide as long; pods bristly-hispid; widely distributed at higher elevations throughout the southwestern United States.....
.....R. neomexicana var. neomexicana

***Robinia neomexicana* var. *rusbyi*, comb. nov.**

Robinia neomexicana Gray var. *rusbyi* (Woot. & Standl.) Peabody,

In press 1983. *R. rusbyi* Woot. & Standl.,

Contr. U.S. Nat. Herb. 16:140. 1913. Type: Wooton s.n.

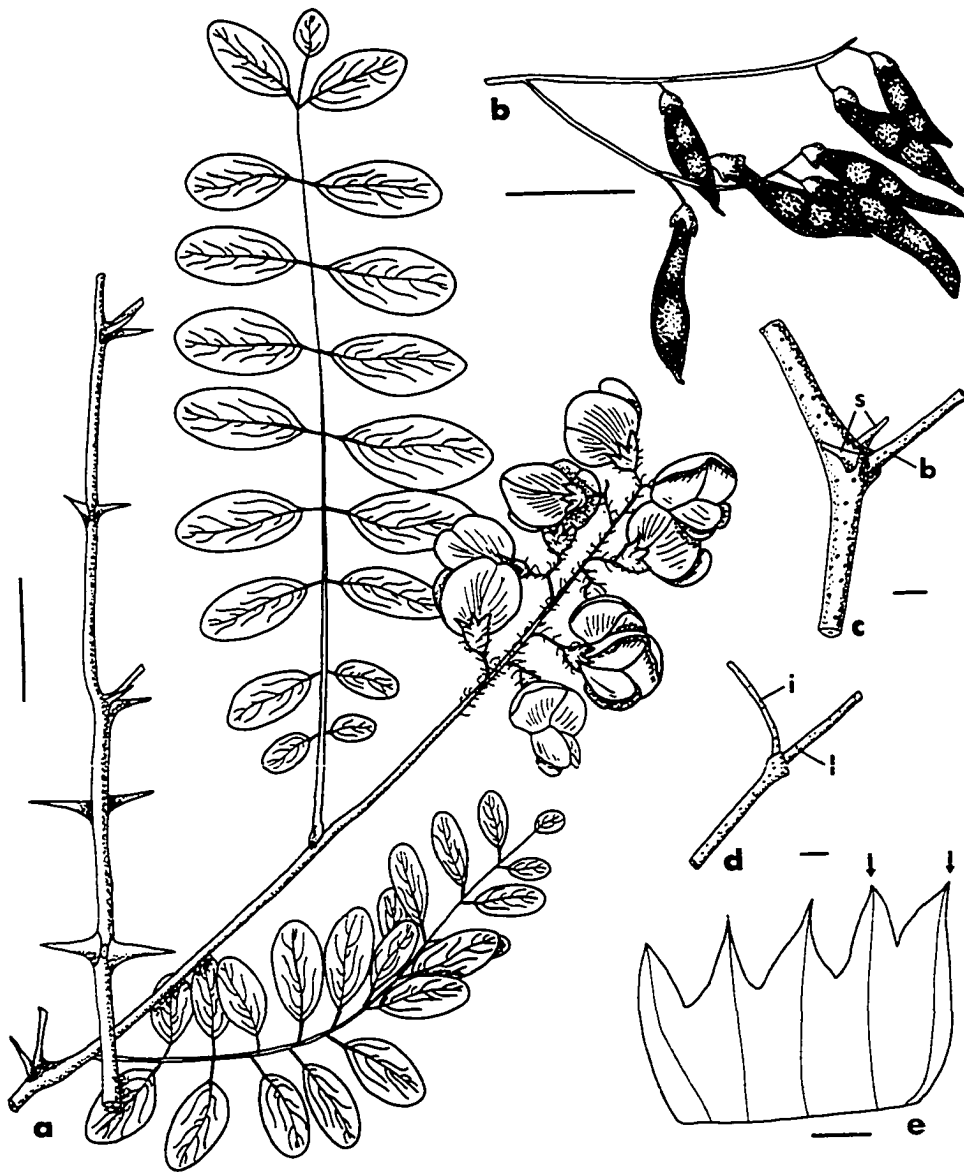
Aug. 8, 1900. US(690238)!

R. breviloba Rydb., N. Amer. Fl. 24:227. 1924. PS

Robinia neomexicana var. *rusbyi* is restricted to the Mogollon Rim in southwestern New Mexico and adjacent southeastern Arizona (Figure 19). Because of intergradation between the two varieties of *R. neomexicana*, identification may be difficult, especially for material that is not in fruiting condition, since the glabrous pods of variety *rusbyi* provide the most reliable distinguishing character. Generally, specimens with glabrous pods also will have reduced inflorescence pubescence (Figure 20).

FIGURE 20. Robinia neomexicana Gray var. rusbyi
(Woot. & Standl.) Peabody

a. Habit, scale = 3 cm; b. fruiting branch, scale = 3 cm; c. branch at nodal region, scale = 2 mm, s - nodal spine, b - branch; d. small branch near stem tip, scale = 2 mm, l - leaf petiole base, i - inflorescence peduncle base; e. calyx dissection, scale = 4 mm, arrows indicate adaxial calyx lobes (based on Peabody 2204.)



Robinia neomexicana var. neomexicana

Robinia neomexicana Gray, Mem. Amer. Acad. ser.2, 5:314. 1855.

Type: Bigelow s.n., May 1857 [New Mexico] Mimbres

Mountains. GH!

R. luxurians (Dieck in Goeze) Rydb., N. Amer. Fl. 24:226.

1924. R. neomexicana Gray var. luxurians Deick in

Goeze, Gard. Chron. ser. 3, 12:699. 1892. PS

R. neomexicana Gray var. subvelutina (Rydb.) Kearns. &

Peeb., J. Wash. Acad. Sci. 29:484. 1939. R. sub-

velutina Rydb., N. Amer. Fl. 24:227. 1924. PS

R. neomexicana Gray var. albiflora Kusche, Mitt. Deut.

Dendr. Ges. 1911:423. 1911. P

Robinia neomexicana var. neomexicana (Figure 19) is distributed from south-central Colorado to southwest New Mexico and to northwest Arizona. It also extends into extreme southwestern Utah (Zion Canyon), extreme southern Nevada, extreme southeastern California (Bathtub Springs in the Mid Hills), and extreme southwestern Texas (Guadalupe Mountains). It has also become established along the eastern front of the Rocky Mountains in north-central Colorado (Figure 19).

