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INTRODUCTION

The Galegeae constitute a tribe of legumes whose members possess pinnately compound leaves with entire leaflets, and 10 stamens (usually diadelphous) with equal anthers. They lack the various specialized characters which are attributed to the other diadelphous tribes of the Leguminosae. Most of the genera are best represented in temperate regions. The members are of minor economic importance. A few are used as ornamentals or windbreak plantings (Caragana, Halimodendron, Robinia), others are secondarily important as weeds (Glycyrrhiza, Sesbania), and still others are poisonous plants of range land pastures (members of Astragalus and Oxytropis).

The tribe has been variously treated by North American students of the legumes. The introduced taxa have essentially been ignored. There has been much disagreement in the interpretations of native entities. Generic and specific delimitations have varied from author to author and many name changes have been proposed.

This study is an investigation of the taxonomy and biogeography of the Galegeae in the north-central states. In some aspects it is preliminary since a definitive solution of a number of problems will require detailed and lengthy investigations of individual species complexes. In general the treatment is concerned with plants at the species level, but in certain instances infraspecific taxa have been considered. The writer has attempted to present a consistent and orderly interpretation of the Galegeae of immediate usefulness to those concerned with problems of classification; he has likewise attempted to point the way for further studies.

The responsibility of a taxonomist to nomenclature is presumed to be secondary. Unfortunately, man-made problems sometimes approach the biological ones in complexity. An effort has been made to put the nomenclature (of the entities studied) in order, and this has indeed been one of the major endeavors of this study.

This paper is one of a series dealing with the legumes of the north-central states. Previous treatments were written by Isely and have dealt with the tribes Loteae and Trifolieae (1951), Hedysareae (1955), and the subfamilies Mimosoideae and Caesalpinoideae (1958).

HISTORICAL ACCOUNT

As here presented, the history of the Galegeae in our region is divided into three categories: exploration, compilation, and taxonomy. The
chronology of the three categories, of course, overlaps and all three types of investigation are being carried on at the present time. However, the exploratory phase of botanical research is basic to the development of those to follow and commonly precedes them by a number of years.

Exploration

A few of our species had been described by Linnaeus as early as 1753. These represented plants of wide distribution and most of them were collected adjacent to populated areas of the eastern United States and Canada. However, most of the members of the Galegeae which are native to our region remained unknown until after the turn of the nineteenth century.

The Lewis and Clark expedition (1804-1806), yielding Astragalus tenellus Pursh from the botanical collection, stands as the real starting point for the exploration of the Galegeae in the north-central states. More important, this epic journey acted as a stimulus for further work. During 1810 and 1811 Thomas Nuttall and John Bradbury collected along the upper Missouri. Among their finds were such species as Astragalus ceramicus (Psoralea longifolia), A. crassicarpus, A. gilviflorus (A. triphyllum), A. missouriensis, A. gracilis (Dalea parviflora), and Oxytropis lambertii. In 1819 Nuttall journeyed from Philadelphia to the "Arkansas" region. There "on the Plains of the Arkansas" he collected Astragalus trichocalyx. Later Nuttall accompanied the Weyeth expedition to the Pacific Northwest. He was thus enabled to traverse the north-central states and to collect a number of previously undescribed species, among them were Oxytropis multiceps, Q. sericea, O. viscida, Astragalus plattensis, A. spatulatus (Homalobus caespitosus), A. tegetarius (Kentrophyta montana), and A. striatus.

Meanwhile, botanical exploration was under way in Canada and in the Pacific Northwest. Species whose ranges extended from those regions into the north-central states were being discovered and described. Dr. John Richardson and Mr. Drummond accompanied Sir John Franklin on his journey to the Polar Sea in search for a northwest passage during the years 1819-1821 and again from 1823-1825. They collected Astragalus aboriginorum, A. bisulcatus (Phaca bisulcata), A. lotiflorus, and A. vexilliflexus (A. pauciflorus). David Douglas collected in the Pacific Northwest during 1825 and 1826 and then traversed the continent to Hudson Bay. The Douglas collections yielded such species as Astragalus agrestis, A. drummondii, A. flexuosus, A. pectinatus, and A. purshii.

In 1839 C.A. Geyer, who traveled with the Nicollet expedition, collected plants in the region of St. Louis and northward to North Dakota. By that time most of the plants belonging to the Galegeae of the region had already been described.

With a few exceptions the period of exploration now entered a second phase which has continued to the present time; that of establishing the geographic distribution and variability of the species discovered and described by others.

During the 1850's and 60's the collections of Hayden, Suckley, Donelson, Mullan, Hall and Harbour, and Parry added to the general botanical
knowledge of the region. Other individuals were at work in more specific areas in the various states.

Towards the end of the nineteenth century, there was renewed activity in collecting and in the quest for botanical knowledge. This activity has continued to the present. It is beyond the scope of the present study to list the names of all students who have contributed to this phase of plant taxonomy. However, an attempt will be made to enumerate those whose efforts have been especially outstanding. O.A. Stevens has studied the flora of North Dakota for fifty years. His excellent specimens are deposited in the herbarium of the U.S. National Museum and in the herbarium of the North Dakota State Agricultural College. W.H. Over, a naturalist from South Dakota, has contributed much to the floristic knowledge of that state. Perhaps the most complete collection of the Nebraska members of the Galegeae is that of J.M. Bates, an amateur botanist who collected widely over that state for many years. His specimens are largely deposited in the herbarium of the University of Nebraska State Museum. E.J. Palmer, J.A. Steyermark, B.F. Bush, and others have contributed enormous numbers of plant specimens from the state of Missouri. In Iowa the collections of B. Shimek, L.H. Pammel, and A. Hayden are among the most important. E.P. Sheldon and J.W. Moore have worked extensively in Minnesota. In Wisconsin N.C. Fassett added much to the knowledge of legumes.

Thus, botanical exploration has persisted to the present time, and with much information still to be gained it will remain an important phase of botany in the future.

Compilation

The compilative phase of botany follows the work of the collector. In 1814 Pursh published the *Flora Americae Septentrionalias* which contains the original descriptions of many species of plants native to the north-central states. The *Genera of North American Plants* (1818) by Nuttall reviews the treatment of Pursh and contains a few original descriptions. The *Flora Boreali-Americana* (Vol. 1, 1829-1834) by Hooker contains many new species based largely on the collections of Richardson, Drummond, and Douglas. Torrey and Gray's *Flora of North America* (1838) possibly contains more original descriptions of the galeaceous plants of the north-central states than any other single publication. Most of the species are based on materials collected by Nuttall.

Subsequent to the pioneer compilations discussed above many other publications have appeared in which the north-central states legumes have been treated. These may be classified into three categories on the basis of their scope; regional floras, state and local floras and checklists, and treatments of legumes specifically. Among the former are the works by Eaton and Wright (1840), Gray (Manual of Botany, 1848 to 1950 in eight editions and under various authors), Britton and Brown (1897), Britton (1901, 1905), Rydberg (1932), Sargent (1933), Bailey (1949), Rehder (1951) and Gleason (1952).

The regional floras are exceeded in numbers by the local and state floras and lists. Outstanding among these are MacMillan (1892), Britton et al. (1894), Rydberg (1895, 1896), Beal (1904), Peterson (1923), McIntosh
STANLEY LARSON WELSH

(1931), Over (1932), Palmer and Steyermark (1935), Winter (1936), Deam (1940), Gates (1940), Jones (1945), Moore and Tryon (1946), and Jones and Fuller (1955).

The Leguminosae have been treated separately in three states; in Wisconsin by Fassett (1939), in Iowa by Fox (1945), and in Illinois by Gambill (1953).

Taxonomy

The nature of the work involved in the preparation of revisionary or monographic treatments is dependent upon the previous exploratory and compilative phases of botanical investigation. The first major taxonomic treatment of the Galegeae in North America is Gray's revision of Astragalus and Oxytropis (1864). Other important works on Astragalus include those by Watson (1871), Sheldon (1894), MacBride (1922), Jones (1923), Rydberg (1929b), Porter (1939), and Barneby (1947a, 1947b, 1947c). Important works on Oxytropis include the revisions by Gray (1884) and Barneby (1952). The genus Tephrosia has been treated by Vail (1895), Britten and Baker (1900), and Wood (1949). Caragana was monographed by Komarov (1908). Robinia, Sesbania, and other genera of the Galegeae of North America were treated in Vol. 24 of the North American Flora by Rydberg (1924-1929).

Data from many other papers are reviewed with respect to the treatment of individual taxa.

MATERIALS AND METHODS

Taxonomic Investigations

Herbarium studies

Studies of herbarium material have formed the central core of the present work. Approximately ten thousand specimens were examined. The objectives of these investigations were: (1) to interpret better the taxonomic entities and the variability in constituent groups; (2) to provide accurate and consistent descriptions of the taxa; (3) to view the distribution of the taxa within the north-central states (in some cases to verify or reject previous reports of occurrence in this region); (4) to attempt to derive information on habitat and other useful data as the labels allowed.

The employment of herbarium material obviously possesses limitations as compared to field observations. In consequence, herbarium investigations have been supplemented by field studies as related below. Notwithstanding, field work is no substitute for thoroughgoing herbarium investigations. When one assembles hundreds of specimens (drawing on the field work of all previous investigators) from all parts of the range of a taxon, it is possible to obtain a picture of phenotypic and geographical characteristics that could be paralleled only by a life-time of field studies. Hence, this explains the emphasis on the laboratory phases of this investigation.

In the course of the herbarium examinations taxonomic criteria relating to size and shape were evaluated through measurements of plant
structures; features not easily subject to linear comparisons were subjected to critical examination. Parts less than 10 mm long were measured with the aid of a Spencer low-power binocular microscope equipped with 1X, 2X, and 3X objectives and 9X wide field oculars. One ocular was furnished with a micrometer disc which had been calibrated with a stage micrometer. All other measurements were made with an ordinary 30 cm rule graduated in millimeters.

Measurements of flowers were made from the base of the calyx to the tip of the banner, or to the tip of the wings if they exceeded the banner. Pod length was determined from the point of insertion within the calyx to the apex of the pod. The length of the stipe (where present) was included in the pod measurements, but the style length was excluded. The calyx tube length was assayed from the point of insertion of the pedicel to the base of the sinus between the teeth and the calyx teeth were measured from the base of the sinus to the tip of the dentation.

The information on collection locality was recorded for each herbarium sheet examined. Where only towns were designated, their county locations were checked either on state highway maps or in the Hammond World Atlas. The distribution of each species was plotted on U.S. Department of Agriculture base maps on which the counties were outlined in blue ink.

When habitat data or information on the habit, flower color, or other peculiarities of a specimen was tabulated on the label, the information was recorded. These data were used in association with that derived from earlier publications and field experience to characterize as closely as possible the habitat, growth characteristics, etc., of each species.

The herbaria consulted during the course of this study are listed below. Preceding each is a key letter or letters by which the institution is identified. The key letters are the standardized abbreviations given by Lanjouw and Stafleu (1959).

F  Chicago Natural History Museum  
GH  Gray Herbarium, Harvard University  
ISC  Iowa State University  
K  Royal Botanic Gardens, Kew  
MICH  University of Michigan  
MIN  University of Minnesota  
MO  Missouri Botanical Garden  
NDA  North Dakota Agricultural College  
NEB  University of Nebraska State Museum  
NY  New York Botanical Garden  
OXF  Fielding Herbarium, Oxford  
PH  Academy of Natural Sciences, Philadelphia  
RM  Rocky Mountain Herbarium, University of Wyoming  
RSA  Rancho Santa Ana Botanic Garden  
SDU  University of South Dakota  
WS  State College of Washington

Since the present study includes the cultivated plants in addition to those which are native, a special effort was made to examine pertinent herbarium material. The search was disappointing because botanists
have generally concerned themselves with native plants or with escaped, cultivated forms.

Field studies

Investigations were carried out in the field during May, June, and July of 1958 and during April, May, and June of 1959. During the 1958 season collections were made in Iowa, Kansas, Nebraska, South Dakota, North Dakota, and Minnesota. The states of Nebraska, South Dakota, North Dakota, and Minnesota were revisited during the 1959 season, and additional trips were made to Missouri and Illinois. Herbarium specimens were prepared from field material. The plants were dried in presses suspended over electric drying units. The specimens are deposited in the herbarium of Iowa State University.

During the course of the field work it was possible to study living material of the majority (37 of 49) of the species of the north-central states Galegeae. Notes were taken especially on those features which are difficult to determine from dried materials. For example, the flower color, which tends to change on drying, was recorded. Likewise, consideration was given to stature, habitat, and population and geographic variability.

Special emphasis was placed on the collection of cultivated plants. Residential landscape plantings, city parks and gardens, and wind-break and hedge plantings were visited on every possible occasion. This resulted in many additional specimens of cultivated legumes and considerable data concerning their distribution and variability.

Nomenclatural Investigations

In order to present a consistent and usable treatment for subsequent students, the author has attempted to determine the correctness of name usage of all taxa studied and to list correctly assigned synonyms. The original descriptions of all names (both names employed and synonyms) have been seen except: (1) those names in Caragana and Halimodendron in which the literature was unavailable; (2) certain horticultural variants of Robinia (forms, varieties, and a few "species"). With respect to the exceptions noted above the names not verified by the writer have been indicated by the term "fide" followed by the name of the author whose treatment has been followed.

As far as available, type specimens or photographs of type material have been studied to verify interpretation from descriptions. Examination of such material has been indicated by an asterisk (*) preceding the name. Types of several species have been studied by previous workers. In those instances in which verification is based upon the interpretation of previous authors the name is indicated by "fide" followed by the author's name.

Varietal and other infraspecific synonyms are included in most species. However, in some Astragali and Oxytropi in which the number of synonyms is large, the synonymy is restricted to the entities occurring in the north-central states.
Herbs, shrubs or trees. Leaves stipulate, odd-pinnate or even-pinnate, rarely palmately trifoliolate or simple; stipels present or lacking; leaflets entire. Inflorescence monopodial, of axillary racemes or rarely sympodial (Tephrosia). Calyx campanulate, cylindric, or turbinate, 5-toothed or 5-lobed. Corolla papilionaceous, pink-purple, yellow, ochroleucous, or whitish. Stamens 10, diadelphous (in ours), the anthers alike. Pods variously shaped, usually dehiscent.

The Galegeae, one of the major tribes of the Leguminosae, consists of some 50 to 60 genera of plants of wide geographic distribution. The greater number of the genera are comprised of temperate plants; a few are best represented in tropical and subtropical regions. Approximately 30 genera and 500 species occur in North America. Of these, 8 genera and 49 species are known from the north-central states.

The Galegeae represent more or less generalized legumes which lack the specialized characters of some of the other tribes. Many of the genera have been assigned to this group only on a negative basis—i.e. because they lack the definitive features which would associate them with any of the more clearly defined tribes. The group possibly contains several phyletic lines and is therefore difficult to define concisely.

Such genera as Astragalus, Oxytropis, Caragana, Halimodendron, and Robinia seem to constitute a natural group, at least morphologically, and possibly in an evolutionary sense. The other genera present in the north-central states (Tephrosia, Glycyrrhiza, Sesbania) appear to represent different phyletic lines. They are probably not closely related to each other or to the genera discussed above. Tephrosia, with its collar- or cup-shaped receptacle at the base of the ovary within the staminal sheath, would possibly be better included in the Phaseoleae. However, since most of the members of the Phaseoleae tend to be woody climbers, Tephrosia is herein retained with the Galegeae. The glandular punctate condition of the herbage of Glycyrrhiza and its indehiscent pods might indicate an affinity with the members of the Psoraleae. However, the pods of Glycyrrhiza are many-seeded as opposed to the usually one-seeded pods of the Psoraleae; again it seems too early to break with tradition. The partitioned pods of Sesbania may demonstrate affinities with some of the Hedysareae, a group with a single specific character (the loment), which may have been derived from several phyletic lines.

The term Galegeae, as herein employed, contains those genera traditionally ascribed to it with the exception of Wisteria. The presence of the collar- or cup-shaped receptacle at the base of the ovary within the staminal sheath in conjunction with the woody, twining habit of the members of this genus suggest a closer relationship with the Phaseoleae.

Because of the limited number of species and genera present within the bounds of the region covered by this paper it is not feasible to evaluate generic relationships and delimitations.
Key to the Genera

1. Leaves even-pinnate.
   2. Plants perennials, shrubs or small trees; leaflets 4-12.
      3. Leaflets 4, remote; inflorescence 1- to 3-flowered; flowers pink-purple; pods inflated, stipitate. Halimodendron
      3. Leaflets 4-12 (if 4 then fascicled); inflorescence 1-flowered; flowers yellow; pods linear, sessile. Caragana

1. Leaves odd-pinnate.
   2. Plants annual, herbaceous; leaflets 24-70. Sesbania
   4. Plants woody, shrubs or trees.
      4. Plants herbaceous.
         5. Racemes terminal; if also lateral, then arising opposite the leaves. Tephrosia
         5. Racemes axillary.
            6. Foliage glandular-punctate; pods covered with hooked spines. Glycyrrhiza
            6. Foliage not glandular-punctate; pods glabrous or merely pubescent.
               7. Keel-tip extended as a beak; pods with the upper (ventral) suture intruded; plants scapose. Oxytropis
               7. Keel-tip blunt; pods with sutures various; plants usually not scapose. Astragalus

Astragalus L.