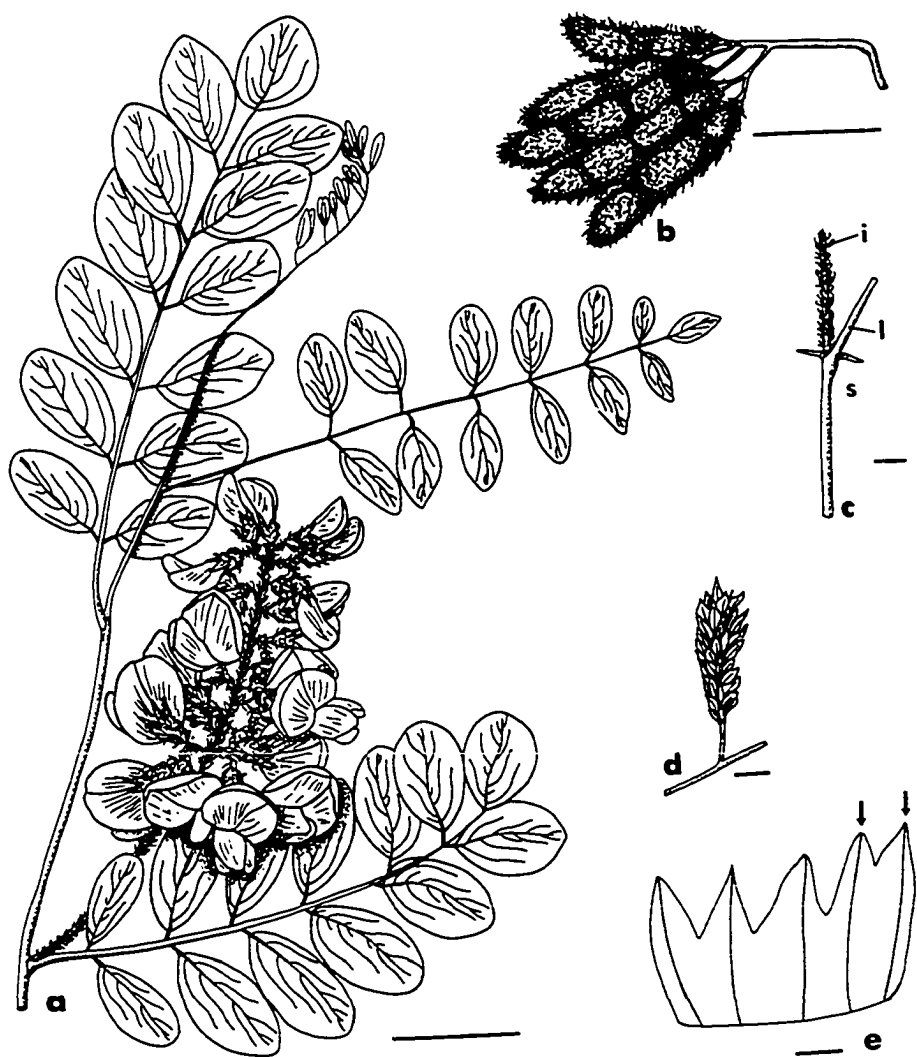
Rydberg (1924) recognized five species of western North American locusts: Robinia rusbyi, R. neomexicana, R. luxurians, R. breviloba, and R. subvelutina. I have placed

R. luxurians and R. subvelutina under variety neomexicana treating them as minor variants which fall entirely within the range of variability of this taxon. Their segregation by Rydberg (1924) is primarily based upon leaflet shape and vestiture which are characters of wide variability. The calyx lobe shape and the distribution of R. breviloba place it within the circumscription of variety rusbyi. Variety albiflora of Kusche (1911) is merely a color variant of the typical form.

Robinia neomexicana var. neomexicana is the most widespread locust in the southwestern United States. In local areas I have observed it to form a dense growth over a large area (e.g. Raton Pass near the Colorado-New Mexico border). It has potential for soil stabilization and wildlife habitat (Graham 1941, Vandersal 1938). Reported hybrids (Rydberg 1924, Dode 1909, Spaeth 1903, Welsh 1978) with other locust species have potential for ornamental applications yielding medium-sized trees with beautiful light-pink pendant racemes.

FIGURE 21. Robinia neomexicana Gray var. neomexicana

a. Habit, scale = 3 cm, showing copious bristly-hispid indumentum in the inflorescence; b. fruiting branch, scale = 3 cm; c. small branch at nodal region, scale = 2 mm, l - leaf petiole base, i - inflorescence peduncle base, s - nodal spine; d. immature inflorescence, scale = 2 mm, showing subtending caducous flower bracts; e. calyx dissection, scale = 4 mm, arrows indicate adaxial calyx lobes (based on Peabody 2192.)



Interspecific hybridization

Hybridization between species appears to be a common phenomenon in the genus Robinia when, usually in cultivation, species grow in proximity to each other (Soulange-Bodin 1828, Mouillefert 1894, Rehder 1915, 1922, 1940, Zabel in Beissner 1903, Nicholson and Mottet 1896/97, Spaeth 1903, Ashe 1925, De Candolle 1825, Poiret 1804, 1816, Sargent 1922b, Schneider 1912, Foucault 1813, Small 1933, Smith 1978). Evidently, there is also some natural hybridization, most conspicuously between R. pseudoacacia and R. hispida, as discussed in the numerical analysis portion of this section.

Type material for most of the presumed hybrids of culture is entirely lacking or not readily available, making identification and typification difficult. Thus, I have had to draw tentative conclusions, based primarily upon the literature, as to the most appropriate nomenclatural placement and putative parental types of these questionable forms. Under each of the following hybrid combinations, I have included: 1) the commonly accepted scientific name (binomial) applied to the combination, 2) the putative parental types as traditionally accepted or as I have viewed them, 3) a list of synonyms followed by author citations that also indicate the form as a hybrid of said putative parental types, and 4) a synopsis of the diagnostic

characters, derived primarily from the literature, but supplemented by my own observations.

Robinia x ambigua Poir. (pro sp.)R. pseudoacacia x viscosa

Robinia ambigua Poir., Enc. Meth. Bot. 6:224. 1804. P.

Poir. 1816, Rehder 1922, 1927, 1940.

R. dubia Fouc. in Desv., J. Bot. (Paris) 2:78. 1818. P.

De Candolle 1825, Mouillefert 1894, Nicholson &
Mottet 1896/97, Zabel in Beisner 1903, Schneider
1907, Small 1933.

R. hybrida Audib. ex DC., Prod. 2:262. 1825. P.

R. intermedia Soul., Ann. Soc. Hort. Paris 2:42. 1828. P.

R. ambigua Poir. var. bella-rosea (Nichols.) Rehder, J.

Arn. Arb. 3:40. 1922. R. bella-rosea Nichols.,
Ill. Dict. Gard. 3:309. 1887. P. Rehder 1915,
Small 1933.

These presumed hybrids are similar to R. pseudoacacia except for the light pink flowers, smaller growth habit, somewhat viscid twigs, and narrower acuminate leaflets. Rehder (1922) suggests that var. bella-rosea "...is nearer to R. viscosa while the typical R. dubia is closer to R. pseudoacacia." This hybrid combination includes the largest number of named hybrids in the genus, probably because of the early cultivation of both parental types in European gardens (Rehder 1922, Peabody 1982, Sargent 1892, Allan 1974). These trees have value for ornamental purposes due

to the combination of the lacy foliage and pink flowers of R. viscosa and the larger growth habit of R. pseudoacacia. Currently accepted cultivar names can be found in Bailey (1976) and in Rehder (1949).

Robinia x holdtii Zabel in Beissner (pro sp.)

R. neomexicana x pseudoacacia

Robinia holdtii Zabel in Beissner, Mitt. Deut. Dendrol. Ges.

1902:497. 1902. P. Rehder 1922, 1940, Schneider 1912.

R. holdtii britzensis Spaeth, Gartenflora 52:337. 1903. P.

R. coloradensis Dode, Bull. Soc. Bot. France 55:650.

1909. P.

These presumed hybrids are similar in appearance to R. pseudoacacia except that young branches and legumes are slightly puberulent and the flowers are light pink. Since the native and naturalized ranges of these two parental types present little chance for natural crossing, hybrids are reported mostly from cultivated material. There is, however, one brief reference to possible natural hybridization in Utah (Welsh 1978).

Robinia x longiloba Ashe (pro sp.)

Robinia hispida var. fertilis x viscosa var. hartwigii

Robinia longiloba Ashe, Bull. Charl. Mus. 14:30. 1918. PS.

R. ashei Schallert, Torreyana 23:105. 1923. P.

These presumed hybrids have abundant stalked gland-tipped hairs in the inflorescences and on the branchlets. The branches are somewhat sticky to the touch but not as distinctly so as in the parental Robinia viscosa var. hartwigii. Both of the names listed in the synonymy represent plants from Oconee County, South Carolina, said to be contiguous to populations of both parental types (Ashe 1918). All of the plants that I have seen in the field appear to combine characters of each parental type.

Robinia x slavinii* Rehder (pro sp.)Robinia pseudoacacia* x *hispida* var. *fertilis**Robinia x slavinii* Rehder, J. Arn. Arb. 3:38. 1922. P.

Sargent 1922b.

R. oconeensis Ashe, Charl. Mus. Quart. 1:28. 1925. PS.

Robinia x slavinii and *R. oconeensis* appear to be hybrids between *R. pseudoacacia* and *R. hispida* in that they are similar to *R. pseudoacacia* except that the younger branches and the leaf and flower rachises are initially sparingly villous, the racemes are 6-10 flowered, the flowers are rosy or light pink, and the pods are roughened by small tubercles partly bearing short bristles less than 1 mm long (Figure 22).

Bashor (1961) studied presumed introgressive hybridization between *Robinia pseudoacacia* and *R. hispida*. Ten populations in Sullivan and Johnson Counties, Tennessee were sampled. Flowering material was examined and scored, yielding 84 OTUs and 6 variables (Table 10). Subsequent analyses included recording variable values for "typical" representatives derived from species descriptions and comparing all OTUs with the typical values by means of a series of polygonal graphs. Figure 23 presents her "typical" polygons and polygons derived from measurements of individuals in one population. Polygon series for the other

FIGURE 22. Robinia x slavinii Rehder (pro sp.)

a. Habit, scale = 3 cm; b. small branch at nodal region, scale = 2 mm, l - leaf petiole base, i - inflorescence peduncle base; c. calyx dissection, scale = 4 mm, arrows indicate adaxial calyx lobes (based on Mahler 4868, ISC.)



nine populations are included in her manuscript. While some similarity between individuals and "typical" forms can be seen in these results, the precision is not good. The overlay of too many polygons that have identical values for one or more axes (Figure 23) leads to confusion as to the real relationship of OTUs to each other. One is uncertain as to which outgoing line matches with which incoming line at such congested points.

I have used the Bashor data set as input into cluster analysis in an attempt to ascertain the extent to which OTUs cluster together forming groups resembling "typical" hispida, "typical" pseudoacacia, and intermediate types. The dendrograph (Figure 24) shows twelve clusters as indicated by the numbered line immediately below the dendrograph. Figure 24 indicates the scaling of each axis for subsequent polygonal graphs. Polygonal graphs were produced for each of the twelve clusters indicated by cluster analysis, and are located below the cluster designation line (Figure 24). Figure 25 shows the comparison between "typical" pseudoacacia and "typical" hispida, and comparison of clusters 6 and 12. There appears to be a significant matching between the polygon of cluster 6 and the "typical" R. hispida polygon, and between the "typical" R. pseudoacacia polygon and the cluster 12 polygon. In all probability, OTUs comprising clusters 6 and

TABLE 10. Raw data for Robinia introgression (Bashor 1961)

OTU	Rachis hispidity	No. leaflet	Keel length	Standard color	Pistil length mm	Calyx notch mm
A2	1 ^a	4	21.0	4 ^b	29.0	3.5
A3	1	4	21.5	4	27.0	4.5
A4	1	4	21.0	4	27.0	3.6
A5	1	4	21.2	4	28.0	4.5
A6	1	4	18.5	3	15.0	3.5
A7	0	3	18.0	4	25.0	4.5
A8	1	4	20.0	4	28.0	4.0
A9	1	3	18.5	4	24.0	4.8
A10	0	3	18.5	4	24.5	5.5
A11	0	7	15.8	0	20.0	0.3
B1	0	4	21.0	4	25.5	3.2
B2	0	4	19.2	4	24.0	2.1
B3	0	9	17.8	0	20.0	0.0
B4	0	3	20.0	4	26.0	2.5
B5	0	3	20.2	4	25.0	1.8
B6	0	7	17.0	0	20.0	0.0
B7	0	5	18.0	1	19.5	0.0
B8	0	5	20.5	4	24.0	1.8
C1	0	4	14.0	2	20.0	1.2
C2	0	4	18.5	3	22.0	1.1
C3	0	5	18.5	3	24.5	1.6
D1	0	5	19.0	1	25.5	1.0
D2	0	4	15.5	2	21.0	1.3
D4	0	10	18.0	0	20.5	0.0
D5	0	4	21.0	2	26.0	1.5
D6	0	6	15.7	0	15.5	0.0
J1	0	7	15.5	0	19.0	1.3
J2	0	10	17.3	0	20.0	0.6
J3	0	8	15.2	0	17.8	0.0
J4	0	7	17.6	0	20.0	1.0
J5	0	9	16.5	0	21.0	0.5
J6	0	6	18.7	0	21.0	0.0
E1	0	5	20.0	2	24.0	1.5
E3	0	6	17.3	2	23.5	1.0
E5	0	5	17.2	2	24.3	1.0
E7	0	6	14.5	2	18.5	1.5
E8	0	6	14.0	1	20.0	0.5
E9	0	5	18.0	2	25.0	1.0
G1	0	6	15.3	3	21.5	0.4
G2	0	6	17.6	2	21.5	0.5

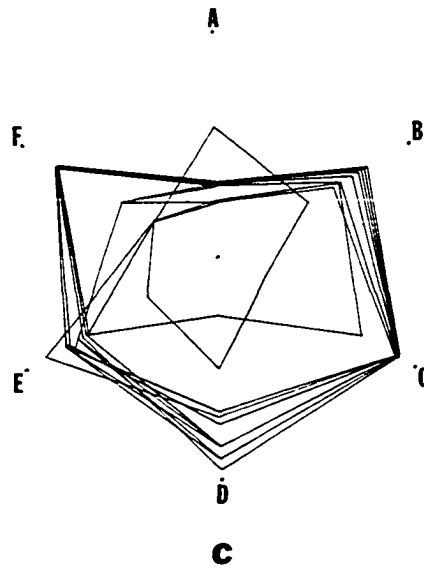
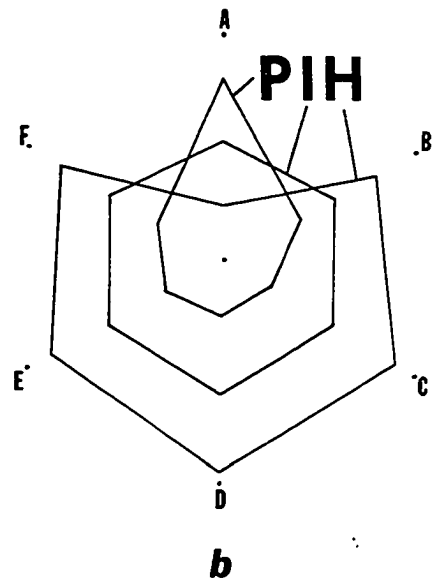
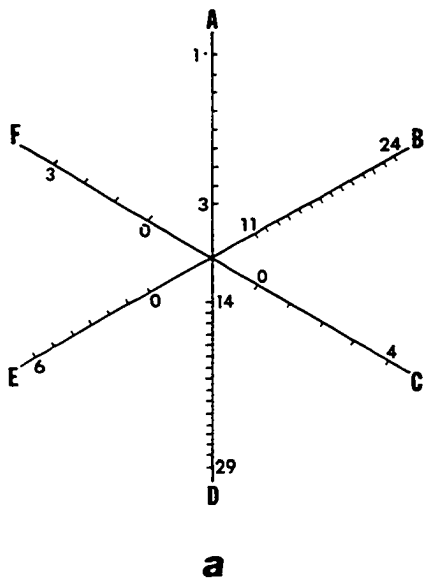
^a 1= yes, 0= no.^b 0= white, 4= pink.