ASTRAGALUS L.
Plants herbaceous, perennial (in ours), caulescent or acaulescent, ascending to erect, decumbent, or prostrate and mat-forming. Stipules connate or free, ovate to lanceolate or triangular-subulate. Leaves alternate, odd-pinnate, 5-plurifoliolate, rarely palmately, trifoliolate or simple; leaflets opposite or scattered, entire. Racemes axillary, sessile to long pedunculate, elongate or spike-like or congested and subcapitate. Flowers papilionaceous, the keel lacking a beak; stamens diadelphous. Calyx cylindric to campanulate, 5-toothed. Pods sessile or stipitate, straight or curved, variously compressed or inflated, papery, woody, or fleshy, dehiscent or indehiscent, glabrous or hairy, 1-celled, partially 2-celled, or completely 2-celled by the intrusion of the dorsal (lower) suture; both sutures prominent or the dorsal suture sulcate or both sutures sulcate.

The Astragali of the north-central states represent only a small part of a great complex which may contain as many as 1200 species. In North America the main body of the genus occurs in the southwestern part of the United States. The species which inhabit the plains and prairies appear largely to represent outliers of the genus from western North America. Perhaps a few may be regarded as relics of a wider distribution in the past. None of the species are endemic to our region.

Classification
The genus Astragalus, with its diversity of forms, has been the subject of many investigations since the time of Linnaeus. It has been divided into numerous segregates by various authors. The most recent and comprehensive segregation is that of Rydberg (1929b) in the North American Flora. This work culminated more than three decades of publication and study by that author. It includes no less than 33 genera. More recent authors such as Porter (1939, 1945, 1951, 1954) and Barneby (1944, 1946, 1947a, 1947b, 1947c, 1951a, 1951b, 1956a, 1956b) have retained all of these segregates in the genus Astragalus.

However, if the Astragalus complex is to be regarded as a single genus it is desirable to divide it into sections to facilitate classification and as a method of postulating phylogenetic groups. The sections are then, to the extent that knowledge permits, comprised of related species. The authors of all major systems of classification (other than those following Rydberg) have recognized sectional names in Astragalus. Although there has been disagreement on the names of the sections and on the disposition of individual species there has been considerable consistency in the delimitation of the groups.

The generic segregates of Rydberg (as discussed above) largely correspond to the sectional delimitations as interpreted by Marcus Jones (1923) and Gray (1864). The species of Astragalus present in our region would be placed in 15 sections in Jones's system, 17 sections in Gray's system, and 15 segregate genera in Rydberg's system. Porter (1951) has used the Rydbergian generic names in the role of subgenera. Barneby, in his revisions of several sections, has followed the treatment of Jones.

The writer essentially follows Jones, not with a feeling that his work is complete, but because of the geographic limitations of the present study, his treatment seems to place north-central states species in more natural groups.
The following is a summary of the present treatment. Where the writer has disagreed with the interpretations of Jones, special note is made. Rydberg segregates are placed in parentheses () following the section name.

Homalobi (Homalobus, Kentrophyta): Plants of various vegetative aspects; mat-forming, decumbent, or erect. Flowers small; calyx campanulate. Pods 1-celled, straight, laterally compressed, dehiscent; the valves coiling in dehiscence. e.g. *A. tenellus*, *A. spatulatus*, *A. vexilliflexus*, *A. tetraspermus*. Jones included *A. sericoleucous* in the Homalobi. However, its affinities appear to be with the Triphylli and it is included in that group in the present paper.


Inflati (Phaca pro parte): Plants erect to prostrate; leaflets linear. Pods stipitate, much inflated, membranous, mottled. e.g. *A. ceramicus*.

Alpini (Atelophragma, Phaca pro parte): Plants decumbent to ascending or erect. Flowers small to moderate in size. Pods stipitate, 1-celled, spreading or pendulous; the sutures variously produced or inflexed as a partial partition. e.g. *A. alpinus*, *A. americanus*, *A. aboriginorum*.

Podo-sclerocarpi (Cnemidophacos): Plants erect or ascending. Leaflets linear. Pods 1-celled, sessile, fleshy, becoming woody at maturity, dehiscent. e.g. *A. pectinatus*.

Uliginosi (Astragalus pro parte, Phaca pro parte): Plants erect or ascending. Flowers of moderate size, yellowish; calyx cylindric or short-cylindric. Pods various in shape and septation, sessile, fastigate, tardily dehiscent. e.g. *A. canadensis*, *A. cooperi*. The retention of *A. cooperi* with the Uliginosi is largely a matter of convenience. It may well represent a distinct section.

Hypoglottides (Astragalus pro parte): Plants decumbent to erect. Flowers erect in subcapitate racemes. Pods 2-celled, erect, tardily dehiscent. e.g. *A. striatus*, *A. agrestis*.

Lotiflori (Batidophaca): Plants caespitose; stems poorly developed. Flowers variously colored; calyx campanulate. Pods 1-celled, ovoid-lanceolate; both sutures prominent, the ventral one acute, the dorsal flattened, tardily dehiscent. e.g. *A. lotiflorus*.

Flexuosi (Pisophaca, Microlobus): Plants decumbent to erect. Flowers small, purplish; calyx campanulate. Pods sessile, 1-celled, dorsally compressed, both sutures prominent. e.g. *A. flexuosus*, *A. gracilis*.

Agrophylli (Xylophacos): Plants caespitose, acaulescent. Leaves plurifoliolate. Flowers moderate to large; purplish or yellowish; calyx cylindric. Pods 1-celled, ovoid to oblong, dehiscent or tardily so. e.g. *A. missouriensis*, *A. purshii*.

Mollissimi (Astragalus pro parte): Plants caespitose; stems short. Flowers large, greenish-purple, calyx cylindric. Pods sessile, 2-celled, oblong, curved, dehiscent. e.g. *A. mollissimus*.

Sarcocarpi (Geoprunnon): Plants caespitose, decumbent to ascending,
Flowers large, purplish or yellowish; calyx cylindric. Pods sessile or sub sessile, 2-celled, fleshy, ovoid to ovoid-lanceolate, indehiscent. e.g. *A. crasscarpus*, *A. plattensis*, *A. tennesseensis*, *A. trichocalyx*.

**Bisulcati** (**Diholcos**): Plants caespitose, ascending to erect. Flowers moderate in size, purplish (rarely other colors); calyx short-cylindric. Pods stipitate, 1-celled, oblong, with two longitudinal furrows on the ventral surface, e.g. *A. bisulcatus*.

**Galegiformes** (**Tium**): Plants caespitose; ascending to erect. Flowers moderate in size, yellowish; calyx cylindric. Pods stipitate, 1-celled, oblong, triquetrous in cross-section. e.g. *A. racemosus*, *A. drummondii*.

**Hamosi** (**Holcophacos**): Plants caespitose; decumbent to erect. Flowers small, purplish; calyx campanulate. Pods sessile, 1-celled (in ours), oblong, curved. e.g. *A. distortus*. Rydberg also recognized a genus *Hamosa* but excluded *A. distortus* from it on the basis of the 1-celled pods of *A. distortus*.

**Taxonomic criteria**

The stature or habit of growth, leaflet number and form, vesture, shape and mode of attachment of stipules, and the nature of the underground parts are the most useful of the vegetative characteristics. The correlation of several vegetative specializations in the same species or species-group facilitates identification. For example, the acaulescent nature of the Triphylli is associated with the palmately trifoliolate leaves and malpighian pubescence. However, more generalized astragali frequently lack specific vegetative characters and other features must be employed for their identification.

The vegetative features of the species of Astragalus herein treated have been characterized more thoroughly than in most previous studies. As far as possible, vegetative characters have been employed as major diagnostic criteria, particularly in the key. In many instances, however, it has been necessary to fall back upon floral and fruit structure.

Calyces of two main types occur in our plants. The tube of a cylindric calyx commonly possesses parallel sides. The so-called campanulate calyx tapers from the end of the tube to the pedicel. Short calyces are frequently campanulate and the longer ones are cylindric. Frequently all the members of a given section will be either cylindric or campanulate, but in a few instances (e.g. Triphylli) both calyx types are present.

Flower color is a good diagnostic character for the separation of plants in living condition. However, it is of limited usefulness in the examination of dried specimens since the differential shades are frequently impossible to distinguish. The keel-tip occasionally fades so that it is not possible to recognize whether it is maculate or immaculate, but this part commonly retains some shade of color even though the remainder of the flower is completely faded.

The vesture of the herbage (or more rarely of the pods and petals) consists of two types. The most common form is that of simple, basally attached trichomes. The second type consists of hairs which are pointed at both ends and attached between the two points (malpighian or dolabri-form trichomes). Of the several species having malpighian hairs only those of *A. racemosus* are difficult to detect, because in that species the attachment of the hair is very near to one end.
The pods of *Astragalus* are diverse and they have constituted the principal feature on which systems of classification and keys for identification have ordinarily been based. The most distinctive pod characters are the degree of septation, the over-all shape, and the cross-sectional form. The presence or absence of a stipe and the vesture of the pods are secondary characters which are valuable in distinguishing individual species. The texture of the valves is difficult to define on an objective basis. A reasonably precise interpretation of terminology may, however, be achieved by comparison of different types of pods. Cross-sectional shape, a principal feature of some keys, is often difficult to determine in pressed specimens, especially if the pods are immature.

**Phylogeny**

The circumboreal distribution of *Astragalus*, plus the presence of a number of species in South America would seem to indicate that the genus is not of recent origin. Its distribution in the northern hemisphere, with population centers in the arid regions, can perhaps be rendered logical by relating it to events of the geologic past. It is possible that *Astragalus* was a component of the transboreal Arcto-Tertiary forest. With the change of climatic conditions the range of the forest elements shrank toward more equable regions. However, certain of the Astragali possibly became stranded in the arid regions where they have since become well established.

*Astragalus* appears to be closely related to *Oxytropis* and the two genera probably arose from common ancestral stock. They seem to have had a parallel development and some forms are strikingly similar.

There is a remarkable resemblance between the spiny, woody Astragali and members of *Caragana*. In the former, the leaf rachis may be persistent and the terminal leaflet reduced to a spine as in many species of *Caragana*. However, the vast majority of the Astragali are herbaceous; the leaf rachis is deciduous, and the terminal leaflet is very much evident. Thus, the woody forms have probably been secondarily derived and their similarity to *Caragana* is merely an example of parallel evolution. This does not rule out the possibility that the genera *Astragalus* and *Caragana* (and *Halimodendron*) have descended from some common ancestral prototype.

Evolution within *Astragalus* appears to have taken place in several directions. The most perceptible modifications have taken place in the pods, but vegetative specializations are apparent in several lines. In some cases the pods have remained more or less stable and the vegetative parts have become greatly modified. The converse may also be true. Sections such as the Galegiformes and the Bisulcati appear to be closely related. They differ primarily in pod structure.

The hypothetical primitive ancestor of modern *Astragalus* probably had several of the following characters; (1) plant body decumbent to erect with well developed stems; (2) leaves plurifoliolate; (3) leaflets oblong to oval or elliptic; (4) stipules connate; (5) racemes elongate and many-flowered; (6) flowers small and with campanulate calyces; (7) pods 1-celled, sessile, straight, laterally compressed, and dehiscent.

Vegetative characters and pod characters seem to have evolved more or less independently. The most radical vegetative modifications
acaulescence, reduction of leaflet number, densely villous to lanose or densely strigose pubescence) appear to have evolved in response to their selective advantage in specialized habitats. Mat-forming plants occur in two different sections of north-central states Astragali (Triphylli, Homalobi). The species involved in these instances occupy more open or barren areas in the drier, upland prairie regions of the western part of our range. Other specializations are present in the Inflati and Pectinati in which the leaflets are long and linear.

The presence (among species) of common pod characters is possibly the best indication of relationships (though not infallibly so) in Astragalus. There are many combinations of pod characters possible and the probability of any given combination arising more than once seems slight. If this is the case then plants bearing similar pod-types are related and the closer the similarity the nearer the relationship.

Cytology
The various cytological studies in Astragalus indicate that the chromosome number is multibasic (Head 1955, Vilkomerson 1943, Ledingham 1957). In the north-central states Astragali, chromosome counts have been reported for fourteen species. The somatic number in three species is 16, in one species 32, in six species 22, and in four species 24; thus indicating the basic numbers of 8, 11, and 12.

Key to the Species of Astragalus

1. Leaves trifoliolate.
   2. Calyx cylindric; flowers whitish; inflorescence sessile.
      3. Corolla glabrous; plants flowering in May and early June. A. gilviflorus
      3. Corolla strigose; plants flowering in late June and July. A. hyalinus
   2. Calyx campanulate; flowers pink-purple, inflorescence pedunculate.
      4. Stipules villous; flowers 6-8 mm long. A. sericoleucus
      4. Stipules glabrous; flowers 9-13 mm long. A. barii

1. Leaves not trifoliolate, usually with 5-many leaflets.
   5. Leaflets spinulose-tipped; plants mat-forming. A. tegetarius
   5. Leaflets not spinulose-tipped; plants various in habit.
   6. Leaves simple, unifoliolate, or rarely some of them trifoliolate.
      7. Leaves long-filiform, at least the upper reduced to linear phyllodia; plants from a rhizome; pods inflated and purple-mottled at maturity. A. ceramicus
      7. Leaves narrowly spatulate; plants acaulescent from a branching caudex; pods narrowly oblong. A. spatulatus
   6. Leaves pinnately compound with 5-many leaflets.
   8. Vesture consisting of malpighian hairs.
      9. Plants caespitose, low-growing; stems poorly developed.
         10. Calyx campanulate; plants strigose to long-villous, greenish; flowers usually yellowish. A. lotiflorus
10. Calyx cylindric; plants silvery with appressed hairs; flowers purplish. *A. missouriensis*

9. Plants decumbent to erect; stems well developed.

11. Pods or ovaries distinctly stipitate; plants with a distinctive odor. *A. racemosus*

11. Pods or ovaries sessile; plants lacking a distinctive odor.

12. Flowers purplish; pods or ovaries strigose; plants blooming from late May to early July. *A. striatus*

12. Flowers yellowish; pods or ovaries glabrous; plants blooming from mid-July to September. *A. canadensis*

8. Vesture consisting of basally attached trichomes.

13. Calyx cylindric.

14. Plants pulvinately caespitose; pods and herbage densely woolly-villous. *A. purshii*

14. Plants not pulvinately caespitose; pods and herbage various but not densely woolly-villous.

15. Pods and ovaries distinctly long-stipitate; pods reflexed.

16. Flowers purplish; pods bisulcate ventrally. *A. bisulcatus*

16. Flowers whitish or yellowish; pods triquetrous in cross-section.

17. Herbage loosely long-villous; plants lacking a distinctive odor. *A. drummondii*

17. Herbage strigose; plants with a distinctive odor. *A. racemosus*

15. Pods or ovaries sessile (rarely substipitate), usually not reflexed.

18. Flowers purplish; plants from a rhizome or caudex; calyx strigose or strigulose.

19. Plants long-villous throughout; pods curved, glabrous. *A. mollissimus*

19. Plants strigose to strigulose throughout; pods various, usually not curved.

20. Plants from a rhizome; calyx-teeth half as long as the tube; pods and ovaries pubescent.

21. Flowers erect; pods long-villous, oblong. *A. agrestis*

21. Flowers spreading; pods strigose, ovoid. *A. plattensis*

20. Plants from a caudex; calyx-teeth less than half as long as the tube; pods glabrous. *A. crassicarpus*

18. Flowers yellowish; the keel usually purple-tipped, calyx long-villous or lanose (strigulose in *A. pectinatus*); plants from a caudex.

22. Leaflets linear; plants from the western plains. *A. pectinatus*

22. Leaflets various but not linear; plants from Missouri, Illinois, or southeastern Kansas.
23. Plants villous; stipules foliaceous; pods villous.  
A. tennesseensis
A. trichocalyx

13. Calyx campanulate.

24. Stipules reflexed, foliaceous; plants in our area localized in the Black Hills.  
A. americanus

24. Stipules erect or spreading, not foliaceous; plants variously distributed.

25. Pods or ovaries distinctly stipitate (the stalk 1 mm or more in length).

26. Plants from a creeping rhizome; pods black-villous at maturity.  
A. alpinus

26. Plants from a caudex; pods glabrous at maturity or merely strigose.

27. Leaflets narrowly elliptic, acute; pods lunate; stipe at maturity 5-10 mm long.  
A. aboriginorum

27. Leaflets elliptic to oblong; obtuse, truncate or retuse (rarely acute); pods various; stipe 1-5 mm long.

28. Peduncles 1-4 cm long (occasionally borne in pairs), shorter than the raceme; flowers yellowish.  
A. tenellus

28. Peduncles 5-15 cm long (borne singly), seldom shorter than the racemes; flowers purplish.  
A. flexuosus

25. Pods or ovaries sessile within the calyx.

29. Flowers whitish or yellowish; pods ovoid-inflated; plants from Minnesota, Wisconsin, and Michigan.  
A. cooperi

29. Flowers usually purplish; pods linear-oblong, oblong, or boat-shaped; plants various in distribution.

30. Leaflets 17-27; pods 15-20 mm long, curved; dorsal suture sulcate; plants of eastern Kansas, Missouri, Iowa, and Illinois.  
A. distortus

30. Leaflets 7-17; pods 5-11 mm long, straight or boat-shaped; plants of the western great plains.

31. Calyx-teeth less than 1 mm in length; pods boat-shaped due to the inflection of the dorsal suture.  
A. gracilis

31. Calyx-teeth more than 1 mm in length; pods straight; both sutures prominent.  
A. vexilliflexus

Astragalus aboriginorum Richards. (Map 6. Plate I, Figs. A, B)

Phaca aboriginorum (Richards.) Hook. Fl. Bor. Am. 1:143. pl. 56. 1830.
Astragalus vaginatus sensu authors, non A. vaginatus Pallas. 1880.
*Astragalus glabriusculus (Hook.) A. Gray var. major A. Gray Proc. Acad. Phila. 1863:60. 1864.
Tragacantha aboriginum (Richards.) Kuntze Rev. Gen. 942. 1891.
Tragacantha glabriuscula (Hook.) Kuntze Rev. Gen. 945. 1891.
Homalobus spaciosus (Sheld.) A. Heller. Cat. N. Am. Pl. ed. 2. 7. 1900.
Homalobus aboriginum (Richards.) Rydb. ex Britton, Man. 554. 1901.
Astragalus aboriginum var. fastigorum M. E. Jones Rev. Astrag. 135. 1923.