Table 10. (continued)

OTU	Rachis hispidity	No. leaflet	Keel length	Standard color	Pistil length mm	Calyx notch mm
G3	0	7	15.2	3	20.2	1.0
G4	0	8	17.3	3	22.5	0.5
G6	0	6.5	16.6	3	19.0	0.8
G7	0	6	18.0	3	23.0	1.2
G8	0	6	16.6	0	20.6	0.6
G10	0	7	16.2	0	18.5	0.1
G11	0	8	16.0	0	19.0	0.3
G12	0	7	15.8	3	27.0	0.6
G13	0	5	18.2	3	24.5	0.6
G14	0	7	18.0	3	22.0	1.0
G16	0	7	17.5	0	19.0	0.5
G17	0	5	18.3	4	24.0	0.8
G18	0	6	20.0	3	25.5	1.3
G19	0	5	18.3	1	22.5	2.5
G20	0	6	18.0	2	22.5	2.5
G21	0	6	16.0	3	26.0	1.3
H1	0	6	18.0	3	22.0	1.1
H2	0	5	18.2	2	24.2	2.0
H3	0	5	16.0	3	21.2	1.0
H4	0	5	17.2	1	20.5	2.0
H5	0	5	17.5	1	23.0	1.0
H6	0	6	18.0	3	22.0	1.2
H7	0	5	19.2	1	24.0	1.5
H8	0	5	17.2	3	22.5	1.0
H9	0	7	16.0	0	19.5	0.3
H10	0	8	18.0	0	19.6	0.0
H11	0	8	18.0	0	22.2	0.5
K1	0	6	18.6	1	20.0	0.1
K2	0	6	19.0	1	21.0	0.1
K3	0	6	18.5	1	20.2	0.1
L1	0	7.5	18.5	0	18.2	0.0
L2	0	5	20.0	2	23.8	3.0
L3	0	5	18.0	2	22.5	2.3
L4	0	5	17.8	2	24.0	2.0
L5	0	8	14.8	0	18.0	0.1
L6	0	6	14.8	0	19.0	0.5
L7	0	5	19.5	2	25.0	3.5
L8	0	6	19.8	2	23.0	3.5
L9	0	5	20.0	2	24.0	3.5
L10	1	6	20.0	2	22.0	3.5
L11	0	5	16.0	1	22.6	2.0
L12	0	5	20.0	1	25.0	1.4
L13	0	5	16.0	1	24.5	2.0
L14	0	6	15.3	0	23.0	0.2

FIGURE 23. Bashor (1961) introgression studies in Robinia

- (a) Axis scales for polygons
- (b) Typical polygon patterns for R. pseudo-acacia (P), R. hispida L. (H), and their arithmetic intermediate (I)
- (c) Superimposed polygons for individual plants in colony A



12 represent R. hispida and R. pseudoacacia respectively.

All 12 clusters can be placed in one of three macroclusters, designated "A," "B," and "C" as indicated immediately below the twelve cluster polygons (Figure 24). Comparison between "typical," measured, and macrocluster polygons (Figure 25) shows high similarity. The polygon for macrocluster B, containing the Robinia hispida cluster, compares somewhat favorably with the "typical" R. hispida polygon; and the polygon for macrocluster C, containing the R. pseudoacacia cluster, also compares favorably with the "typical" R. pseudoacacia polygon.

It appears that the populations sampled in this study contain: 1) plants that closely resemble Robinia hispida (cluster 6), 2) plants that are somewhat similar to R. hispida but approach R. pseudoacacia (macrocluster B), 3) plants that closely resemble R. pseudoacacia (cluster 12), and 4) plants that are somewhat similar to R. pseudoacacia but approach R. hispida (macrocluster C). This pattern of morphological distribution indicates a mixing of the gene pools of R. pseudoacacia and R. hispida. My herbarium and field studies have indicated a similar situation in a population of plants located in Blount County, Tennessee along the Foothills Parkway, four miles north of its intersection with Highway 129 (Table 4).

Figure 24. Dendrograph of Bashor (1961) Robinia data

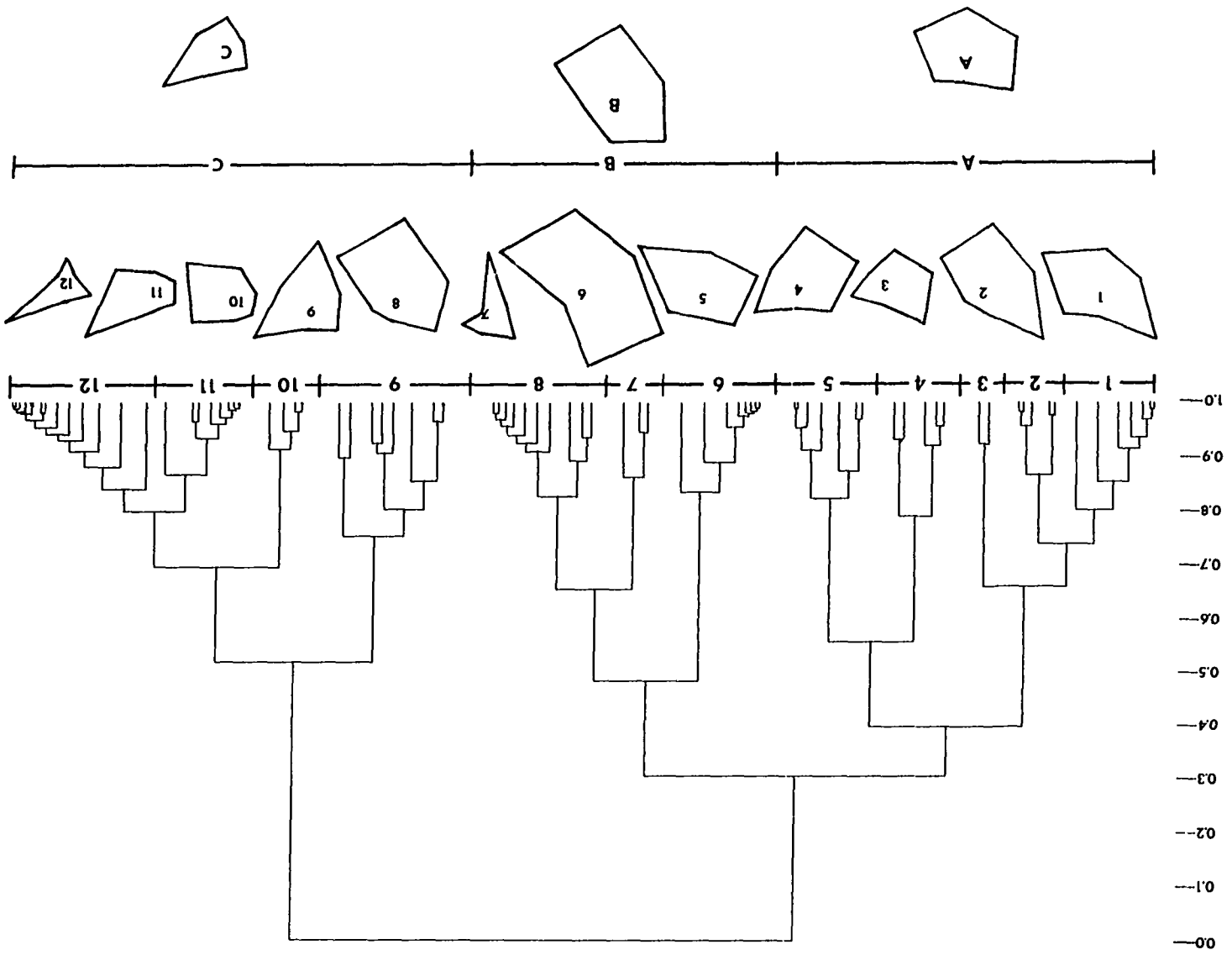
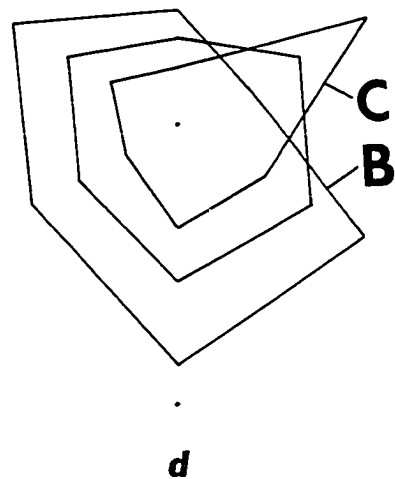
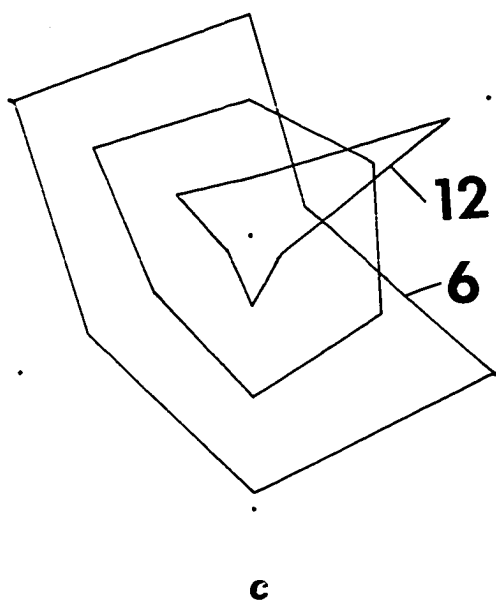
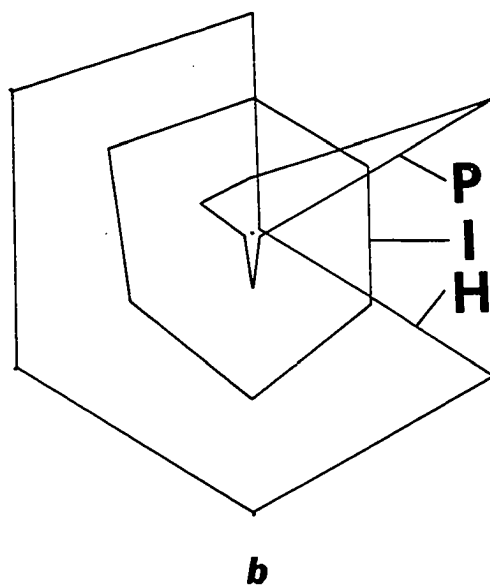
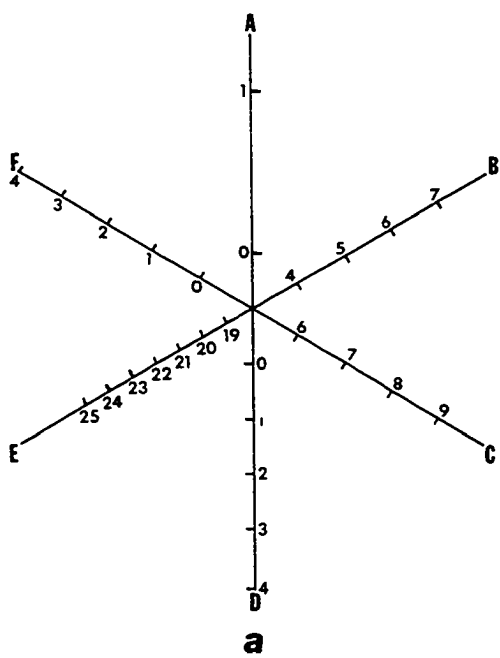


FIGURE 25. Polygon comparisons of Bashor (1961)
Robinia data

- (a) Axis scales for polygons
- (b) Polygon comparisons for typical R. pseudoacacia (P), R. hispida L. (H),
and their arithmetic intermediate (I)
- (c) Polygon comparisons of clusters 6
and 12
- (d) Polygon comparisons of macroclusters
C and B



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JEREMY ANDREW PEABODY

1977 - 1979

Life is sweet for those who love.

Life is bitter for those who lose.

Love is not lost for those who remember.

APPENDIX: SPECIMENS EXAMINED FOR PHENETIC ANALYSIS

OTU no.	Herbarium of deposit	Herbarium accession no.	Collector	Collector no.	Taxon
1 ¹	UNM ²	46575	<u>Robertson</u>	<u>1390</u>	neom ³
2	UNM	56301	<u>Hutchins</u>	<u>4305</u>	neom
3	UNM	57092	<u>Hutchins</u>	<u>5583</u>	neom
4	UNM	46574	<u>Robertson</u>	<u>379</u>	neom
5	UNM	32815	<u>Rice</u>	<u>52</u>	neom
6	UNM	45499	<u>Hutchins</u>	<u>2114</u>	neom
7	UNM	45498	<u>Hutchins</u>	<u>2113</u>	neom
8	UNM	29731	<u>Clark</u>	<u>9683</u>	neom
9	UNM	29730	<u>Clark</u>	<u>9683</u>	neom
10	UNM	65544	<u>Foxx & Tierney</u>	<u>11</u>	neom
11	UNM	24399	<u>Martin</u>	<u>3191</u>	neom
12	UNM	24659	<u>Martin</u>	<u>3191</u>	neom
13	UNM	32814	<u>Potter</u>	<u>53</u>	neom
14	UNM	45445	<u>Hutchins</u>	<u>2376</u>	neom
15	UNM	32548	<u>Tippeconnic</u>	<u>sn</u>	neom
16	UNM	32783	<u>Lindquist</u>	<u>57</u>	neom
17	UNM	40959	<u>Bedker</u>	<u>979</u>	neom
18	UNM	5561	<u>Clark</u>	<u>15274</u>	neom
19	UNM	46578	<u>Robertson</u>	<u>94</u>	neom
20	UNM	46576	<u>Robertson</u>	<u>209</u>	neom
21	UNM	23042	<u>Nisbet</u>	<u>56</u>	neom
22	UNM	3369	<u>Castetter</u>	<u>6630</u>	neom
23	UNM	5836	<u>Clark</u>	<u>16122</u>	neom
24	UNM	6869	<u>Castetter</u>	<u>6631</u>	neom
25	UNM	22016	<u>Nisbet</u>	<u>sn</u>	neom
26	UNM	51303	<u>Hutchins</u>	<u>3468</u>	neom
27	UNM	55738	<u>Hutchins</u>	<u>4287</u>	neom
28	UNM	43107	<u>Hutchins</u>	<u>2114</u>	neom
29	UNM	48064	<u>Hutchins</u>	<u>2114</u>	neom

¹ See Table 7.

² Holmgren & Keuken 1974.