Stems 14-40 cm long, single to several from a branching caudex, erect or ascending, strigose to villous with simple hairs. Stipules 4-10 mm long, the lower ones connate-clasping, those above nearly free, the free ends triangular to lanceolate, strigose on the dorsal surface, acute. Leaves 3-8 cm long, short-pedicellate; leaflets 9-19, 9-23 (34) mm in length, 2-7 mm in width, glabrous to strigose above, strigose to villous below, narrowly elliptic, acute. Peduncles (2) 6-9 (15) cm, strigose. Bracts narrowly lanceolate, longer than the pedicels, strigose with black hairs. Racemes 2-11 cm, several-flowered, at first much contracted, elongating at maturity. Flowers 8-11 mm long, yellowish white, the keel purple-tipped. Calyx campanulate, strigose with black, simple hairs; tube 3-4 mm; teeth 1.5-4 mm, linear subulate. Pods 24-34 mm, lunate, papery, glabrous (rarely strigose when young), 1-celled, dehiscent; both sutures prominent; stipe 5-10 mm in length.

Astragalus glabriusculus, A. forwoodii, and Atelophragma wallowense are based on pubescence variants. However, the degree and position of pubescence is variable and many types occur in a single population. Indeed, plants with the pubescence characteristics of several of the segregates have been observed by the writer in a population on a single hillside near Spearfish, South Dakota. It is thus possible that the maintenance of those segregates, in any sense, is not justified. One is also led to suspect the validity of both A. lineare and A. heriotii which Rydberg (1928a) describes as differing largely in pubescence and leaflet shape.
As only a fraction of the total range of this complex is included in the north-central states it is beyond the scope of this paper to present a definitive analysis of the many segregates.

The pods of *A. aboriginorum* are commonly glabrous. However, it is not uncommon for plants outside our range to bear strigose pods. Pubescent pods were noted by the writer in a single specimen from our region. The specimen was collected on the bank of the Heart River in Grant County, North Dakota by O A. Stevens and represents the only collection of the species from that state. In this material only the very young pods were strigose.

The type of this species has not been seen by the writer, but a specimen collected by Dr. Richardson on the Franklin Journey (MO) has been examined. It is labeled Phaca aboriginorum and agrees closely to the specimen figured by Hooker (1830). Hooker indicates that he had seen material which had been collected by Dr. Richardson. Since our material agrees closely with the Richardson specimen and with the Hooker figure and description there appears to be little doubt as to the typification of this species.

Polunin (1959) has recently treated *A. aboriginorum* as a synonym under *A. australis* (L.) Lam. The present author has examined a number of collections of *A. australis* from Europe and indeed that species does appear to belong to the same complex as *A. aboriginorum*. However, until it is possible to examine critically the members of this complex throughout its range it is best to retain our material under the name of *A. aboriginorum*.

The spelling of the specific epithet was *aboriginorum* in the original description, but Sprengel (1827), Torrey and Gray (1838), Gray (1864), and Rydberg (1900) have used the spelling *aboriginum*. The original spelling is retained in this paper because the International Code (Lanjouw, 1956, art. 73) states that the original spelling is to be retained unless it is a typographic error or an orthographic variant. Neither of these exceptions appear to fit this situation.

The species extends from Quebec to Alaska then southward to Nevada and New Mexico. The plants occur in meadows, stream banks, and wooded regions. In our region the flowering period extends from late May through June.

Ledingham (1957) has reported the somatic chromosome number of *A. aboriginorum* as 16.

*Astragalus agrestis* Dougl. (Map 1. Plate 1, Figs. C, D)

*Astragalus agrestis* Dougl. ex G. Don, Gen. Syst. 2:258. 1832.
*Astragalus hypoglossis sensu* authors, non L. 1771.
*Phaca hypoglossis* sensu MacMill. Metasp. Minn. Valley 324. 1892. pro syn.

**Astragalus agrestis** var. polyspermus (T. and G.) M.E. Jones


Stems 9-43 cm long, few to several from a rhizome, decumbent, strigose throughout with simple hairs. Stipules 4-11 mm in length, connate-clasping below, the free ends lanceolate to triangular, glabrous or strigose on the dorsal (outer) surface, ciliate, herbaceous. Leaves 4-7 cm; leaflets 13-19, 6-15 mm long, 2-4 mm wide, narrowly elliptic, obtuse, strigulose above and below with simple hairs. Peduncles 4-19 cm long, strigose. Bracts linear-lanceolate, exceeding half the length of the calyx tube, villous with black and white hairs. Racemes 1-4 cm long, subcapitate, few- to several-flowered. Flowers 17-24 mm long, purple or occasionally ochroleucous, erect. Calyx cylindric, villous with dark and light simple hairs; tube 6-7 mm; teeth 2.8-5.5 mm, half as long as the tube, linear, usually black-villous. Pods 8-10 mm long, woolly villous, erect, subsessile, rupturing the persistent calyx, 2-celled by intrusion of the dorsal suture; the lower (dorsal) suture sulcate.

The stature of this species varies from one location to another. Plants from better sites may be four decimeters in height and those from less favorable situations may not exceed one decimeter. When the plants grow where competition is keen they frequently produce only a single stem, but in open sites they branch profusely and form dense clumps of vegetation. The prevailing flower color is pink-purple, but occasional specimens bear white flowers. *A. virgultulus* Sheldon was based on a caespitose form with white flowers.

*A. agrestis* is frequently mistaken for the related *A. striatus* from which it can be distinguished by its rhizomatous habit, long villous pods, and basifixed pubescence. *A. agrestis* has also been confused with *A. plattensis* which occurs in a similar habitat and has a rhizomatous habit. *A. plattensis* is usually more caespitose, has decumbent or ascending stems, fewer flowers, and more lax racemes. The mature pods of *A. plattensis* are much larger, ovoid-acuminate, and merely strigose.

*A. agrestis* appears to be a part of a complex with Eurasian as well as American representation. The majority of the early American workers considered our material to fall within the specific limits of *A. hypoglottis* (a European member of this complex). Jones (1895) was the first to take a firm position that *A. agrestis* was an entity distinct from *A. hypoglottis*. In 1898 he pointed out that *A. agrestis* differed from the European plants by its shaggy calyx, long calyx teeth, long bracts, and rough or puberulent vesture of the leaves. The treatment of *A. agrestis* in Jones' revision of the North American species of *Astragalus* (1923) includes a detailed comparison of the two species. The present author has also had some opportunity to study European material and concurs with Jones' interpretation.

However, R.C. Barneby (Wappingers Falls, N.Y.; 1959) in a personal communication now believes that *A. agrestis* is indistinguishable from the Siberian and central Asian *A. dasyglottis* Fisch. (possibly the source of the synonym *A. dasyglottis* Nutt.). The writer has not looked into the Asiatic end of this problem and is therefore unable to evaluate Barneby's
interpretation. No doubt the total Hypoglottides complex to which \textit{A. agrestis} belongs should be studied as a unit; only then will it be possible to equate the constituent taxa in a consistent fashion. For the present, it seems desirable to maintain \textit{A. agrestis} as definitive for the American representative.

Beyond our area the species extends northward to Alaska and south to Washington, Utah, and New Mexico. The plants occur in low, moist meadows, along stream courses and drainages, and less commonly in upland better drained sites and in woods. It is a common component of moist prairies of the northern great plains. The blooming period extends from May to early July.

The somatic chromosome number of \textit{A. agrestis} was reported as 16 by Ledingham (1957, under the name \textit{A. goniatius}).

\*\textit{Astragalus alpinus} L. (Map 7. Plate II, Figs. A, B)

\textbf{Astragalus alpinus} L. Sp. Pl. 760. 1753.
\textbf{Phaca astragalina} DC. Astrag. 64. 1802.
\textbf{Phaca andina} Nutt. Ex T. and G., Fl. N. Am. 1:345. 1838. \textit{pro syn.}
\textbf{Tragacantha alpina} (L.) Kuntze Rev. Gen. 942. 1891.
\textbf{non A. giganteus} S. Wats. 1882.
\textbf{non P. alpina} L. 1753.
\textbf{Astragalus andinus} (Nutt,) M.E. Jones Rev. Astrag. 137. 1923.

Stems 9-44 cm long, few to several from a creeping rhizome, decumbent, strigulose throughout. Stipules 4-8 mm long, the lower ones connate-clasping, the upper ones nearly free, ovate to triangular, herbaceous, strigulose to glabrous on the dorsal surface. Leaves 6-15 cm long; leaflets 19-25, 7-20 mm long, 3-9 mm wide, ovate to elliptic or oblong, the apex retuse or rounded, strigulose above and below with simple pubescence. Peduncles 2-17 cm, strigulose. Bracts oblong, obtuse, longer than the pedicels, black-villous on the dorsal surface. Racemes 1-8 (13) cm, subcapitate, the flowers at first erect, later spreading and finally reflexed in age, several-flowered, elongating somewhat at maturity. Flowers 7-12 mm, light to dark purple, fading to yellow on drying. Calyx campanulate, strigulose with black hairs; tube 2.0-3.3 mm long; teeth 0.9-2.2 mm in length, narrowly triangular. Pods 12-21 mm, pendulous, strigose with black hairs, oblong-lanceolate, straight or slightly curved; the lower (dorsal) suture sulcate; stipe 2-4 mm long.

This species occurs in two widely separated regions in the north-central states: the South Dakota Black Hills and northern Wisconsin. The Black Hills representatives differ from their eastern congeners mainly in flower color, possessing pale whitish-purple petals except for
Map 1. Range of **Astragalus agrestis** and **A. hyalinus**.

Map 2. Range of **Astragalus bisulcatus**.
Plate II. Astragalus alpinus, A. Section of stem with leaf and inflorescence. B. Fruit. Astragalus americanus, C. Section of stem with leaf and inflorescence. D. Fruit.
the tip of the keel which is dark purple. The Wisconsin plants on the other hand bear brightly colored pink-purple flowers.

This species is widely distributed through the boreal, mountain, and subarctic regions of America, Europe, and Asia. In North America it occurs from Labrador to Alaska and southward to Vermont and Colorado. In our area the plants grow as a part of the ground layer in coniferous forests. The blooming period extends from June to late July.

*Astragalus americanus* (Hook.) M. E. Jones (Map 4. Plate II, Figs. C, D)


pro parte. non Phaca frigida L. 1759.


Phaca americana (Hook.) Rydb. ex Britt. and Brown, Ill. Fl. 2:304. 1897.

Stems 30-75 cm long, few to several from a woody caudex, ascending to erect, sparsely villous with simple hairs. Stipules 11-22 mm long, ovate to lanceolate, free, the lower ones reflexed, turning brown with age, glabrous to sparsely villous with simple hairs. Leaves 9-16 cm long; leaflets 9-15, 15-58 mm long, 5-18 mm wide, oblong to lanceolate, obtuse, sparsely villous below, glabrous above. Peduncles 5-16 cm long. Racemes 2-9 cm long, several-flowered. Bracts oblong to elliptic, obtuse, nearly equalling the calyx. Flowers 12-13 mm, whitish, the keel with a purple tip. Calyx campanulate, oblique; tube 4-5 mm, glabrous or nearly so; teeth 0.2-0.7 mm, villous with black hairs (or some with a fringe of white hairs). Pods 23-32 mm long, ovoid-inflated, 1-celled, reflexed, glabrous (in ours); stipe 6-9 mm long, exceeding the calyx.

The pods from specimens collected in the Black Hills are glabrous, but there is a tendency for plants from widely scattered sites outside our range to have strigose pods. In this feature *A. americanus* approaches *A. umbellatus* of northern latitudes. However, the more robust nature, long peduncles, and small flowers distinguish *A. americanus* from that species.

Richardson (Franklin's Journey, 1823) listed this species as Phaca frigida Willd. Hooker (1830) followed suit but recognized three varieties, *europea*, *americana*, and *littoralis*, distinguished on pod and calyx characters. Rydberg (1929b) has recognized the varieties *americanus* and *littoralis* as distinct species. Jones (1923) held that *A. americanus* was distinct from the European *A. frigidus*. The present author concurs with the treatment of Jones.

Beyond our region the species extends from Quebec to the Yukon Territory and Alaska, south to British Columbia and Wyoming. The plants grow in wooded regions along streams or drainages. In the Black Hills the plants flower early in July. August specimens are in fruit.
Astragalus barrii Barneby (Map 7)


Plants mat-forming; stems short, several to many from a broadly spreading caudex. Stipules 4-8 mm, glabrous dorsally, ciliate. Leaves 1-4 cm long; leaflets 3, 3-12 mm long, 1-3 mm wide, narrowly oblanceolate to elliptic, silvery-strigose with malpighian hairs. Peduncles 7-16 mm long. Bracts narrowly lanceolate, hyaline, glabrous dorsally, ciliate, longer than the pedicles. Racemes 1- to 3-flowered. Flowers 9-13 mm long; teeth 1.5-2.2 mm long, linear lanceolate. Pods 4-7 mm long, lance-ellipsoid, strigose, 1-celled, sessile.

A. barrii is possibly more closely related to A. sericoleucus than to any other species of Astragalus present in the north-central states. Both A. barrii and A. sericoleucus belong to that series of the Triphylli in which the purplish flowers are borne on pedunculate racemes. A. barrii is distinguished from A. sericoleucus largely on the basis of its glabrous stipules and larger flowers.

The writer has followed Barneby in maintaining A. barrii as a distinct species. However, when further information is available on this taxon it may possibly be relegated to the position of a variety.

Barneby (1956) reports the species as occurring in Fall River and Shannon Counties in South Dakota and from Wyoming and Montana. The plants grow in open places on calcareous soils at the tops of bluffs and along ravines. The blooming period of A. barrii is from late April through May.

Astragalus bisulcatus (Hook.) A. Gray (Map 2. Plate III, Figs. A-C)


Tragacantha bisulcata (Hook.) Kuntze Rev. Gen. 943. 1891.


Stems 15-70 cm, several to many from a branching caudex, ascending to erect, minutely strigose throughout with simple hairs. Stipules 6-10 mm, connate-clasping below, the upper ones nearly free, triangular-lanceolate, glabrous to strigose on the dorsal surface. Leaves 6-10 cm long; leaflets 17-29, 8-27 mm in length, 2-10 mm in width, lanceolate to elliptic or oblong, distant or opposite, glabrous above, strigose below with simple pubescence. Peduncles 5-13 cm, minutely strigose. Bracts narrowly lanceolate, longer than the pedicels, sparsely strigose, ciliate.
Plate III. *Astragalus bisulcatus*, A. Inflorescence with flowers and fruits. B. Leaf. C. Flower.
Racemes 4-19 cm long, many-flowered, at first very dense, later becoming lax as the rachis elongates. Flowers 10-15 mm long, some shade of pink or pink-purple (occasionally whitish), spreading. Calyx short-cylindric, very gibbous at the base (the rear of the calyx extending beyond the attachment of the pedicel); tube 3.5-5.5 mm; teeth 1.7-4.5 mm, narrowly linear. Pods 18-22 mm, linear-oblong, two furrows running the length of the ventral (upper) surface, reflexed, strigose, occasionally glabrous; stipe 4-6 mm long.

*A. bisulcatus* is frequently confused with (and perhaps related to) *A. racemosus* which occupies a similar habitat. *A. racemosus* is readily distinguished by its whitish flowers, long-stipitate and triquetrous pods, and only slightly gibbous calyces.

This species was described by Hooker from specimens collected by Drummond on the plains of the Saskatchewan. The descriptive epithet *bisulcata* has accompanied the taxon through transfers to several different genera. The only segregate to be elevated to specific rank was Gandoger's forma *decalvans*. Corolla color and pod pubescence (differential characters on which *decalvans* was based) do not correlate and there appears to be no basis for the recognition of the taxon *decalvans* in any category (a view also held by Porter, 1939).

*A. bisulcatus* extends northward into Saskatchewan and Alberta; southward through the mountains to New Mexico. It has been demonstrated (Trelease and Beath, 1949) that *A. bisulcatus* is a primary selenium indicator. The habitat of this species is restricted to seleniferous soils. Where seleniferous formations are exposed, as in the case of the Niobrara formation of western North and South Dakota, either *A. bisulcatus* or other selenophytes, such as *A. racemosus*, or *A. pectinatus*, are present. In only a few instances has the writer observed *A. bisulcatus*, *A. racemosus*, and *A. pectinatus* growing in the same vicinity. Evidently, controls in addition to selenium are present which limit the distribution of these plants since the ranges of the three species do not coincide.

This very attractive pink-purple flowered plant blooms from late May to mid-July in the north-central states. The flowering period is prolonged by the production of additional inflorescences as the season advances.

Both Vilkomerson (1943) and Ledingham (1957) have reported the somatic chromosome number of *A. bisulcatus* as 24.

*Astragalus canadensis* L. (Map 3. Plate IV, Figs. A-C)

* Astragalus canadensis* L. Sp. Pl. 757. 1753.
  * Tragacantha canadensis* (L.) Kuntze Rev. Gen. 943. 1891.
*Astragalus canadensis var. longilobis Fassett Rhodora 38:94. 1936.
Astragalus canadensis var. brevidens (Gand.) Barneby Leafl. West. Bot. 4:238. 1946.