³ OTU codes:

neom = Robinia neomexicana var. neomexicana
 rusb = R. neomexicana var. rusbyi
 hisp = R. hispida var. hispida
 nana = R. hispida var. nana
 rose = R. hispida var. rosea of some authors
 hart = R. viscosa var. hartwigii
 visc = R. viscosa var. viscosa
 pseu = R. pseudoacacia
 fert = R. hispida var. fertilis.

OTU no.	Herbarium of deposit	Herbarium accession no.	Collector	Collector no.	Taxon
30	UNM	1542	<u>Castetter</u>	6628	neom
31	UNM	32590	<u>Hinds</u>	3	neom
32	UNM	13961	<u>Roberson</u>	sn	neom
33	UNM	26051	<u>Martin</u>	4050	neom
34	UNM	29166	<u>Martin & Jones</u>	115	neom
35	UNM	13953	<u>Anderson</u>	1115	neom
36	UNM	32036	<u>Jones</u>	1041	rusb
37	ARN		<u>Wolfe</u>	2716	rusb
38	NCU	201999	<u>Radford</u>	11006	hisp
39	NCU	201991	<u>Radford</u>	21887	hisp
40	NCU	12734	<u>Harbison</u>	6522	hisp
41	NCU	201446	<u>Hunt</u>	sn	hisp
42	NCU	364369	<u>Wyatt</u>	841	hisp
43	NCU	354417	<u>Wyatt</u>	841	hisp
44	NCU	201441	<u>Ahles</u>	40885	hisp
45	NCU	283556	<u>Matthews</u>	sn	hisp
46	NCU	411515	<u>Williams</u>	114	hisp
47	NCU	210896	<u>Jones</u>	sn	hisp
48	NCU	68613	<u>Harbison</u>	sn	hisp
49	NCU	11970	<u>Totten</u>	sn	hisp
50	NCU	68784	<u>sc</u>	sn	hisp
51	NCU	68785	<u>sc</u>	sn	hisp
52	NCU	12663	<u>Harbison</u>	1583	hisp
53	NCU	23954	<u>Totten</u>	sn	hisp
54	NCU	210428	<u>Laing</u>	998	hisp
55	NCU	258341	<u>Matthews</u>	sn	hisp
56	NCU	315191	<u>Tucker</u>	4054	hisp
57	NCU	68837	<u>Ashe</u>	sn	hisp
58	NCU	68819	<u>Ashe</u>	sn	hisp
59	NCU	12703	<u>Harbison</u>	5011	hisp
60	NCU	316416	<u>Williams</u>	sn	hisp
61	NCU	504887	<u>Coile</u>	627	hisp
62	NCU	503172	<u>Thomas</u>	49	hisp
63	NCU	12696	<u>Harbison</u>	3253	hisp
64	NCU	385994	<u>Holley</u>	sn	hisp
65	NCU	390285	<u>Barnes</u>	81	hisp
66	NCU	390283	<u>Hall</u>	147	hisp
67	NCU	68835	<u>Ashe</u>	sn	hisp
68	NCU	344498	<u>James</u>	10646	hisp
69	NCU	341799	<u>Henson</u>	sn	hisp
70	NCU	505515	<u>Wiersma</u>	675	hisp
71	NCU	390284	<u>Rogers</u>	45	hisp
72	NCU	285982	<u>Propst</u>	sn	hisp
73	NCU	127066	<u>Moore</u>	5950	hisp
74	NCU	383819	<u>Godfrey</u>	69427	hisp

OTU no.	Herbarium of deposit	Herbarium accession no.	Collector	Collector no.	Taxon
75	NCU	282591	<u>Logue</u>	<u>6-14</u>	hisp
76	NCU	298856	<u>Gabrielson</u>	<u>565</u>	hisp
77	NCU	12699	<u>Harbison</u>	<u>16482</u>	hisp
78	NCU	344500	<u>James</u>	<u>10027</u>	hisp
79	NCU	337052	<u>Harvill</u>	<u>16064</u>	hisp
80	NCU	245948	<u>Smith</u>	<u>35</u>	hisp
81	NCU	329292	<u>Mahler</u>	<u>4898</u>	hisp
82	NCU	12659	<u>Harbison</u>	<u>sn</u>	hisp
83	NCU	224447	<u>Will</u>	<u>sn</u>	hisp
84	NCU	499797	<u>Anderson</u>	<u>4818</u>	hisp
85	NCU	383051	<u>Lorenz</u>	<u>6129</u>	hisp
86	NCU	365181	<u>Correll</u>	<u>37118</u>	hisp
87	NCU	269403	<u>Redfearn</u>	<u>14541</u>	hisp
88	NCU	268100	<u>Redfearn</u>	<u>14445</u>	hisp
89	NCU	307320	<u>Stephens</u>	<u>10527</u>	hisp
90	NCU	195989	<u>Hatchett</u>	<u>47</u>	hisp
91	NCU	196140	<u>Wahl</u>	<u>11090</u>	hisp
92	NCU	268098	<u>Redfearn</u>	<u>14445</u>	hisp
93	NCU	269410	<u>Redfearn</u>	<u>17053</u>	hisp
94	NCU	402523	<u>Kinaman</u>	<u>18108</u>	hisp
95	NCU	335642	<u>Chester</u>	<u>2061</u>	hisp
96	NCU	333138	<u>Carr</u>	<u>63</u>	hisp
97	NCU	292101	<u>Ellis</u>	<u>1185</u>	hisp
98	NCU	58067	<u>Duncan</u>	<u>13578</u>	nana
99	NCU	201995	<u>Radford</u>	<u>33094</u>	nana
100	NCU	201410	<u>Radford</u>	<u>12056</u>	nana
101	NCU	201997	<u>Ahles</u>	<u>24732</u>	nana
102	NCU	201419	<u>Ahles</u>	<u>24644</u>	nana
103	NCU	68805	<u>Ashe</u>	<u>sn</u>	nana
104	NCU	68640	<u>sc</u>	<u>sn</u>	nana
105	NCU	12640	<u>Harbison</u>	<u>4124</u>	nana
106	NCU	68769	<u>Ashe</u>	<u>sn</u>	nana
107	NCU	68770	<u>Ashe</u>	<u>sn</u>	nana
108	NCU	68777	<u>sc</u>	<u>sn</u>	nana
109	NCU	68778	<u>Ashe</u>	<u>sn</u>	nana
110	NCU	165876	<u>Kraal</u>	<u>10157</u>	nana
111	NCU	33790	<u>Browne</u>	<u>205</u>	nana
112	NCU	202005	<u>Radford</u>	<u>21368</u>	nana
113	NCU	257391	<u>Bradley</u>	<u>329</u>	nana
114	NCU	201438	<u>Bell</u>	<u>7683</u>	nana
115	NCU	68789	<u>Ashe</u>	<u>sn</u>	nana
116	NCU	68806	<u>Ashe</u>	<u>sn</u>	nana
117	NCU	231737	<u>Gabrielson</u>	<u>72</u>	nana
118	NCU	202007	<u>Ahles</u>	<u>10682</u>	nana
119	NCU	26088	<u>Smith</u>	<u>681</u>	nana

OTU no.	Herbarium of deposit	Herbarium accession no.	Collector	Collector no.	Taxon
120	NCU	26134	<u>Smith</u>	<u>737</u>	nana
121	NCU	68850	<u>Cocker</u>	<u>sn</u>	nana
122	NCU	201984	<u>Radford</u>	<u>21866</u>	nana
123	NCU	201429	<u>Terrell</u>	<u>2920</u>	nana
124	NCU	10802	<u>Harbison</u>	<u>sn</u>	nana
125	NCU	21861	<u>Stewart</u>	<u>953</u>	nana
126	NCU	68633	<u>Holland</u>	<u>sn</u>	nana
127	NCU	34474	<u>Bell</u>	<u>sn</u>	nana
128	NCU	68790	<u>Ashe</u>	<u>sn</u>	nana
129	NCU	68791	<u>Ashe</u>	<u>sn</u>	nana
130	NCU	68758	<u>sc</u>	<u>sn</u>	nana
131	NCU	68677	<u>Ashe</u>	<u>sn</u>	nana
132	NCU	201994	<u>Ahles</u>	<u>40382</u>	nana
133	NCU	447242	<u>Ellis</u>	<u>193</u>	nana
134	NCU	31820	<u>Bell</u>	<u>sn</u>	nana
135	NCU	9417	<u>Harbison</u>	<u>sn</u>	nana
136	NCU	68578	<u>Harbison</u>	<u>sn</u>	nana
137	NCU	68636	<u>Harbison</u>	<u>sn</u>	nana
138	NCU	68804	<u>Ashe</u>	<u>sn</u>	nana
139	NCU	68635	<u>Holmes</u>	<u>sn</u>	nana
140	NCU	68634	<u>Holmes</u>	<u>sn</u>	nana
141	NCU	68579	<u>Totten</u>	<u>sn</u>	nana
142	NCU	12711	<u>Harbison</u>	<u>1157</u>	nana
143	NCU	68638	<u>Ashe</u>	<u>sn</u>	nana
144	NCU	68786	<u>Ashe</u>	<u>sn</u>	nana
145	NCU	12660	<u>Harbison</u>	<u>1581</u>	rose
146	NCU	331651	<u>Radford</u>	<u>45460</u>	rose
147	NCU	425105	<u>Leonard</u>	<u>3179</u>	rose
148	NCU	202002	<u>Bell</u>	<u>6832</u>	rose
149	NCU	68628	<u>Leclair</u>	<u>sn</u>	rose
150	NCU	68576	<u>Leclair</u>	<u>sn</u>	rose
151	NCU	201463	<u>Bell</u>	<u>3554</u>	rose
152	NCU	201427	<u>Radford</u>	<u>11119</u>	rose
153	NCU	202000	<u>Bell</u>	<u>6490</u>	rose
154	NCU	15240	<u>Leclair</u>	<u>sn</u>	rose
155	NCU	68664	<u>Ashe</u>	<u>sn</u>	rose
156	NCU	12654	<u>Ashe</u>	<u>sn</u>	rose
157	NCU	68798	<u>Ashe</u>	<u>sn</u>	rose
158	NCU	68715	<u>Ashe</u>	<u>sn</u>	rose
159	NCU	68828	<u>Ashe</u>	<u>sn</u>	rose
160	NCU	68683	<u>Ashe</u>	<u>sn</u>	rose
161	NCU	68685	<u>Ashe</u>	<u>sn</u>	rose
162	NCU	68820	<u>Ashe</u>	<u>sn</u>	rose
163	NCU	12704	<u>Harbison</u>	<u>4206</u>	rose
164	NCU	12702	<u>Harbison</u>	<u>3270</u>	rose

OTU no.	Herbarium of deposit	Herbarium accession no.	Collector	Collector no.	Taxon
165	NCU	27523	<u>Ashe</u>	<u>sn</u>	rose
166	NCU	68800	<u>Ashe</u>	<u>sn</u>	rose
167	NCU	472069	<u>Boufford</u>	<u>16023</u>	rose
168	NCU	12733	<u>Harbison</u>	<u>4055</u>	rose
169	NCU	12698	<u>Boufford</u>	<u>16483</u>	rose
170	NCU	26084	<u>Smith</u>	<u>684</u>	rose
171	NCU	68696	<u>Philson</u>	<u>sn</u>	rose
172	NCU	473503	<u>McCurdy</u>	<u>395</u>	rose
173	NCU	398081	<u>Leonard</u>	<u>3179</u>	rose
174	NCU	457947	<u>Boufford</u>	<u>14254</u>	rose
175	NCU	201434	<u>Radford</u>	<u>34682</u>	rose
176	NCU	201998	<u>Radford</u>	<u>11924</u>	rose
177	NCU	68573	<u>Ashe</u>	<u>sn</u>	rose
178	NCU	201421	<u>Pitillo</u>	<u>405</u>	rose
179	NCU	389971	<u>Leonard</u>	<u>3166</u>	rose
180	NCU	384727	<u>Morton</u>	<u>43418</u>	rose
181	NCU	385000	<u>Morton</u>	<u>43418</u>	rose
182	NCU	308180	<u>Freer</u>	<u>5574</u>	rose
183	NCU	308476	<u>Freer</u>	<u>5581</u>	rose
184	NCU	27525	<u>Ashe</u>	<u>sn</u>	rose
185	NCU	12665	<u>Harbison</u>	<u>3252</u>	rose
186	NCU	27922	<u>Rehder</u>	<u>sn</u>	rose
187	NCU	68824	<u>Ashe</u>	<u>sn</u>	rose
188	NCU	247063	<u>Grimm</u>	<u>sn</u>	rose
189	NCU	201409	<u>Radford</u>	<u>11041</u>	rose
190	NCU	68799	<u>Ashe</u>	<u>sn</u>	rose
191	NCU	68682	<u>Ashe</u>	<u>sn</u>	rose
192	NCU	202003	<u>Bell</u>	<u>6832</u>	rose
193	NCU	27521	<u>Ashe</u>	<u>sn</u>	rose
194	NCU	27522	<u>Ashe</u>	<u>sn</u>	rose
195	NCU	68595	<u>Ashe</u>	<u>sn</u>	hart
196	NCU	68676	<u>Ashe</u>	<u>sn</u>	hart
197	NCU	12713	<u>Harbison</u>	<u>2620</u>	hart
198	NCU	425284	<u>Sargent</u>	<u>sn</u>	hart
199	NCU	417462	<u>Wofford</u>	<u>44959</u>	hart
200	NCU	68679	<u>Harbison</u>	<u>17830</u>	hart
201	NCU	9560	<u>Harbison</u>	<u>sn</u>	hart
202	NCU	12707	<u>Harbison</u>	<u>2618</u>	hart
203	NCU	68851	<u>Totten</u>	<u>sn</u>	hart
204	NCU	9558	<u>Totten</u>	<u>sn</u>	hart
205	NCU	201463	<u>Totten</u>	<u>sn</u>	hart
206	NCU	425283	<u>Sargent</u>	<u>sn</u>	hart
207	NCU	68678	<u>Ashe</u>	<u>sn</u>	hart
208	NCU	68593	<u>Ashe</u>	<u>sn</u>	hart
209	NCU	68591	<u>Ashe</u>	<u>sn</u>	hart