Stems 25-130 cm, few to several from a branching woody caudex, ascending to erect, glabrous to minutely strigose throughout with simple pubescence. Stipules 5-12 mm long, connate-clasping, narrowly triangular, strigose on the dorsal surface. Leaves 10-31 cm; leaflets 15-35, 19-52 mm long, 6-16 mm wide, glabrous to sparsely strigose above, strigose below with at least some malpighian hairs; lanceolate to oblong, obtuse. Peduncles 4-12 cm long, strigose. Bracts narrowly lanceolate, longer than the pedicels, strigose on the dorsal surface. Racemes (3) 6-17 (19) cm long, many-flowered, little elongating in fruit. Flowers 12-15 mm long, ochroleucous, at first erect, later spreading or reflexed. Calyx cylindric, strigose with malpighian hairs; tube 5-8 mm; teeth 1.5-5.0 mm, narrowly linear to triangular. Pods 11-15 mm long, sessile, lance-ovoid to oblong, 2-celled, tardily dehiscent, erect, glabrous (rarely pubescent); both sutures prominent.

This species varies greatly in stature. The plants normally attain a height of between 0.5 meter and 1 meter, but occasional specimens may be less than 0.3 meter or over 1 meter in height.

The vesture of the leaves and stem is various. The leaflets commonly are strigose below and glabrous above; however, in extreme cases both surfaces are densely strigose as for example: Sheldon 1587, Aug. 1891, Lake Benton, Minn. Between these extremes are a series of intermediates which exhibit many degrees of pubescence.

The length of the calyx teeth and bracts are likewise inconsistent. Fassett's A. canadensis var. longilobus represents a form with slender calyx teeth. A specimen collected in Winneshiek Co., Iowa (E.W.D. Holway, July 13, ISC) has calyx teeth to 5 mm in length. Whether such plants deserve the rank of a variety requires further study.

A specimen collected at Jefferson, Minnesota (H.L. Lyon, July 20, 1899, MIN) has exceptionally long bracts which much exceed the flowers in late bud. Typically the bracts exceed the length of the pedicel but not the calyx.

Although A. canadensis is not usually confused with other species of Astragalus (except perhaps A. cooperi) in the north-central states, it is frequently mistaken for Glycyrrhiza lepidota (and vice versa).

The glutinous nature of the calyx, smaller flowers, and acute leaflets should readily distinguish G. lepidota.

Confusion has existed concerning the various forms of this species in
Map 3. Range of *Astragalus canadensis*.

Map 4. Range of *Astragalus americanus*, *A. ceramicus*, and *A. cooperi*. 
the western part of the United States. The names A. mortoni, A. spicatus, A. pachystachys, and A. torreyi have been variously applied to western phases of the total Astragalus canadensis complex.

This species is represented in one form or another from coast to coast. It grows in a variety of habitats and is commonly found in moist prairies, swampy areas, and in wooded regions.

The somatic chromosome number of A. canadensis has been reported as 16 by Tschechow (1935), Vilkomerson (1943), and Ledingham (1957).

Astragalus ceramicus Sheld. (Map 4. Plate V, Fig. A)

*Phaca picta A. Gray Mem. Am. Acad. 4:37. 1849.
Astragalus pictus var. angustus M. E. Jones Zoe 4:37. 1893.
Astragalus longifolius (Pursh) Rydb. Fl. Neb. 2:47. 1895. non A. longifolius Lam. 1783.
*Astragalus pictus var. magnus M. E. Jones, Rev. Astrag. 109. 1923.
Plate V. *Astragalus ceramicus*, A. Plant with leaves, flowers and fruit. *Astragalus cooperi*, B. Inflorescence and leaf.

Plants 14-41 cm long, stem arising from a creeping rhizome, prostrate to erect, strigose with malpighian hairs. Stipules 3-11 mm, connate clasping at the base of the plant, with upper ones free, triangular subulate, stiff, persistent, strigose on the dorsal surface. Leaves 6-18 cm long; leaflets 1-11, the terminal leaflet commonly reduced to a long linear phyllode, more leaflets present on the lower leaves than on the upper. Peduncles 2-5 cm long, strigose. Bracts lanceolate-subulate, shorter than the pedicels. Racemes 2-5 (10) cm long. Flowers 7-12 mm in length, yellowish, the keel purple-tipped. Calyx campanulate, strigose; tube 2.2-4.0 mm; teeth 1.0-2.5 (3.5) mm, narrowly triangular. Pods 18-43 (51) mm long, thin-walled, inflated, glabrous, yellowish with purple mottling, or occasionally without mottling, 1-celled; stipe 2-5 mm long, usually included in the calyx.

This complex varies in the size of the pods and the nature of the leaves. The pods of the plants from our region are generally larger (25-50 mm long) than those from the west or southwest portions of the range (18-37 mm long). The pod size may or may not be correlated with leaflet number, but specimens from the west do tend to have a larger number of leaflets. The plants with many leaflets have been called var. foliolosus and those with a reduced number var. filifolius. There are many intergrades between these forms. The intraspecific variability of this complex awaits further study.

The long list of synonyms presented above actually involves only two specific types. These are the types of Psoralea longifolia and Phaca picta. As both of the specific epithets were preoccupied in Astragalus numerous name changes have resulted. A. ceramicus represents that segment of the complex which contains the type of Psoralea longifolia. If one wishes to recognize a second species the name A. angustus is available for the foliolose part of the complex. However, if one wishes to recognize only a single species having two varieties, the names would be A. ceramicus var. ceramicus for the type variety and A. ceramicus var. foliolosus for the foliolose portion of the species.

Outside our range the species extends westward to Montana and southward to Arizona and New Mexico. The rhizomatous habit allows the plants to adjust to changes in soil level. It is thus well suited to growth in sandy situations. The plants are common in the Sand Hills of western Nebraska where they occur in the sandy "blow outs." The blooming period extends from May to July.

Astragalus cooperi A. Gray (Map 4. Plate V, Fig. B)

non A. neglectus Freyn. 1893. non A. neglectus Fisch. ex Steud. 1841.
Astragalus neglectus forma limonius (Farwell) Fern. Rhodora 39:318. 1937

Stems 50-75 cm long, few from a woody caudex, sparsely strigose with simple pubescence, ascending to erect. Stipules 3-5 mm, clasping, the free ends triangular, sparsely strigose, ciliate. Leaves 5-11 cm in length; leaflets 11-25, 10-29 mm long, 2-8 mm wide, oblong-elliptic or lanceolate, obtuse, truncate or retuse, strigose with simple hairs below, glabrous above. Peduncles 3-7 cm long, strigose. Bracts triangular, shorter than or equaling the pedicels. Racemes 1-5 cm long, several-to many-flowered. Flowers 10-12 mm long, whitish or yellowish. Calyx campanulate, strigose, fragile and soon crumbling; tube 3.5-5.0 mm long; teeth 1.5-2.3 mm long, triangular to narrowly triangular. Pods 12-35 mm long, glabrous, inflated, ovoid, sessile, 1-celled; both sutures sulcate.

A. cooperi has been mistaken for A. canadensis from which it can be separated by its short peduncles, campanulate (rarely subcylindric) calyces and inflated 1-celled pods. Also, the flowers are generally smaller.

Cooperi is the first available epithet, the earlier neglecta being pre-occupied. As a substitute name A. cooperi must be based upon Phaca neglecta. The writer has examined three I.H. Lapham specimens (MO, US) which are possibly isotypes of the specimens cited by Torrey and Gray in the description of P. neglecta, and find that they closely agree with the original description and with the material considered herein as A. cooperi.

The species extends eastward to Pennsylvania and New York and northward into Ontario. The plants occur on sandy lake shores, river banks, and in open woods. The blooming period extends from late June to late July.

Astragalus crassicarpus Nutt. (Map 5. Plate VI, Figs. A,B)

Astragalus succulentus var. paysoni Kelso Rhodora 39:151. 1937.

Stems 5-50 cm long, few to several from a woody caudex, prostrate to decumbent or ascending, strigose throughout with simple hairs. Stipules 4-12 mm long, fused to the petiole base, ovate to triangular, acuminate, the margins scarious, ciliate, glabrous on the dorsal surface. Leaves 4-11 cm long; leaflets 15-27, 8-20 mm in length, 2-8 mm in width, narrowly lanceolate to elliptic or linear-oblong, acute or obtuse, occasionally retuse (at least on the lower leaves), glabrous above, sparsely strigose to pilose below. Peduncles 2-8 cm long, strigose to pilose. Bracts lanceolate, glabrous on the dorsal surface, ciliate, longer than the pedicels. Racemes 2-4 cm, few- to several-flowered, at first dense, becoming lax in age. Flowers 14-20 mm, pinkish to purple, fading yellowish, the tip of the keel often remaining purple. Calyx cylindric, strigulose to villous with light to dark, simple hairs; tube 5.2-8.0 (9) mm; teeth 1.3-4.0 mm, triangular-subulate. Pods 16-27 mm long, 12-22 mm broad, ovoid-globose to quadrate, abruptly acuminate, sulcate along both sutures when fresh, fleshy prior to maturity and frequently reddish, becoming woody on drying, 2-celled, glabrous, sessile.

A. crassicarpus varies in several characters. The color of the flowers on the plants in the eastern part of the north-central states is at first a bright pink-purple, but this quickly fades to a yellowish or greenish color. Plants from central North Dakota westward have light yellowish wing-tips and banner, but the keel is pink-purple. Barneby (1956) has included the eastern plants in the type variety (possibly on the basis of the geographical area in which the type was collected), and treated the western plants as the variety paysoni.

The pods vary in shape from globose to ellipsoid or quadrate, but the apex in all cases is abruptly acuminate. The pods are frequently broader than long. In those which are exposed to the sunlight a red pigment is commonly formed, which accounts, at least in part, for the common name of "ground plum." In rare instances the young pods may be minutely strigose.

The racemes are usually composed of somewhat compact subcapitate racemes. However, some plants from the Black Hills region and from North Dakota have very lax racemes. The plants bearing lax racemes also frequently possess light colored flowers and represent, at least in part, variety paysoni (Kelso) Barneby. The flowers of this variety may average slightly larger than those of the variety crassicarpus which ranges eastward.

The use of the above varietal names in A. crassicarpus appears to have some value as most of the flowering specimens can logically be placed in one category or another. However, fruiting specimens are often difficult to assign.

A. crassicarpus has been confused with A. trichocalyx. The two species appear to be closely related and have many similarities in
Plate VI. *Astragalus crassicarpus*, A. Section of stem with leaf and inflorescence. B. Fruit. *Astragalus distortus*, C. Section of stem with leaf and inflorescence. D. Fruit.
common. Indeed some authors (Barneby, 1956) have treated A. tricho-
calyx as a variety of A. carssicarpus. The present author has maintained
A. trichocalyx as a distinct species on the basis of its geographic distri-
bution, growth habit, flower color, and densely lanose calyx.

The utilization of the name A. crassicarpus has been subject to dis-
pute. It was published in Fraser’s Catalogue in 1813. The nomenclatural
difficulties involve the facts: (1) that the description is too brief to de-
limit the species definitely; (2) that there is doubt as to the authorship
of the Catalogue; (3) that it has been alleged that the Catalogue is not a
valid publication source.

With respect to the first point, the description is indeed generalized,
but there does not appear to be any other Astragalus "above the River
Platte" which has the fruit "about the size and form of A. physodes, but
thick and succulent."

Recently Shinners (1955, 1956), Cronquist et al. (1956), and Cronquist
(1957) have discussed the authorship of the Catalogue and its validity:
Nuttall did claim the authorship of a copy of the Catalogue which he sent
to the Philadelphia Academy (Greene, 1890), and he acknowledged his
responsibility (1818) for certain names in the Catalogue (cf. Amorpha
canescens, Glycyrrhiza lepidota). As to the validity of that publication,
the International Code does not hold that it is invalid. According to the
International Code (art. 29, Lanjouw et al., 1956), publication on or after
1 Jan. 1953 of a new name in tradesmen’s catalogues or in nonscientific
newspapers, even if accompanied by a Latin diagnosis, does not consti-
tute effective publication. Therefore, unless the Frazer Catalogue is
declared invalid A. crassicarpus appears to be the earliest validly and
effectively published name.

Beyond our area the species extends from Manitoba to Alberta in the
north and southward along the plains to Texas and New Mexico. The
plants occur in moist prairies, uplands, and on the short-grass prairie
slopes of the Black Hills. In our region, it flowers from late March to
early June.

Vilkomerson (1943) has reported the somatic chromosome number of
A. crassicarpus as 22.

Astragalus distortus T. and G. (Map 7. Plate VI, Figs. C, D)

Holcophacos distortus (T. and G.) Rydb. ex Small, Fl. SE. U.S. 618.
1903.

Stems 10-40 (60) cm long, decumbent to ascending, few to several
from a branching caudex, sparsely strigose to glabrous. Stipules 3-8
mm long, free, triangular-subulate, glabrous on the dorsal surface,
ciliate. Leaves 5-12 cm long; leaflets 17-27, 6-13 mm long, 2-7 mm
wide, elliptic to oblanceolate, truncate to retuse, sparsely strigose
below with simple hairs, glabrous above. Peduncles 5-15 cm, sparsely
strigose. Racemes 1-6 cm, several-flowered, at first crowded, later
becoming lax. Bracts lanceolate, shorter than or equalling the pedicels.
Map 5. Range of *Astragalus crassicarpus*.

Map 6. Range of *Astragalus aboriginorum* and *A. drummondii*.
Flowers 9-14 mm long, purple or ochroleucous with the keel purple-tipped. Calyx campanulate, strigose with white, simple hairs; tube 2.4-4.0 mm; teeth 1-2 mm long, triangular. Pods 15-20 mm long, sessile, 1-celled, curved, tapering at both ends, oblong, glabrous (occasionally sparsely strigose); dorsal suture sulcate, ventral suture conspicuous.

The flowers of *A. distortus* vary in color. They are commonly a bright pink-purple but yellowish flowers with purple-tipped keels frequently occur. White flowers are apparently rare but they do occur in this species as in most other Astragali.

Rydberg (1929) has included *Phaca debilis* Nutt. in the synonymy of *A. distortus*. However, the descriptions of the two taxa do not agree in several points, and the type of *P. debilis* was collected beyond the range of *A. distortus*. Thus *P. debilis* and its synonyms have been omitted from the above list.

The range of the species extends southwestward to Texas and Louisiana and eastward to West Virginia. The plants occur on open sandy places along bluffs and streams, in open prairie glades along limestone outcrops, and in upland prairies. The plants flower from mid-April to early June.

*Astragalus drummondii* Dougl. (Map 6)


*Tragacantha drummondii* (Dougl.) Kuntze Rev. Gen. 744. 1891.


Stems 25-65 cm long, several from a woody caudex, shaggy villous with simple hairs, erect, coarse, ridged, stipules 5-12 mm long, free, ovate to triangular, sparsely villous with spreading hairs. Leaves 6-12 cm long; leaflets 21-33, 10-20 mm long, 4-7 mm broad, elliptic to oblanceolate, obtuse or truncate, villous with spreading, simple hairs below, glabrous above. Peduncles 6-15 cm, villous, at least some of the hairs black. Bracts ovate-lanceolate, acute, strigose, ciliate, shorter than or equalling the pedicels. Racemes 2-14 cm long, several- to many-flowered, at first much contracted, elongating in age. Flowers 16-21 mm, ochroleucous or whitish, the keel with a purple tip. Calyx cylindric, villous with dark and light simple hairs, persistent; tube 5.5-8.0 mm; teeth 2.4-4.0 mm, triangular-acuminate. Pods 24-40 mm long, linear-oblong, glabrous, reflexed; partially 2-celled by intrusion of the lower (dorsal) suture, the upper suture prominent; stipe 6-12 mm long.

*A. drummondii* has traditionally been placed with *A. racemosus* in the section Galegiformes (*Tium* Rydberg). However, there are some disconcerting differences between the two species. For example, the chromosome numbers differ; one is a selenium accumulator and the other is not, and the plants occupy distinct habitats. Pending a resolution of the relationships of *A. drummondii*, the author is maintaining it with the Galegiformes, but with some reservations.

The species was described by Hooker (1834) from materials collected by Douglas on the Eagle and Red Deer Hills of the Saskatchewan. The complete description and the fine figure of *A. drummondii* in the *Flora*
Boreali-Americana (loc. cit.) leave little doubt as to the typification of this species.

Beyond our region the species occurs northward to Saskatchewan and Alberta, southward through the mountains to Utah and New Mexico. The plants grow on foothills at middle elevations, but frequently extend down onto the high plains. The flowering period extends from late May to late June in our region.

A somatic chromosome number of 22 has been reported for A. drummondii by both Vilkomerson (1943) and Ledingham (1957).

**Astragalus flexuosus** (Hook.) G. Don (Map 17, Plate VII, Figs. A.B)

**Astragalus flexuosus** (Hook.) G. Don Gen. Syst. 2:256. 1832.


Astragalus flexuosus Dougl. ex Hook., Fl. Bor. Am. 1:141. 1830.

pro syn.


Astragalus fendleri (A. Gray) A. Gray Fl. Wright. 2:44. 1853.


Tragacantha flexuosa (Hook.) Kuntze Rev. Gen. 945. 1891.


Astragalus flexuosus var. sierrae-blancae (Rydb.) Barneby Leafl.

West. Bot. 4:54. 1944.