OTU no.	Herbarium of deposit	Herbarium accession no.	Collector	Collector no.	Taxon
210	NCU	68592	<u>Harbison</u>	<u>16457</u>	hart
211	NCU	201432	<u>sc</u>	<u>sn</u>	hart
212	NCU	68833	<u>sc</u>	<u>sn</u>	hart
213	NCU	12655	<u>Ashe</u>	<u>sn</u>	hart
214	NCU	432700	<u>Jones</u>	<u>20773</u>	hart
215	NCU	68853	<u>Ashe</u>	<u>sn</u>	hart
216	NCU	68752	<u>Necker</u>	<u>sn</u>	visc
217	NCU	11972	<u>Totten</u>	<u>sn</u>	visc
218	NCU	201462	<u>Freeman</u>	<u>58107</u>	visc
219	NCU	34438	<u>Bell</u>	<u>sn</u>	visc
220	NCU	239181	<u>Roszbach</u>	<u>3771</u>	visc
221	NCU	436613	<u>Boufford</u>	<u>6394</u>	visc
222	NCU	268811	<u>Wahl</u>	<u>20967</u>	visc
223	NCU	49890	<u>Bissell</u>	<u>618</u>	visc
224	NCU	201968	<u>Freeman</u>	<u>5858</u>	visc
225	NCU	486087	<u>Ahles</u>	<u>82623</u>	visc
226	NCU	340598	<u>Radford</u>	<u>22324</u>	visc
227	NCU	201460	<u>Radford</u>	<u>27147</u>	visc
228	NCU	201425	<u>Bell</u>	<u>7220</u>	visc
229	NCU	201461	<u>Ahles</u>	<u>42871</u>	visc
230	NCU	264291	<u>Ahles</u>	<u>59206</u>	visc
231	NCU	9736	<u>Ashe</u>	<u>sn</u>	fert
232	NCU	12736	<u>Ashe</u>	<u>sn</u>	fert
233	US	1889220	<u>Walker</u>	<u>1568</u>	fert
234	US	1337124	<u>Kelsey</u>	<u>1647</u>	hart
235	US	331614	<u>Biltmore</u>	<u>873b</u>	hart
236	US	24849	<u>Nash</u>	<u>sn</u>	visc
237	US	1337114	<u>Morong</u>	<u>349</u>	visc
238	US	773324	<u>Schrenk</u>	<u>sn</u>	visc
239	US	1337123	<u>Smith</u>	<u>144</u>	visc
240	US	137810	<u>Tweedy</u>	<u>sn</u>	visc
241	US	1337122	<u>Mertz</u>	<u>sn</u>	visc
242	US	1633626	<u>Muenschner</u>	<u>3409</u>	visc
243	US	1602317	<u>Gates</u>	<u>15281</u>	visc
244	US	1286249	<u>Weatherby</u>	<u>5183</u>	visc
245	US	280069	<u>Pearce</u>	<u>sn</u>	visc
246	US	310473	<u>Pollard</u>	<u>sn</u>	visc
247	US	1889217	<u>Walker</u>	<u>1562</u>	visc
248	US	2590265	<u>Blake</u>	<u>sn</u>	visc
249	US	2588301	<u>Chickering</u>	<u>sn</u>	visc
250	US	1807700	<u>Ehlers</u>	<u>3684</u>	visc
251	US	739021	<u>Wooton</u>	<u>sn</u>	rusb
252	US	739022	<u>Wooton</u>	<u>sn</u>	rusb
253	US	1221178	<u>Egglston</u>	<u>16819</u>	rusb
254	ISC	229220	<u>Isely</u>	<u>7294</u>	pseu

OTU no.	Herbarium of deposit	Herbarium accession no.	Collector	Collector no.	Taxon
255	ISC	227090	<u>Welsh</u>	1039	pseu
256	ISC	262035	<u>Isely</u>	10261	pseu
257	ISC	262105	<u>Isely</u>	10278	pseu
258	ISC	257299	<u>Isely</u>	9467	pseu
259	ISC	199253	<u>Moore</u>	10031	pseu
260	ISC	205280	<u>Sparling</u>	795	pseu
261	ISC	283663	<u>Welsh</u>	7037	pseu
262	ISC	230100	<u>Isely</u>	7696	pseu
263	ISC	260412	<u>Isely</u>	10045	pseu
264	ISC	260410	<u>Isely</u>	10179	pseu
265	ISC	325331	<u>Isely</u>	11292	pseu
266	ISC	48739	<u>Dewey</u>	197	pseu
267	ISC	227089	<u>Welsh</u>	962	pseu
268	ISC	331306	<u>Gates</u>	20247	pseu
269	ISC	331288	<u>Spalding</u>	sn	pseu
270	ISC	331334	<u>Horr</u>	3717	pseu
271	ISC	213986	<u>Wallis</u>	359	pseu
272	ISC	257373	<u>Isely</u>	9648	pseu
273	ISC	257374	<u>Isely</u>	9637	pseu
274	ISC	76969	<u>Summers</u>	sn	pseu
275	ISC	32196	<u>Broenlie</u>	20	pseu
276	ISC	256747	<u>Hall</u>	sn	pseu
277	ISC	235205	<u>Stratton</u>	2969	pseu
278	ISC	218833	<u>Isely</u>	6431	pseu
279	ISC	235853	<u>Isely</u>	8463	pseu
280	ISC	236012	<u>Isely</u>	8258	pseu
281	ISC	280577	<u>Mahler</u>	4809	pseu
282	ISC	280572	<u>Mahler</u>	4824	pseu
283	ISC	280569	<u>Mahler</u>	4822	pseu
284	ISC	272958	<u>Waddle</u>	70	pseu
285	ISC	235204	<u>Stratton</u>	3658	pseu
286	ISC	35396	<u>Combs</u>	sn	pseu
287	ISC	227603	<u>Stevens</u>	sn	pseu
288	ISC	230053	<u>Isely</u>	7682	pseu
289	ISC	227300	<u>Welsh</u>	819	pseu
290	ISC	229224	<u>Isely</u>	7281	pseu
291	ISC	259362	<u>Henderson</u>	65-96	pseu
292	ISC	346204	<u>Ahles</u>	79961	pseu
293	ISC		<u>Peabody</u>	2204	rusb
294	ISC		<u>Peabody</u>	2192	neom
295	ISC		<u>Peabody</u>	2192	neom
296	ISC		<u>Peabody</u>	2199	hart
297	ISC		<u>Peabody</u>	2169	pseu
298	ISC		<u>Peabody</u>	2119	pseu
299	ISC		<u>Peabody</u>	2156	hisp

OTU no.	Herbarium of deposit	Herbarium accession no.	Collector	Collector no.	Taxon
300	ISC		<u>Peabody</u>	<u>2155</u>	hisp
301	ISC		<u>Peabody</u>	<u>2154</u>	hisp
302	ISC		<u>Peabody</u>	<u>2153</u>	hisp
303	ISC		<u>Peabody</u>	<u>2120</u>	hisp
304	ISC		<u>Prabody</u>	<u>2097</u>	hisp
305	ISC		<u>Peabody</u>	<u>2203</u>	hisp
306	ISC		<u>Peabody</u>	<u>2164</u>	hisp
307	ISC		<u>Peabody</u>	<u>2163</u>	hisp
308	ISC		<u>Peabody</u>	<u>2162</u>	hisp
309	ISC		<u>Peabody</u>	<u>2203</u>	hisp
310	ISC		<u>Peabody</u>	<u>2198</u>	fert
311	ISC		<u>Peabody</u>	<u>2194</u>	fert
312	ISC		<u>Peabody</u>	<u>2203</u>	hisp
313	ISC		<u>Peabody</u>	<u>2145</u>	fert
314	ISC		<u>Peabody</u>	<u>2158</u>	visc
315	ISC		<u>Peabody</u>	<u>2166</u>	visc
316	ISC		<u>Peabody</u>	<u>2165</u>	visc
317	ISC		<u>Peabody</u>	<u>2160</u>	visc
318	ISC		<u>Peabody</u>	<u>2159</u>	visc
319	ISC		<u>Peabody</u>	<u>2197</u>	visc
320	ISC		<u>Peabody</u>	<u>2166</u>	visc
321	ISC		<u>Peabody</u>	<u>2165</u>	visc
322	ISC		<u>Peabody</u>	<u>2160</u>	visc
323	ISC		<u>Peabody</u>	<u>2159</u>	visc
324	ISC		<u>Peabody</u>	<u>2158</u>	visc