Stems 25-65 (70) cm long, several from a branching subterranean caudex, decumbent to ascending, flexuous, strigulose throughout with simple hairs. Stipules 3-8 mm long, connate-clasping, the free ends triangular-acuminate. Leaves 5-8 cm, petioles short; leaflets 15-25, 6-11 mm long, 2-4 mm wide, elliptic to oblong or linear-oblong, obtuse, truncate or cuspidate, glabrous above, strigulose with simple hairs below. Peduncles 5-15 cm long, strigulose. Bracts lanceolate, longer than the pedicels or equalling them, 1-2 mm long. Racemes 4-16 cm, several-flowered, elongating in fruit. Flowers 8-10 mm long, pinkish or purplish; the keel purple-tipped. Calyx campanulate, strigulose with white and dark simple hairs; tube 3.0-3.8 mm; teeth 0.5-1.3 mm, triangular. Pods 13-20 mm long, oblong, tapering at both ends, 1-celled, round in cross-section, spreading, dehiscent, strigose; both sutures prominent; stipe 1-2 mm long, included in the persistent calyx.
A. flexuosus has been mistaken for A. gracilis in vegetative condition. The larger stipules of A. flexuosus can be used to distinguish most doubtful specimens. Another species that is frequently confused with A. flexuosus is A. tenellus. From that species A. flexuosus may be distinguished by its dorsally compressed pods and pink-purple flowers (in ours). The stipules of A. tenellus commonly turn black on drying and this may be used as a feature in the separation of doubtful material.

There is some difficulty in designating a proper author citation for A. flexuosus. The combination A. flexuosus Douglas was originally published as a synonym of Phaca flexuosa Hooker (1830). In 1832 Don published the name Astragalus flexuosus, ascribing the name to Douglas. He did not list Hooker's P. flexuosa in the synonymy and indicated that the plant had been collected in North West America (Hooker cites P. flexuosa from "Red River and Assinaboin"). Until it is possible to examine these types it is perhaps best to treat Don's name as an inadvertent comb. nov. of Hooker's P. flexuosa.

The species occurs from Saskatchewan and Alberta southward to New Mexico and Arizona. The single collection from Nebraska is probably adventive. The habitat of A. flexuosus varies from dry gravelly soil along road sides to grassy prairies and the slopes of mountains. It is commonly found at middle and low elevations in more open situations. In the north-central states the plants flower from late May to mid-July.

Ledingham (1957) states that the somatic chromosome number of A. flexuosus is 22.

Astragalus gilviflorus Sheld. (Map 11. Plate VIII, Fig. A)

Orophaca caespitosa (Nutt.) Britt. ex Britt. and Brown. Ill. Fl. 2:306. 1897.

Plants pulvinately caespitose. Stems 1-4 cm long, several from a branching woody caudex, entirely covered by stipules and leaf bases. Stipules 10-18 mm long, glabrous, hyaline, ciliate, connate-clasping, ovate, the free ends occasionally produced into a bifid apex. Leaves 3-7 cm long, palmately trifoliolate (rarely 5-foliolate), silvery pilose with malpighian hairs; leaflets 7-20 mm long, 2-7 mm wide, spatulate to elliptic. Flowers borne in 1- to 4-flowered sessile, axillary clusters, 18-29 mm long, ochroleucous to whitish, the keel purple-tipped. Bracts stipule-like, clasping, ovate with a long acuminate apex, glabrous, hyaline, borne immediately below the base of the calyx. Calyx cylindric, villous; tube 10-14 mm long, teeth 3.0-4.0 mm long, triangular-subulate. Pods 7-9 mm long, acuminate-ovoid, with a short beak, villous, 1-celled, sessile.
This species varies considerably in the length of the leaves, size of the clump which is formed, and in the size of the flowers. All of these characters appear to be affected by the type of environment in which the plants grow. Those of open or barren areas where there is little competition are frequently more robust than plants from less favorable sites where competition is keen. The stage of development is also important as regards the length of the leaves and the size of the plant. The longest leaves most commonly occur on fruiting specimens. Young plants may be only 5-10 cm broad, but old specimens may commonly exceed 25 cm in breadth.

A. gilviflorus is possibly most closely related to A. hyalinus. Indeed, these two species form a distinct morphological series in the Triphyllii. The inflorescences are sessile or subsessile, the flowers are yellowish or whitish, and the calyces are long cylindric in the members of this series. A. gilviflorus can be distinguished from A. hyalinus by its glabrous petals and larger flowers.

Because A. gilviflorus is a substitute name it must be based upon A. triphyllus Pursh. No type of A. triphyllus has been seen, but there seems to be little doubt that Pursh's characterization (1814, p. 740) could apply to any other species "in upper Louisiana." He described the plant as "A. acaulis, argenteus, foliis ternatis, foliolis sessilibus lanceolatis, scapo nullo, leguminibus sessilibus oblongis" and further that the leaves were "of a shining silver colour."

The species extends northward into Saskatchewan and Alberta, and westward into Montana and Wyoming. The plants occur along slopes, bluffs, and ravines in upland situations. The blooming period is from early May to mid-June.

The somatic chromosome number of A. gilviflorus is reported to be 22 (Ledingham, 1957).

**Astragalus gracilis** Nutt. (Map 8. Plate VII, Figs. C, D)

Astragalus gracilis Nutt. Gen. 2:100. 1818.
Dalea parviflora Pursh Fl. Am. Sept. 474. 1814. non A. parviflorus Lam. 1783.
Psoralea parviflora (Pursh) Poir. ex Lam., Encyc. Suppl. 4:590. 1816.
Tragacantha parviflora (Pursh) Kuntze Rev. Gen. 941. 1891.
Phaca gracilis (Nutt.) MacMill. Metasp. Minn. Valley 325. 1892. pro syn.
Map 7. Range of *Astragalus alpinus*, *A. barrii*, *A. distortus*, and *A. sericoleucus*.

Map 8. Range of *Astragalus gracilis*. 
Astragalus parviflorus var. microlobus (A. Gray) M. E. Jones Rev. Astrag. 193. 1923.
Astragalus microphacos Cory Rhodora 38:495. 1935.

Stems 15-100 cm long, few to several from a woody caudex or from short vertical rhizomes which lead from an underground caudex, strigose with simple hairs, prostrate to erect. Stipules 1-4 mm long, connate-clasping, the free ends triangular-subulate, strigose. Leaves 4-9 cm, short-petiolate; leaflets 7-17, 5-23 mm long, 1-4 mm wide, narrowly linear to linear-oblong, obtuse or retuse, strigose below, glabrous above, commonly folding on drying. Peduncles 3-13 cm long, strigose. Bracts narrowly lanceolate-subulate, shorter than the pedicels. Racemes 2-17 cm long, several- to many-flowered, elongating at maturity. Flowers 4-8 mm long, light purple. Calyx campanulate, strigose, tube 1.0-2.5 mm long, teeth 0.4-0.9 mm long, triangular. Pods 5-10 mm long, ovate, boat-shaped, 1-celled, strigulose, cross-ribbed, reflexed, sessile; the dorsal suture sulcate or occasionally merely flattened.

A. gracilis varies in the shape of the leaflets and in the stature or habit of growth. In one extreme the plants are tall and erect or ascending and commonly bear narrowly linear leaflets. At the other extreme the plants are short and prostrate to decumbent, and commonly bear oblong to linear-oblong leaflets. The low-growing plants also commonly possess shorter peduncles and racemes and fewer flowers. The flower and fruit size intergrade and there are a series of intermediates in both leaflet shape and plant stature. This complex of forms has been variously interpreted. Some authors have treated the group as two distinct species (Gray and Rydberg); others have believed it more realistic to consider it a single species consisting of two varieties (Jones and Gates). The present author agrees with the latter treatment.

A. gracilis appears to be closely related to A. flexuosus. The habit of the low-growing forms is similar to A. flexuosus. The stems arise from a series of short vertical rhizomes which are borne on subterranean caudices. A. flexuosus commonly exhibits a similar habit. The stems in both species are flexuous and both have dorsally compressed pods.

It is possible that the low-growing forms of A. gracilis have arisen as the result of introgressive hybridization between the tall A. gracilis and A. flexuosus.

Beyond our region this species extends from eastern Montana southward to New Mexico, northern Texas, and western Oklahoma. A. gracilis is common on dry bluffs, slopes, and in open grasslands. The flowering period is from mid-May to mid-July.
*Astragalus hyalinus* M.E. Jones (Map 1)


Plants pulvinately caespitose. Stems 1-3 cm long, several from a branching caudex. Stipules 6-15 mm long, connate-clasping, ovate, hyaline, glabrous on the dorsal surface, bearing a tuft of long-villous hairs at the base; margin ciliate. Leaves 1-3 cm long, palmately trifoliolate (occasionally 5-foliolate), silvery pilose with malpighian hairs; leaflets 6-8 mm long, spatulate. Flowers borne sessile in the axils of the leaves, 1-3, 12-16 mm long, yellowish or whitish, strigose on the outside with malpighian hairs. Calyx cylindric, woolly villous; tube 7.0-7.5 mm long, teeth 2.5-3.0 mm long, narrowly triangular. Pods 7-10 mm long, 1-celled, pilose to villous with malpighian hairs, sessile.

The fruit of this species has not been seen by the writer, but Porter (Harrington, 1954) reports the pods as being 7-10 mm long.

Barneby has reported *A. hyalinus* from Fall River Co., South Dakota (personal communication). Beyond our area the species occurs through northeastern Colorado and southeastern Wyoming. The plant grows in open areas along bluffs and ravines where it is frequently associated with other members of the Triphylli. The blooming period of *A. hyalinus* occurs during July; later than other members of the complex.

*Astragalus lotiflorus* Hook. (Map 9. Plate VIII, Figs. B, C)

**Astragalus lotiflorus** Hook. Fl. Bor. Am. 1:152. 1834.


**Tragacantha lotiflora** (Hook.) Kuntze Rev. Gen. 946. 1891.


**Astragalus ammonotus** Greene Erythea 3:76. 1895.


**Phaca reverchoni** (A. Gray) Rydb. ex Small. Fl. SE. U.S. 619. 1903.


**Astragalus nebraskensis** (Bates) Bates Torreya 5:216. 1905.


**Cytospora elatiocarpa** (Sheld.) Lunell Am. Midl. Nat. 4:428. 1916.

**Cytospora lotiflora** (Hook.) Lunell Am. Midl. Nat. 4:428. 1916.
Batidophaca cretacea (Buckl.) Rydb. N. Am. Fl. 24:322. 1929.

Stems 3-17 cm long, caespitose, several from a branching caudex, strigose to villous with malpighian hairs. Stipules 4-9 mm long, connate-clasping, the free ends triangular-subulate, strigose. Leaves 6-14 cm long, petioles of moderate length; leaflets 9-19, 12-18 mm long, 4-6 mm wide, oblong to elliptic or oval, obtuse or occasionally acute, strigose to villous above and below with malpighian hairs. Inflorescences of two types; the early ones pedunculate (6-10 cm long), frequently not producing fruit; the later ones sessile or short-pedunculate (to 2 cm long), usually producing fruit. Flowers 6-10 mm, yellowish or rarely purplish, the late flowers cleistogamous. Calyx campanulate, strigose with malpighian hairs, splitting in fruit; tube 3.0-4.3 mm; teeth 2.5-4.5 mm, narrowly triangular. Pods of both flower types 19-33 mm, strigulose to villous (occasionally long-villous) with malpighian hairs, 1-celled, lance-ovoid, sessile, drying to a yellowish tan color; both sutures prominent, the ventral one acute, the dorsal one flattened, tardily dehiscent.

The varieties pedunculosus and brachypus of Gray were based upon variants of A. lotiflorus which bear pedunculate and sessile inflorescences respectively. However, both types are frequently produced by the same plant and the recognition of these forms in varietal status seems untenable. Sheldon (1894) elevated variety brachypus to specific rank (A. elatiocarpus) because of his mistaken idea that the sessile flowers were elevated by the elongation of the peduncle as the fruit matured.

The vesture ranges from appressed short-villous to long-villous. An extremely villous form, occurring from North Dakota to Kansas and Wyoming, was described by Bates as the variety nebraskensis. There are numerous intermediates between this variety and the more widespread less conspicuously pubescent form.

The color of the flowers, though usually yellowish, varies considerably. There are gradations from whitish to yellowish, light purple, and dark pink-purple. A pale violet-flowered form was described as A. batesii A. Nels.

The plants from the southern part of the great plains tend to have large numbers of flowers and long peduncles. This part of the complex represents what has been called A. reverchoni (Phaca cretacea). These plants also tend to have a greater proportion of fertile pedunculate flowers and fewer cleistogamous inflorescences than those farther north; whether they deserve varietal status is beyond the scope of this paper.

The species does not seem to be closely related to others in the north-central states although it is superficially similar to A. missouriensis. It can be distinguished from the latter species by its spreading pubescence and campanulate calyx with long teeth.

A. lotiflorus was described by Hooker (1834) from material collected by Drummond at Carlton House, Saskatchewan, and his excellent description and discussion of the species could hardly apply to any other.
The names A. _reverchoni_ and _A. ammolotus_ require clarification. _A. reverchoni_ is a substitute name which was proposed by Gray to replace _Phaca cretacea_ as that name was preoccupied in _Astragalus_. The name _A. ammolotus_ was proposed by Greene (1895) to replace _A. elatio-carpus_ because "it was compounded of words taken from two languages."

_A. lotiflorus_ extends northward through Saskatchewan and Alberta, and southward to Oklahoma and New Mexico. The plants occur on sandy bluffs, on gravelly beaches, and in dry prairies. The blooming period extends from late April through June.

*Astragalus missouriensis* Nutt. (Map 10. Plate IX, Figs. A, B)

*Astragalus melanocarpus* Nutt. Fraser Cat. 1. 1813. nom. nud.
*Astragalus missouriensis* var. β Nutt. ex T. and G., Fl. N. Am. 1:331. 1838.
*Tragacantha missouriensis* (Nutt.) Kuntze Rev. Gen. 946. 1891.
*Xylophacos missouriensis* (Nutt.) Rydb. ex Small, Fl. SE. U.S. 620. 1903.

Plants caespitose. Stems 4-12 cm long, few to several from a branching caudex, decumbent to ascending, grayish-canescent, mostly covered by stipules and leaf bases. Stipules 4-10 mm, connate-clasping, ovate to lanceolate, strigose with malpighian hairs. Leaves 5-11 cm, silvery-canescent throughout due to appressed malpighian hairs; leaflets 13-17, 5-15 mm long, 3-7 mm wide, elliptic to obovate. Peduncles 2-12 cm, coarse, canescent. Bracts lanceolate, strigose on the dorsal surface, longer than the peduncles. Racemes 1-4 cm, subcapitate, few-flowered. Flowers 12-20 mm, pink-purple (rarely white). Calyx cylindric, strigose with black and white malpighian hairs, appearing gray; tube 6.2-8.5 mm, teeth 2.0-4.5 mm, triangular-subulate. Pods 15-28 mm, lance-ovoid, sessile, 1-celled, drying dark, strigose with malpighian hairs, dehiscent; both sutures prominent.

The specific epithet _melanocarpus_ (listed above) has long been treated as a synonym of _A. missouriensis_. However, since the name was published without a description (nomen nudum), there has been proper doubt as to its disposition. The writer has examined a specimen (OXF) of _A. missouriensis_ which was collected at "Red River" Canada by Douglas. It is labeled _A. melanocarpus_. This indirect evidence adds weight to the traditional application of _A. melanocarpus_ in the synonymy of _A. missouriensis_.
Plate IX. Astragalus missouriensis, A. Part of plant with leaves and inflorescence. B. Fruit.
Outside our region the species ranges northward into Saskatchewan and Alberta then southward to Utah and New Mexico. It typically occurs in short-grass prairies, uplands, bluffs, and in more open regions. Flowering extends from late April in the southern part of the range to early July in North Dakota.

The somatic chromosome number of *A. missouriensis* is reported to be 22 (Ledingham, 1957).

*Astragalus mollissimus* Torr. (Map 11. Plate X, Figs. A,B)


Plants caespitose, 10-30 cm tall. Stems several to many from a caudex, decumbent to ascending, villous throughout with simple hairs. Stipules 8-18 mm long, connate-clasping, ovate to lanceolate, acuminate, densely villous. Leaves 10-24 cm, densely villous with fine spreading hairs; leaflets 21-35, 8-25 mm long, 4-12 mm wide, ovate to elliptic or obovate. Peduncles 9-18 cm, very coarse, villous. Bracts lanceolate, villous, longer than the pedicels. Racemes 2-11 mm, several- to many-flowered, little elongating in fruit. Flowers 15-19 mm, greenish-purple. Calyx cylindric, white-villous; tube 7.0-9.0 mm, teeth 2.5-5.0 mm, triangular-acuminate. Pods 13-20 mm, curved, oblong, glabrous, sessile, 2-celled by the intrusion of the dorsal suture; both sutures sulcate.

The species extends southwestward from our region through eastern Wyoming and Colorado to New Mexico and Texas. The plants are common in short-grass prairies where they grow in the flats and on rolling hills or bluffs. In over-grazed pastures they may be the most conspicuous vegetation.

*A. mollissimus* has long been regarded as a livestock poisoner (Ritter, 1917). The animals which eat it develop a craving for the plant and frequently die from it. It is not a selenophyte, but the poisoning produced may be mistaken for that of selenium (Trelease and Beath, 1949).

The plants flower from May to early July.

*Astragalus pectinatus* (Hook.) G. Don (Map 12. Plate XI, Figs. A,B)

*Astragalus pectinatus* (Hook.) G. Don Gen. Syst. 2:257. 1832.
*Astragalus pectinatus* Dougl. ex Hook., Fl. Bor. Am. 1:142. 1830.
Map 9. Range of *Astragalus lotiflorus*.

Map 10. Range of *Astragalus missouriensis*. 
Map 11. Range of *Astragalus gilviflorus* and *A. mollissimus*.

Map 12. Range of *Astragalus pectinatus* and *A. plattensis*. 
Stems 20-50 cm long, several to many from a branching woody caudex, ascending to erect, strigose throughout with simple hairs. Stipules 4-10 mm, connate-clasping, the lower ones fused through half their length or more, ovate, acuminate, glabrous to strigose, ciliate. Leaves 4-9 cm, the petiole almost lacking; leaflets 7-17, 22-70 mm long, 1-3 mm wide, linear, decurrent with the rachis, the terminal one merely a continuation of the rachis. Peduncles 2-10 cm, coarse, strigose. Bracts lanceolate, sparsely strigose with at least some black hairs, longer than the pedicels. Racemes 3-10 cm, at first tightly clustered, later elongating and becoming lax, little elongating in fruit. Flowers 18-22 mm, whitish or yellowish; the keel immaculate. Calyx cylindric, strigose; tube 5.6-8.8 mm; teeth 1.2-2.1 mm, narrowly triangular. Pods 11-23 mm, oblong to ovoid, fleshy when young, becoming woody in age, 1-celled, criss-ribbed, glabrous, sessile, dehiscent, reflexed; both sutures prominent.

The calyx teeth and bracts are commonly black hairy but many specimens bear only white pubescence on these members.

The type specimen of _A. pectinatus_ has not been seen by the writer. However, a Douglas specimen labeled _A. pectinatus_ has been examined (OXF). It agrees closely with the material from the north-central states, and with the description and plate of _Phaca pectinata_ (Hooker, 1830).

Although the name _A. pectinatus_ Douglas was published (as a synonym) prior to the combination _A. pectinatus_ (Hook.) Don, it does not have priority in nomenclature. Because both names are evidently based on the same type the second name (by definition, Art. 64, Inter. Code, 1956) cannot be rejected as a later homonym; it must therefore be taken up as the name of the species.

Beyond our region this species occurs from Alberta and Saskatchewan south to Colorado. The habitat of this plant is restricted to seleniferous soils (Trelease and Beath, 1949). It is commonly found in low areas along drainages and along fence-rows and roadsides where the soil has been disturbed. _A. pectinatus_ possesses the rank odor (sometimes said to be "snake-like") typical of seleniferous plants.

This very handsome species flowers from May in the southern part of the range to early July in the northern part.

The somatic chromosome number of _A. pectinatus_ has been reported to be 22 by both Vilkomerson (1943) and Ledingham (1957).

*Astragalus plattensis* Nutt. (Map 13, Plate XI, Figs. C, D)

Phaca plattensis (Nutt.) MacMil. Metasp. Minn. Valley 325. 1892.
pro syn.
Astragalus crassicarpus var. pachycarpus (T. and G.) M.E. Jones
Stems 10-30 cm long, from a creeping rhizome, decumbent to ascending, villous with simple hairs. Stipules 5-9 mm, clasping, ovate to lanceolate or triangular, glabrous to sparsely strigose dorsally, ciliate. Leaves 5-9 (15) cm; leaflets 13-29, 9-16 mm long, 3-8 mm wide, elliptic to oval, acute or obtuse, strigulose above and below with simple hairs. Peduncles 3-8 (9) cm long, villous. Bracts narrowly lanceolate, longer than the pedicels. Racemes 1-3 cm long, few-flowered, subcapitate. Flowers 14-18 mm, purplish, spreading. Calyx cylindric, sparsely villous; tube 6.0-7.5 mm; teeth 2.0-3.5 mm, linear-subulate. Pods 13-20 mm, ovoid-acuminate, with a stout beak, 2-celled, sub sessile, strigose with simple hairs; the upper (ventral) suture sulcate.

The relationships of *A. plattensis* appear to lie with the Sarcocarpi. It can be distinguished from other members of that section on the basis of its rhizomatous habit, and ovoid-acuminate, strigose pods.

The synonymy of this species has recently been enlarged by the addition of *A. pachycarpus* and its segregates (Barneby, 1956a). Although *A. pachycarpus* and *A. plattensis* were published simultaneously there has never been any doubt as to the application of *A. plattensis*. However, the application of *A. pachycarpus* has been confused from the first. Gray (1864) thought it might be a depauperate form of *A. caryocarpus*. Jones (1923) treated it as a variety of *A. crassicarpus*. Barneby’s review of the typification of *A. pachycarpus* (loc. cit.) leaves little doubt as to the disposition of this entity.

Beyond the limits of our region the species extends westward into Wyoming and south to Texas. The plants grow in sandy areas along drainages, slopes, and flats in the prairies and plains. The blooming period extends from late April to late June.

*Astragalus purshii* Dougl. (Plate XI, Figs. E, F)

*Astragalus purshii* Dougl. ex Hook., Fl. Bor. Am. 1:152. 1834.


non *A. mollissimus* Torr. 1838.


*Astragalus purshii* var. interior Jones Rev. Astrag. 222. 1923.


*Astragalus purshii* var. incurvus (Rydb.) Jepson Fl. Cal. 2:360. 1936.

*Astragalus incurvus* (Rydb.) Abrams Ill. Fl. Pac. St. 2:566. 1944.

Plants caespitose; stems 5-9 cm, poorly developed, commonly covered by leaf-bases and stipules, several to many from a branching caudex. Stipules 5-8 mm, free, ovate to lanceolate, obtuse, densely villous on the dorsal surface. Leaves 3-9 cm, densely villous to lanate throughout with simple hairs; leaflets 7-15, 6-12 mm long, 2-4 mm wide, elliptic to oblong or obovate, obtuse. Peduncles 2-8 cm, at first ascending, later prostrate, villous. Bracts ovate to lanceolate, villous. Racemes to 3 cm, subcapitate, few- to several-flowered, little elongating
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in fruit. Flowers 20-25 mm, yellowish, the keel purple-tipped. Calyx cylindric, villous; tube 9.0-1.0 mm, teeth 1.4-6.0 mm, triangular-subulate, black-hairy. Pods 10-20 mm, straight or curved, oblong, densely woolly-villous, 1-celled, sessile.

The species was based on materials collected "on the low hills of the Spokane River, North-West America" (Hooker, 1834) by Douglas. The writer has examined an authentic Douglas specimen of $A$. purshii (OXF) from "N. W. America" (probably an isotype) and finds that it falls within the limits of the species as presently interpreted.

Only a single collection of $A$. purshii is known from our region; it was collected by Carr at Newell, Butte County, South Dakota. According to Barneby's (1947b) detailed subspecific classification, the sheet represents the "typical" form, i.e. var. purshii. Stevens (1950) has also reported $A$. purshii from the western part of North Dakota, but the specimens prove to be the hairy $A$. lotiflorus var. nebraskensis. $A$. purshii is widespread west of our range.

The plants grow on hillsides, valleys, and prairies. The flowering period extends from late April to early June.

*Astragalus racemosus* Pursh (Map 13, Plate XII, Figs. A-D)

*Astragalus galegoides* Nutt. Gen. 2:100. 1818.
*Astragalus racemosus* var. typicus C.L. Porter Madrono 8:99. 1945.
*Astragalus racemosus* var. treleasei C.L. Porter Madrono 8:99. 1945.

Stems 24-60 cm long, several to many in clumps from a branching woody caudex, strigose with malpighian hairs that are attached very near to one end. Stipules 5-10 mm long, the lower ones connate-clasping, the upper ones free, triangular, strigose, fragile. Leaves 6-14 cm long; leaflets 13-27, 15-32 mm long, 4-8 mm wide, narrowly elliptic to oblong or narrowly lanceolate, glabrous above, strigose below. Peduncles 4-13 cm long, strigose. Bracts scarious, narrowly lanceolate, longer than the pedicels. Racemes 3-15 cm long, elongating at maturity, several-to many-flowered. Flowers 13-17 mm, yellowish; the keel not usually maculate. Calyx cylindric, strigose, tube 5.0-7.0 mm long, teeth (1.5) 2.0-6.0 (8.0) mm, narrowly triangular to linear. Pods 24-34 mm, narrowly oblong, cordate in cross-section, glabrous (rarely strigose), 1-celled; the upper suture prominent, the lower one sulcate; stipe 4-8 mm long.

The most notable variation in $A$. racemosus involved the length of the bracts, length of the calyx teeth, and the vesture of the pod. In 1895
Jones described two varieties of *A. racemosus* based largely on bract characters. In the variety *longisetus* the narrowly lanceolate bracts are longer than the calyces. The type of variety *brevisetus* has bracts that equal the length of the pedicels and are ovate in shape. These entities represent the extremes of a wide range of variation and possibly do not deserve varietal status.

The calyx teeth are frequently shorter in specimens from Kansas and southern Nebraska than in those from North Dakota. However, the specimen having the longest calyx teeth of any examined by the writer was from Kansas.

The pods are usually glabrous, but plants from widely scattered areas have strigose pods. There does not seem to be a correlation between pod strigosity and other characteristics of the species.

As pointed out previously (under *A. drummondii*) *A. racemosus* has traditionally been placed with *A. drummondii* in the section *Galegiformes*. However, *A. racemosus* has more points of similarity with *A. bisulcatus* (usually placed in the *Bisulcati*) than with *A. drummondii*. *A. racemosus* and *A. bisulcatus* possess the same habit of growth, and the same chromosome number. Both are selenium accumulators. The pods are alike in being stipitate, but those of *A. bisulcatus* are characterized by two furrows running the length of the ventral surface rather than a dorsal invagination.

*Astragalus racemosus* and *A. canadensis* are sometimes confused in early flower. The stipe on the ovary of *A. racemosus* is distinct even during early anthesis; the ovary of *A. canadensis* is sessile.

Beyond our range the plants extend from Saskatchewan south to New Mexico and Texas. They grow in clay, calcareous, or sandy soil along drainages and ravines and are also common in low prairies. Disturbed places where the topsoil has been removed, as along roadsides and washes, are frequently covered by great numbers of plants.

The species under discussion has been listed by Trelease and Beath (1949) as a primary selenium indicator. Although the plants are seldom eaten by livestock they can cause serious poisoning.

*A. racemosus* has a distinctive odor which is characteristic of seleniumiferous plants (Beath, 1937). Nuttall (1818) noted the disagreeable odor in his description of *A. galegoideae*.

The blooming period extends from late April in Kansas to late August in North Dakota. The handsome clump-forming plants bearing long racemes of whitish flowers present a striking appearance.

A somatic chromosome number of 24 has been reported for *A. racemosus* by both Vilkomerson (1943) and Ledingham (1957).

*Astragalus sericoleucus* A. Gray (Map 7. Plate XIII, Figs. A, B)

Phaca sericea Nutt. ex T. and G., Fl. N. Am. 1:343. 1838. non
A. sericea DC. 1802.
Tragacantha sericea (Nutt.) Kuntze Rev. Gen. 942. 1891.
Orophaca sericea (Nutt.) Britt. ex Britt. and Brown, Ill. Fl. 2:307. 1897.
Map 13. Range of *Astragalus purshii* and *A. racemosus*.

Map 14. Range of *Astragalus spatulatus*. 
Plants pulvinately caespitose. Stems 1-8 cm long, spreading, several from a woody taproot, covered by stipules and leaf bases. Stipules 5-10 mm, connate-clasping, ovate, villous with malpighian hairs. Leaves palmately trifoliolate, occasionally 5-foliolate, 1-2 cm long; leaflets 5-8 mm long, spatulate, silvery-strigose with malpighian hairs. Peduncles 1-2 cm long, strigose. Bracts longer than the pedicels, lanceolate-subulate, hyaline. Racemes 2- to 4-flowered. Flowers 6-8 mm long, purple. Calyx densely pilose with malpighian hairs, campanulate; tube 2.0-3.0 mm, teeth 1.0-2.2 mm, triangular-subulate. Pods 5-6 mm long, lance-ovoid, densely pilose, sessile.

*A. sericoleucus* appears to be closely related to *A. barrii*. These two species constitute the north-central states representatives of that series of the Triphylli which have pedunculate inflorescences and purplish flowers.

The species occurs westward from our region through eastern Wyoming and eastern Colorado. The plants grow on the high plains along exposed bluffs and ravines in the short-grass prairie. The blooming period extends through May and June.

*Astragalus spatulatus* Sheld. (Map 14. Plate XIII, Fig. C)


non *A. canescens* DC. 1802.


non *A. caespitosus* Pallas 1800.

*Tragacantha caespitosa* (Nutt.) Kuntze Rev. Gen. 943. 1891.


Plants pulvinately caespitose. Stems prostrate, several from a branching caudex. Stipules 6-12 mm long, connate-clasping, hyaline, strigose with malpighian hairs or glabrous, ciliate or smooth. Leaves 2-5 cm long, unifoliolate (rarely some of them trifoliolate), narrowly spatulate, acute, strigose above and below with malpighian hairs. Peduncles 3-7 cm long, appressed strigose. Bracts with a midvein, the margins hyaline, narrowly lanceolate, longer than the pedicels, strigose along the midvein, ciliate. Racemes 1-3 cm long, few- to several-flowered, subcapitate. Flowers 7-9 mm long, purple or ochroleucous. Calyx campanulate, strigose with malpighian hairs; tube 2.0-2.6 mm; teeth 1.5-2.5 mm, linear-subulate. Pods 10-15 mm long, sessile, linear-oblong, laterally compressed, 1-celled, strigose with malpighian hairs; both sutures prominent; the valves coiling in dehiscence.
A. *spatulatus* varies in stature, leaflet number and texture, and in flower color. The plants are most commonly low-growing and reach a height of from 5-8 cm; exceptionally they grow to 12 cm. To the west of our area the plants are occasionally less than 3 cm tall, and are packed together in dense mats.

Leaflet number varies from one to three (rarely five), but generally only a single leaflet is produced. The leaves may be thin and narrowly spatulate or thick and broad. The flowers are most frequently a dark pink-purple color, but plants bearing yellowish colored flowers are not uncommon.

It is possible that one might confuse the plants of *A. spatulatus* which bear three leaflets with the members of the Triphylli, but the light green color of the leaves, the narrowly spatulate leaflets, and linear-oblong pods distinguish it from the members of that section.

Sheldon (1894) recognized the lack of a name in Astragalus for *Homalobus caespitosus* Nuttall and for the other segregates (*H. canescens* and *H. brachycarpus*) which did not differ enough to warrant specific rank. His *A. spatulatus* is based on *Homalobus caespitosus*. Our material closely matches the type of *H. caespitosus*.

For some time *Phaca simplicifolia* Nuttall (a different species) was confused with *A. spatulatus* and this accounts for the treatment by Jones (1895, 1902, 1923; see synonymy above). In 1925 Tidestrom distinguished between *H. brachycarpus* and *A. spatulatus* and proposed the name *A. simplex* to replace the former. Later (1937) he reduced this species to varietal status under *A. spatulatus*.

Beyond our region *A. spatulatus* extends from Saskatchewan and Alberta south to Utah and Colorado. The plants grow in open stretches of soil on bluffs and ravines, and on hills in the short-grass prairies, commonly associated with the members of the Triphylli. The flowering period extends from May through June.

The somatic chromosome number of *A. spatulatus* is reported to be 24 (Ledingham, 1957).

*Astragalus striatus* Nutt. (Map 15. Plate XIII, Figs. D, E)


*Astragalus adsurgens* sensu authors. non *A. adsurgens* Pallas 1800.


*Astragalus nitidus* Dougl. ex Hook., Fl. Bor. Am. 1:149. 1834.

pro syn.


A. *spatulatus* varies in stature, leaflet number and texture, and in flower color. The plants are most commonly low-growing and reach a height of from 5-8 cm; exceptionally they grow to 12 cm. To the west of our area the plants are occasionally less than 3 cm tall, and are packed together in dense mats.

Leaflet number varies from one to three (rarely five), but generally only a single leaflet is produced. The leaves may be thin and narrowly spatulate or thick and broad. The flowers are most frequently a dark pink-purple color, but plants bearing yellowish colored flowers are not uncommon.

It is possible that one might confuse the plants of *A. spatulatus* which bear three leaflets with the members of the Triphylli, but the light green color of the leaves, the narrowly spatulate leaflets, and linear-oblong pods distinguish it from the members of that section.

Sheldon (1894) recognized the lack of a name in Astragalus for *Homalobus caespitosus* Nuttall and for the other segregates (*H. canescens* and *H. brachycarpus*) which did not differ enough to warrant specific rank. His *A. spatulatus* is based on *Homalobus caespitosus*. Our material closely matches the type of *H. caespitosus*.

For some time *Phaca simplicifolia* Nuttall (a different species) was confused with *A. spatulatus* and this accounts for the treatment by Jones (1895, 1902, 1923; see synonymy above). In 1925 Tidestrom distinguished between *H. brachycarpus* and *A. spatulatus* and proposed the name *A. simplex* to replace the former. Later (1937) he reduced this species to varietal status under *A. spatulatus*.

Beyond our region *A. spatulatus* extends from Saskatchewan and Alberta south to Utah and Colorado. The plants grow in open stretches of soil on bluffs and ravines, and on hills in the short-grass prairies, commonly associated with the members of the Triphylli. The flowering period extends from May through June.

The somatic chromosome number of *A. spatulatus* is reported to be 24 (Ledingham, 1957).
Astragalus nitidus var. robustior (Hook.) M.E. Jones Rev. Astrag. 170. 1923.


Stems 15-45 cm long, decumbent to erect, several to many from a caudex, strigose with malpighian hairs. Stipules 6-10 mm long, chartaceous, connate-clasping, the free ends lanceolate to triangular-subulate, strigose on the dorsal surface. Leaves 6-12 cm long; leaflets 15-23, 13-28 mm long, 3-9 mm wide, oblong to elliptic, acute or obtuse, strigose throughout with malpighian hairs. Peduncles 6-16 cm long, equalling or shorter than the subtending leaves. Bracts ovate-lanceolate, longer than the pedicels. Racemes 2-6 cm long, few- to several-flowered, subcapitate. Flowers 13-16 mm long, purplish or occasionally yellowish or white. Calyx short-cylindric, strigose with dark and light hairs; tube 5-6 mm long; teeth 2.0-4.0 mm long, linear-subulate. Pods 7-12 mm long, sulcate on the lower (dorsal) suture, 2-celled, erect, sessile, strigose.

This widespread species shows considerable variation in flower color, number of flowers, and in the shape and texture of the leaflets. A. chandonetti was based upon a form having yellowish flowers and variety albidus on a form with white flowers. The number of flowers and the shape and texture of the leaflets seem to be the result of response to the environment. Plants from more favorable sites frequently possess a large number of flowers and thicker, broader leaflets.

Nuttall (1818) treated A. striatus under the name A. laxmanni, a European species described by Jacquin in the Hortus Botanicus Vindobonensis (1776). The figure of A. laxmanni in that publication (tab. 37) is of a very slender plant which seems beyond the circumscription of A. striatus, at least as represented in this country.

Hooker (1834) identified our material as A. adsurgens Pallas (another European taxon), and that name became well established in the literature of North American botany. Pallas' figure of A. adsurgens is similar in many features to A. striatus and it is possible that the latter is merely an American extension of the total adsurgens complex. However, until it is possible to examine Asiatic and European material critically, a definitive solution to the problem is not possible.

A. striatus extends from the Northwest Territories and Alaska in the north to Colorado in the south. The plants occur mostly in upland situations along bluffs and ravines in short-grass prairie regions. The blooming period extends from early June to mid-August.

According to Ledingham (1957) the somatic chromosome number of A. striatus is 32.

Astragalus tegetarius S. Wats. (Map 17. Plate XV, Fig. A)

non A. montanus L. 1753.

non A. viridis Bunge 1869.
Map 15. Range of *Astragalus striatus*.

Map 16. Range of *Astragalus tenellus*.

*Tragacantha montana* (Nutt.) Kuntze Rev. Gen. 941. 1891.


*Homalobus montanus* (Nutt.) Britt. ex Britt. and Brown, Ill. Fl. 2:306. 1897.

*Astragalus montanus* (Nutt.) M.E. Jones Rev. Astrag. 80. 1923. non *A. montanus* L. 1753.


Stems 5-30 cm long, prostrate or decumbent, mat-forming, several from a branching caudex, strigose with malpighian hairs. Stipules 3-7 mm long, connate-clasping, ovate, awned-subulate, strigose or glabrous, ciliate. Leaves 1-2 cm long; leaflets 5-7, 8-12 mm long, strigose to strigulose, linear-subulate, awn-tipped. Racemes short-pedunculate or sessile; flowers 1-3, 5-6 mm long, purplish or whitish with a purple-tipped keel. Bracts longer than the pedicel, acute, lanceolate, ciliate, herbaceous. Calyx campanulate, white pilose; tube 1.8-2.7 mm; teeth 1-2 mm, narrowly triangular. Pods 5-7 mm long, narrowly oblong, straight, strigose to pilose, 1-celled, sessile, laterally compressed; both sutures prominent.

The relationship of *A. tegetarius* to the other members of the section Homalobii appears to be through *A. vexilliflexus*. Some of the montane forms of *A. vexilliflexus* are almost indistinguishable from *A. tegetarius*. In our area the latter is distinctive on the basis of the subulate, awn-tipped leaflets, extremely short pedunculate or sessile inflorescences and one- to three-flowered racemes.

When Nuttall described *Kentrophyta montana* and *K. viridis* (T. and G., 1838) the name *montana* was already occupied in *Astragalus*. Gray, in his revision of the genus *Astragalus* in 1864, included both of the species of *Kentrophyta* in a single species under the name of *Astragalus kentrophyta*. He had earlier (1863) applied this name to *K. montana* alone and had presumably recognized that the name *montana* was occupied in *Astragalus*. However, when he placed *K. viridis* with *K. montana* he should have taken up the name *viridis* (unoccupied at that time) for the species. The name *A. kentrophyta* then becomes an illegitimate name (Art. 70, par. 1, Inter. Code, 1956). The earliest available name then is *A. tegetarius* S. Wats.

According to Barneby (1951a) this species is represented in our region by the variety *viridis*. The above list of synonymy includes only those names involved with variety *viridis*.

As only a small part of the total *tegetarius* complex is included within the north-central states it is not practical in the present paper to attempt to evaluate the western subspecific categories.

The species is widespread in the western United States. It extends from Alberta, south and west to California and Arizona. The plants grow in more open areas along bluffs and ravines in our region. The flowering period extends throughout June and July.
Astragalus tenellus Pursh (Map 16. Plate XIV, Figs. B, C)

Astragalus tenellus Pursh Fl. Am. Sept. 2:473. 1814. (*fide Pursh 1814)


Homalobus tenellus (Pursh) Britt. ex Brit. and Brown, Ill. Fl. 2:305. 1897.


Astragalus tenellus forma acerbus (Sheld.) Macbr. Contr. Gray Herb. 65:35. 1922.

Astragalus tenellus var. clementis (Rydb.) Macbr. Contr. Gray Herb. 65:35. 1922.


Stems 23-54 mm long, several from a branching caudex, decumbent to ascending, strigose throughout with simple hairs. Stipules 2-6 mm long, connate-clasping, strigose to glabrous on the dorsal surface, the free ends triangular, often blackening on drying. Leaves 5-8 cm long, petioles short or lacking; leaflets 15-21, 8-20 mm long, 2-4 mm wide, linear-oblong to narrowly lanceolate or elliptic, obtuse or acute, strigose below, glabrous above. Peduncles 1-4 cm long, strigose, shorter than the racemes, occasionally in pairs. Bracts ovate, ciliate, shorter or longer than the pedicels. Racemes 3-10 cm long, several- to many-flowered, elongating at maturity. Flowers 7-9 mm long, ochroleucous (rarely purplish); the keel purple-tipped. Calyx campanulate, strigose; tube 2.0-2.5 mm long, teeth 0.9-1.7 mm long, triangular. Pods 12-18 mm long, laterally compressed and nearly flat, 1-celled, dehiscent, glabrous (in ours); both sutures prominent; stipe 1-5 mm long.

The writer has seen the type of Ervum multiflorum (PH). It agrees closely with the material herein treated as A. tenellus. Pursh (1814), in speaking of E. multiflorum, noted that "of this plant I had an imperfect specimen in the Lewisian Herbarium, together with some pods of an Astragalus, which led me into the error of placing it under that genus;
Plate XIV. *Astragalus vexilliflexus*, A. Section of stem with leaf and inflorescence. *Astragalus tenellus*, B. Section of stem with leaves and inflorescences. C. Fruit.
but having since seen fine specimens in the collection of Mr. Bradbury, I was enabled to correct this error." This statement gives at least indirect evidence as to the typification of A. tenellus.

Since both names (A. tenellus and E. multiflorum) were published at the same date some authors (e.g. Gray, 1864) have taken up the name multiflorus for this species. Indeed, the author who first unites taxa bearing names or epithets of the same date has the right to choose one of them, and his choice must be followed. However, Pursh only altered the circumscription of the taxon and transferred it to the genus Ervum. He should have retained the epithet tenellus (Art.51, 55, Inter. Code, 1956). Thus, the name A. tenellus is maintained in the present treatment.

This wide-ranging complex varies in several characteristics. The pods are normally short-stipitate and glabrous, but they are not infrequently long-stipitate and they may also be strigose. Homalobus stipitatus, based on plants collected along the upper Missouri by Geyer, is merely a long-stipitate form. H. strigulosus (isotype US) was based on material which differs from the more common form of the species only in its strigose pods. An isotype of H. clementus (US) has strigose, short-stipitate pods and purplish flowers.

Although not closely related A. flexuosus is not infrequently confounded with A. tenellus; the laterally flattened pods, peduncles shorter than the racemes, and stipules which blacken on drying are diagnostic of the latter.

A. tenellus extends from the Yukon Territories and Alaska southward through the mountains to New Mexico. The plants occur in badlands on saline soil, along dry hillsides, gravelly beaches, and in the prairies. They also occur at higher elevations in forest areas. The blooming period extends from early June to late July or early August.

The somatic chromosome number of A. tenellus has been reported to be 24 (Ledingham, 1957).

*Astragalus tennesseensis A. Gray (Map 18. Plate XV, Figs. B, C)

Astragalus tennesseensis A. Gray ex Chapm., Fl. S. States 98. 1860.
Astragalus plattensis var. missouriensis Boltwood ex Coulter, Bot. Gaz. 5:71. 1880.
Geoprumnon tennesseensis (A. Gray) Rydb. ex Small, Fl. SE. U.S. 615. 1903.

Stems 10-40 cm long, several from a woody caudex, decumbent to ascending, villous with spreading simple hairs. Stipules 12-17 mm long, foliose, connate-clasping below, the upper ones free, ovate, acuminate, villous. Leaves 6-13 cm long, short-petiolate; leaflets 21-37, 10-23 mm long, oblong to elliptic, obtuse or truncate, villous below, glabrous above, peduncles 3-13 cm long, villous. Bracts narrowly lanceolate, much longer than the pedicels. Racemes 2-5 cm, closely several-flowered, little elongating in fruit. Flowers 14-19 mm long, yellowish or whitish. Calyx cylindric, gibbous at the base, white-villous; tube 6.5-8.0 mm long; teeth 2.0-4.0 mm long, triangular. Pods 23-30 mm
Map 17. Range of Astragalus flexuosus and A. tegetarius.

long, lance-ovoid, fleshy, 2-celled, sessile, villous, cross-ridged in a reticulate pattern.

*A. tennesseensis* has several features which readily distinguish it from the related members of the Sarcocarpi. It may be distinguished from both *A. crassicarpus* and *A. trichocalyx* by its long-villous, cross-reticulate pods and from *A. plattensis* by its longer pods and habit of growing from a caudex. It also bears long-villous hairs throughout the stems and leaves, which, in addition to its large foliose stipules, can be used to distinguish the plants in vegetative condition.

Gray (Chapman, 1860) described *A. tennesseensis* from plants collected on hills near Nashville, Tennessee by Lesquereux and at Lagrange, Alabama by Hatch (type, GH). He later (1864) reduced the species to varietal status under *A. plattensis*, but later authors have maintained it as a distinct species. Barneby (1956a) believes that it is not only a distinct species but it may well form a type of a section apart.

Beyond our region it is known from Tennessee and from Alabama. The plants grow in open woodlands and on barren calcareous soils. They flower from mid-April to late May.

* Astragalus trichocalyx * Nutt. (Map 18. Plate XV, Figs. D, E)

*Astragalus mexicanus* sensu A. Gray Pl. Wright. 1:51. 1852. pro parte. non *A. mexicanus* A. DC. 1833.
*Geoprumnon mexicanus* sensu Rydb. ex Small, Fl. SE. U.S. 616. 1903.

Stems 14-76 cm long, decumbent to erect, robust (rarely very slender), sparsely short-villous, several from a branching woody caudex. Stipules 5-13 mm long, connate-clasping on the lower nodes, the upper ones free, triangular-subulate, glabrous, ciliate. Leaves 7-15 cm long, short-petiolate; leaflets 19-35, 8-25 mm long, 3-9 mm wide, narrowly lanceolate to elliptic or linear-oblong, dimorphic, the early leaflets shorter and retuse or truncate, the later ones longer and obtuse or acute, villous below, glabrous or sparsely villous above. Peduncles 4-10 (15) cm long, robust, villous. Bracts linear-oblong, acute, longer than the pedicels. Racemes 2-6 cm, few- to several-flowered, subcapitate, little elongating in fruit. Flowers 15-23 mm, ochroleucous, the keel purple-tipped. Calyx cylindric, white woolly-villous or lanose; tube 6.0-8.2 mm; teeth 1.5-3.4 mm, triangular. Pods 18-30 mm long, 15-19 mm wide, obovoid to subglobose, thick and fleshy, 2-celled, glabrous, sessile.

The stature of *A. trichocalyx* varies greatly during the growing season. The plants begin to flower when they are only a few centimeters in height. They then elongate rapidly throughout flowering and fruiting. Flowering specimens of *A. trichocalyx* are easily distinguished from
those of A. crassicarpus by their white soft lanose pubescent calyces and light colored flowers. The more robust nature of A. trichocalyx, though difficult to define objectively, cannot be discounted. In fruiting specimens the problem of separation is more difficult; usually A. trichocalyx can be distinguished by its large size and by its long thick peduncles.

The type of A. trichocalyx (PH) was collected on the plains of the Arkansas by Nuttall and closely matches the description as published in the flora of North America (T. and G., 1838).

A. trichocalyx was long confused with A. mexicanus which, being the earlier name, took precedence in the literature. Recently (1956a) Barneby has satisfactorily demonstrated that A. mexicanus is in reality a variant of A. crassicarpus which is endemic to Texas (A. crassicarpus var. berlanderi). Thus, the combination A. trichocalyx becomes the earliest name available for this taxon.

Outside the north-central states the species extends through Arkansas, Oklahoma, and Texas. It grows in exposed or open areas and is common in some of the limestone regions of south-central Missouri. The flowering period extends from early April to late May.

Astragalus vexilliflexus Sheld. (Map 18. Plate XIV, Fig. A)


Stems 10-44 mm long, several to many from a branching, woody caudex, decumbent to ascending, strigose with appressed simple hairs. Stipules 4-7 mm long, connate-clasping, ovate, strigose; the tips frequently spreading. Leaves 2-5 cm long, petiolate; leaflets 9-13, 7-14 mm long, narrowly elliptic to lance-elliptic or oblong, acute or obtuse, strigose below, sparsely strigose above, commonly folding on drying. Peduncles 1-5 cm long strigose, equaling or longer than the racemes. Bracts narrowly lanceolate, strigose, longer than the pedicels. Racemes 1-3 cm long, few- to several-flowered. Flowers 5-9 mm long, purple (occasionally whitish, the banner at right angles to the calyx tube. Calyx campanulate, strigose; tube 1.5-2.0 mm long, teeth 1.3-2.3 mm long, linear-subulate. Pods 6-11 mm, laterally compressed but not flat, 1-celled, sessile, strigose; both sutures prominent.

The specimens of A. vexilliflexus from our region vary greatly in size. Those collected in western North Dakota are frequently less than 20 cm long, but the specimens from South Dakota may exceed 35 cm. The larger plants tend to bear a greater number of flowers and fruits. The size differences appear to be largely due to the habitat, with the larger plants occurring on the better sites.

Since A. vexilliflexus is a substitute name typification must be based on A. pauciflorus Hooker. The writer has seen the type of this species; it agrees with the excellent description in the Flora Boreale-Americana (Hooker, 1834) and closely circumscribes the species herein treated as A. vexilliflexus.
The range of the species extends from Alberta southward to Idaho and Wyoming. In our areas the plants occur in the badlands of western North and South Dakota. The flowering period extends from June to mid-August.

**CARAGANA Lam.**

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<table>
<thead>
<tr>
<th>Species</th>
<th>Description</th>
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<tbody>
<tr>
<td>Caragana Lam. Encyc. Meth. Bot. 1:615. 1783.</td>
<td>Small to large deciduous shrubs or small trees. Leaves even-pinnate; the rachis extended as a bristle or spine; leaflets 4-12 (in ours), oblong-oblong, oblong or oval, entire. Stipules small and deciduous or persistent as spines. Flowers solitary, yellow. Calyx campanulate or turbinate; teeth well developed or nearly obsolete. Pods cylindrical, linear-oblong, straight, glabrous, dehiscent.</td>
</tr>
<tr>
<td>Caragana Lam. Encyc. Meth. Bot. 1:615. 1783.</td>
<td>This genus which contains some 50 to 60 species is native to southern Russia, Siberia, and China. Certain of the species have been widely cultivated in this country and elsewhere as ornamentals and hedge plants. Caragana was monographed by Komarov (1908). The genus has been little studied in this country. Available herbarium material is scanty, and it has obviously not been possible to observe the various taxa in their native areas. Komarov's specific determinations, which from available data appear sound, have essentially been followed.</td>
</tr>
</tbody>
</table>
| Caragana arborescens Lam. (Map 19. Plate XVI, Fig. A) | 1. Shrubs 2-6 cm tall; leaflets 8-12. **C. arborescens**  
1. Shrubs to 2 mm tall; leaflets 4.  
2. Plants armed with spiny stipules; leaflets linear-oblong. **C. aurantiaca**  
2. Plant unarmed; leaflets oblong. **C. frutex** |

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<table>
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<th>Species</th>
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<tbody>
<tr>
<td>Caragana arborescens Lam. Encyc. Meth. Bot. 1:615. 1783.</td>
<td>Shrubs to 6 m tall. Leaves 4-10 cm long, leaflets 8-12, 12-25 mm long, 5-15 mm wide, lance-oblong to elliptic or oval (in ours), cuspidate, villous above and below, becoming glabrate in age. Stipules narrow,</td>
</tr>
</tbody>
</table>
Caragana inermis Moench Meth. Pl. 135. 1794. (fide Rehder, 1949).  
Caragana caragana Karsten Deutsch Fl. 697. 1882. (fide Rehder, 1949).  
Shrubs to 6 m tall. Leaves 4-10 cm long, leaflets 8-12, 12-25 mm long, 5-15 mm wide, lance-oblong to elliptic or oval (in ours), cuspidate, villous above and below, becoming glabrate in age. Stipules narrow, |

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Plate XVI. Caragana arborescens, A. Section of stem with leaves and flowers. Caragana frutex, B. Section of stem with leaves and flowers. Caragana aurantiaca, C. Section of stem with leaves and flowers.
occasionally persisting as spines. Bracts reduced to rudiments at the juncture of the peduncle and the pedicel. Flowers 17-23 mm long, borne singly on peduncles 12-35 mm long, few to several from each bud. Pedicels 5-15 mm long. Calyx turbinate, pubescent; tube 4.5-7.5 mm long; teeth small or nearly obsolete, margin villous. Pod 35-55 mm long, straight, linear-oblong, glabrous, sessile; the valves coiling in dehiscence.

*C. arborescens* is cultivated throughout much of the north-central states where it serves a variety of purposes. It is used as a landscape shrub, hedge plant, or windbreak plant. The attractive yellow flowers which appear as the leaves develop make this plant a desirable ornamental. The soft, light-green foliage adds to the beauty of the plant, and its compact form and dense branching habit lead to its use as a hedge and windbreak. The species is hardy in cold and dry climates and as such it is well suited to the northwestern part of our range.

The binomial *Caragana arborescens* is a substitute name for *Robinia caragana* L., and as such must be typified by the latter name. Linnaeus' description of *Robinia caragana* is not complete enough to adequately typify the species, and one must rely upon the treatments of Komarov (1908) and Rehder (1949).

Komarov (1908) indicates that *C. arborescens* is native from central Siberia at 60° N. latitude to the Argun River in Mongolia. The blooming period extends from early May in the southern part of our range to mid-June in the northern part.

Both Kreuter (1930) and Tschechow (1930) have reported the somatic chromosome number of *C. arborescens* to be 16.

**Caragana aurantiaca Koehne (Map 19. Plate XVI, Fig. C)**

*Caragana aurantiaca* Koehne Dendrol. 340. 1893.

*Caragana arenaria* Dippel Handb. Laubh. 3:715. 1893.

non *C. arenaria* Loudon 1838. (fide Rehder, 1949).


Shrubs to 1.2 m tall. Leaves 1-2 cm long, sessile to subsessile; leaflets 4, 5-15 mm long, 2-3 mm wide, linear-oblong-obovate, acuminate-subulate, minutely puberulent below, glabrous above. Stipules 3-6 mm long, persistent as brownish spines. Peduncles 3-10 mm long. Pedicels 3-5 mm long. Bracts to 1 mm long at the juncture of the peduncle and pedicel. Flowers solitary, 15-22 mm long, yellow, an orange spot on the banner; wing auricles more than half as long as the claw. Calyx campanulate, glabrous; tube 3.5-4.5 mm long; teeth 1-2 mm long, triangular; the margin minutely pubescent. Pods 25-35 mm long, straight, sessile, glabrous.

Although unknown in the herbaria of our region this shrub is cultivated throughout much of North Dakota. In that region it is used as a landscape shrub and hedge plant. Its compact branching habit and spiny nature along with the attractive flowers render it a desirable ornamental.

*G. aurantiaca* is perhaps most closely related to *G. pygmaea* DC.
Map 19. Cultivated range of *Caragana arborescens*, *C. aurantiaca*, and *C. frutex*.

Map 20. Range of *Glycyrrhiza lepidota* and *Sesbania exaltata*. 
from which it is distinguished by its flower color, more broadly campanulate calyces, and very long wing auricles.

According to Komarov (1908) the species is native to Turkey, Russia, and China and the adjacent regions of Altai. The plants flower in North Dakota during late May and June.

Caragana frutex (L.) Koch (Map 19. Plate XVI, Fig. B)

Caragana digitata Lam. Encyc. 1:616. 1783.
Caragana cuneata Moench Meth. Pl. 135. 1794. (fide Rehder, 1949).
Caragana frutescens (L.) DC. Prodr. 2:268. 1825.
Caragana frutescens var. a latifolia DC. Prodr. 2:268. 1825.
Caragana frutescens var. β angustifolia DC. Prodr. 2:268. 1825.
Caragana frutex var. macrantha Rehder Jour. Arnold Arb. 3:40. 1922.

Shrubs to 2 m tall. Leaves 2-3 cm long; leaflets 4, 10-20 mm long (in ours), 5-12 mm wide, oblanceolate, truncate or emarginate, cuspidate, villous above and below. Stipules adnate to the petiole, the free ends subulate. Bracts reduced to a collar at the juncture of the pedicel and peduncle. Flowers 18-28 mm long, borne singly on peduncles 5-20 mm long, few to several from each bud; pedicels 3-6 mm long. Calyx turbinate to short-cylindric, glabrous; tube 5.0-8.0 mm long; teeth 1-2 mm long, the nerves in each denture extended into a short spine, the margin minutely hairy. Pods 25-40 mm long, straight, linear-oblong, sessile, glabrous; the valves coiling upon dehiscence.

C. frutex does not appear to be as widely cultivated in the north-central states as C. arborescens. It is, however, an attractive spring-flowering shrub. C. frutex constitutes an important part of the landscape plantings on the campus of Iowa State University. The plants are hardy and occasionally produce some flowers in the autumn as well as in the spring.

Caragana frutex is typified by Robinia frutex L. Since the writer has not seen the type and the original description is not adequate to typify the species he has had to rely upon the treatments of Komarov (1908) and Rehder (1949).

Komarov (1908) has reported that C. frutex is native from eastern
Europe to the Ural Mountains and Siberia. The plants from our region flower in May and frequently again in September and early October.

Tschechow (1930) has reported the somatic chromosome number of C. frutex (as C. frutescens) to be 32.

**GLYCYRRHIZA L.**


Liquiritia Nutt. Fraser Cat. 1813, nom. nud. (fide Nutt., 1818).

Plants herbaceous perennials. Leaves odd-pinnate stipulate; leaflets several to many, glandular punctate. Raceme several- to many-flowered; flowers yellowish or whitish. Calyx short-cylindric, glutinous; teeth lanceolate. Pods armed with uncinate appendages, indehiscent (in ours).

Glycyrrhiza is a widely distributed genus of about 15 species which occur in the Mediterranean region of Europe, subtropical Asia, Australia, extratropical South America and western North America. From G. glabra, an eastern European and western Asiatic species, is extracted the commercial licorice.

Only a single species is known from the United States. Its roots are evidently devoid of licorice properties and it is relegated to the position of a weedy species.

**Glycyrrhiza lepidota** Pursh (Map 20. Plate XVIII, Fig. A)


Liquiritia lepidota Nutt. Fraser Cat. 1813. nom. nud. (fide Nutt., 1818).


Stems 35-85 cm long, ascending to erect, few to several from creeping rootstocks, pubescent throughout, the younger parts glandular punctate. Stipules 3-9 mm long, lanceolate, sparsely pubescent. Leaves 8-17 cm long; leaflets 15-19, 20-45 mm long, 5-17 mm wide, lanceolate, acute, glandular punctate on both surfaces, pubescent along the veins on the lower surface. Peduncles 3-7 cm long, sparsely villous and glandular throughout. Bracts lanceolate, scarious, glandular punctate and pubescent on the dorsal surface, exceeding half the length of the calyx. Racemes 3-8 cm long, many-flowered, dense. Flowers 3-12 mm long, yellowish. Calyx short-cylindric, glandular pubescent; tube 3-4 mm long; teeth 2.0-3.5 mm long, lanceolate. Pods 15-18 mm long, sessile, covered with uncinate appendages.

The species has been treated by various authors as consisting of an eastern variety with merely glandular punctate leaves and stems and a western variety with glandular-villous stems. The western form has been called variety glutinosa. All except a small number of our plants appear to belong to the eastern form of the species. There is a great
deal of variation in the degree of glutinosity from plants which are almost glandless to those in which the glands are very dense.

Beyond our region the species extends north into Saskatchewan and Alberta then southward to California and Texas. The plants grow on moist lake shores, in pasture land, along riverbanks, and in prairies. The blooming period extends from mid-June to early September.

The somatic chromosome number of *G. lepidota* is reported by Led-ingham (1957) to be 16.

**HALIMODENDRON** Fischer

*Halimodendron* Fischer ex DC., Prodr. 2:269. 1825.


*Pseudoacacia* sensu Moench, Meth. 146. 1794. pro parte.


*Halimodendron* is a monotypic genus which appears to be closely related to the genus *Caragana*. The plants are native to the region extending from the Caucasus to the Altai. The species has been widely cultivated in Europe but evidently to a much lesser extent in this country.

*Halimodendron halodendron* (Pall.) Schneider (Plate XVII, Fig. D)

*Halimodendron halodendron* (Pall.) Schneider Ill. Handb. Laubh. 293, fig. 58. 1907.


*Caragana argentea* Lam. Encyc. 1:616. 1783.

*Pseudoacacia halodendron* (Pall.) Moench Meth. 146. 1794.


*Halimodendron argenteum* (Lam.) Fisch. in DC., Prodr. 2:269. 1825.

*Halimodendron argenteum* var. *a vulgare* Fisch. ex DC., Prodr. 2:269. 1825.

*Halimodendron argenteum* var. *subvirescens* Fisch. ex DC., Prodr. 2:269. 1825.

*Halimodendron subvirescens* (Fisch.) G. Don Gen. Syst. 2:244. 1832.


*Halimodendron halodendron* forma *purpureum* Schneider Ill. Handb. Laubh. 293. 1907.
Plate XVII. Sesbania exaltata. A. Inflorescence and subtending leaf. B. Leaf. C. Fruit. Halimodendron halodendron, D. Section of stem with leaves, flowers and last year's fruit.
Shrubs to 2 m tall. Leaves 2-4 cm long, even-pinnate; the rachis produced at a spine and sometimes persistent at a thorn; leaflets 4, 5-20 mm long, 2-8 mm wide, distant, oblanceolate, cuspidate, minutely puberulent above and below. Stipules short, persistent as spines. Peduncles 10-25 mm long. Bracts to 1 mm long. Inflorescence 1- to 3-flowered; flowers 13-17 mm long, pink-purple. Calyx turbinate; tube 3-4 mm long; teeth to 1 mm long, broadly triangular, the margin pubescent. Pods 20-25 mm long, inflated, obovoid, glabrous, dehiscent; stipe 2-5 mm long.

H. halodendron is presently known from only two locations in the north-central states, cultivated on college grounds at Iowa State University and North Dakota State College. The Fargo, North Dakota plant is a robust shrub spreading by means of rhizomes. It flowers profusely and produces numerous pods which persist throughout the winter. The Iowa State University plants are in a poor state of vigor and have not flowered for several years.

This species seems to have possibilities as a spring-flowering ornamental and might be expected to do well in some of the more arid and saline parts of our region.

OXYTROPIS DC.

Oxytropis DC. Astragal. 24, 66. 1802. nom cons. (homonymum prius Spiesia Neck.)


Herbaceous perennial plants, mostly acaulescent. Leaves alternate, odd-pinnate. Stipules connate-clasping, adnate to the petiole, ovate to lanceolate or triangular. Inflorescence a scapose raceme. Bracts lanceolate to ovate. Flowers few to many, purplish, yellowish, or whitish; the keel-tip produced into a beak, maculate or immaculate. Calyx tube cylindrical or campanulate, 5-toothed. Pods sessile or subtipitate (in ours), straight, erect (reflexed in O. deflexa), papery, leathery, or woody, 2-celled or partly so by the intrusion of the ventral (upper) suture.

The genus Oxytropis, with its circumboreal distribution, is best represented in Europe and Asia. Of the possibly 200 species in this genus only 22 are known for North America and only one-third of those occur within the north-central states.

Validity of the Genus

Oxytropis is defined on the basis of flower structure, pod characteristics, and habit. No single character is infallible in the separation of Oxytropis from the closely related genus Astragalus, and certain authors (e.g. Tidestrom, 1937 and Shinners, 1958) have combined the two genera. On this point the writer agrees with Barneby (1952). Until it can be shown that the gap between the two genera is no greater than that existing between sections within Astragalus, that there are species referable with equal justice to either genus, or that Oxytropis is polyphyletic, the
submergence of Oxytropis in the older genus will do nothing to clarify relationships. Indeed, a union of the two genera is not only impractical but patently unrealistic in the phylogenetic sense.

It is this author's (possibly somewhat subjective) opinion that Oxytropis represents a unified phyletic group, related to, but definitely apart from, the sprawling Astragalus assemblage. Such overlap of characters as appears to exist seems due to somewhat parallel evolutionary tendencies and not to inter-reticulation of the constituent complexes.

In the species from our region there is no major problem in the separation of the members of the two genera. The beaked-keel is prominent in all of our species of Oxytropis and is not present in any of the Astragali. In all except one species of Oxytropis in the north-central states the pods are erect, and in all of them the pods are partly or completely 2-celled by the intrusion of the ventral (upper) suture. Only a few north-central states Astragali bear erect, 2-celled pods; in these, the dorsal (lower) suture is intruded. The caespitose, acaulescent habit of Oxytropis is common to all of our species except O. deflexa.

Relationships

On morphological bases the species of Oxytropis present in the north-central states can be divided into three phylogenetic lines. O. deflexa, with the caulescent habit and reflexed pods, and O. splendens, with its fastigate leaflets, do not appear to be closely related to the other members in our region. The remaining species are morphologically much alike and possibly represent an irregular natural unit. However, O. multiceps with its inflated calyces is perhaps less closely related to the other members (O. lambertii, O. sericea, O. campestris, O. viscida).

Cytology

The basic chromosome number of the genus appears to be 8; cytological studies indicate that the genus contains a series of polyploids. The chromosome number is known for five of our species; two are diploids, one is a tetraploid, and two are hexaploids.

Key to the Species of Oxytropis

1. Plants usually caulescent; stipules only slightly adnate to the petioles; pods pendulous. O. deflexa
   1. Plants scapose or subscapose, stipules adnate to the petioles; pods erect or spreading.
   2. Inflorescence and pod glandular-viscid. O. viscida
   2. Inflorescence and pod variously pubescent, but not glandular-viscid.
   3. Leaves with verticillate leaflets. O. splendens
   3. Leaves with leaflets opposite or scattered, but not verticillate.
   4. Pubescence of malpighian hairs; the flowers usually pink-purple. O. lambertii
   4. Pubescence basifixed; flowers purplish, yellowish, or whitish.
Oxytropis campestris (L.) DC. (Map 21. Plate XVIII, Fig. B)

5. Racemes 1- to 5-flowered, subcapitate; calyx expanding in fruit. O. multiceps

5. Racemes 6- to many-flowered, subcapitate to elongate; calyx not expanding in fruit.

6. Corolla purplish, pinkish, or bluish (plants from North Dakota, Minnesota, or Wisconsin). O. campestris

6. Corolla whitish or yellowish, rarely purplish (plants from the Black Hills and western Nebraska).

7. Flowers mostly 12-15 mm long, yellowish; the keel usually immaculate; foliage green. O. campestris

7. Flowers mostly 18-25 mm long, whitish (rarely purplish); the keel-tip usually maculate; foliage sericeous. O. sericea

Oxytropis campestris (L.) DC. Astragalus, 74. 1802. (fide Barneby, 1952).

Astragalus campestris L. Sp. Pl. 761. 1753.
Spiesia monticola (A. Gray) Kuntze Rev. Gen. 207. 1891.
Aragallus monticola (A. Gray) Greene Pittonia 3:212. 1897.

*Oxytropis gracilis A. Nels. Erythea 7:60. 1899.
pro parte.
Oxytropis luteola (Greene) Piper and Beattie Fl. N.W. Coast 227. 1915.

Oxytropis albirtina (Greene) Rydb. Fl. Pl. Prair. and Pl. 484. 1932.
*Oxytropis chartacea Fassett Rhodora 38:95. 1936.
Plate XVIII. Glycyrrhiza lepidota, A. Inflorescence and leaf. Oxytropis campestris, B. Plant with inflorescence.


Plants caespitose, acaulescent, from a branching caudex. Leaves 7-20 cm; leaflets 13-33, 11-26 mm long, 2-5 mm wide, lance-elliptic to linear oblong; opposite or distant, pilose above and below with simple hairs, green. Stipules ovate to lanceolate, acuminate, connate, adnate to the petioles, villous, ciliate. Scape 8-20 cm, villous. Raceme 3-9 cm, lax. Bracts linear-lanceolate, herbaceous, longer than the calyx. Flowers 12-17 mm long, yellow, pink-purple, or polychrome. Calyx cylindric, villous with dark and light hairs; tube 6.0-6.5 mm; teeth 2.5-3.5 mm, triangular. Pods sessile, 8-15 mm long, extended into a beak, erect, pilose, partially 2-celled by intrusion of the upper (ventral) suture.

This widely distributed (Eurasia and North America) complex is represented, according to Barneby's (1952) interpretations, by three varieties in the north-central states out of a total of eight in North America. The writer has attempted to critically evaluate the varieties present in our region and has found Barneby's treatment to be reasonably adequate. However, much work still remains to be done concerning the interrelationships of the varieties and the details of their distribution.

The relationships of O. campestris to the other species of Oxytropis in the north-central states are uncertain. There are intermediate forms between O. campestris var. gracilis and O. sericea. These are (perhaps in arbitrary fashion) usually referable to one species or another. The cytology of such populations should prove interesting because the somatic chromosome number of O. campestris var. gracilis is reported as 32 and that of O. sericea (var. spicatus) is said to be 48 (Ledingham, 1957). Barneby (1952) has suggested that O. campestris var. dispar arose as a fertile hybrid between O. lambertii and O. campestris var. gracilis. The cytological nature of variety dispar is unknown, but the somatic chromosome number of O. lambertii has been reported by Ledingham (1957) as 48. O. viscida appears to be closely related to O. campestris, and indeed it may represent an evolutionary line from some basic O. campestris type.

The writer has not seen the type of O. campestris and the original description is not adequate to typify this species. Therefore, the treatment by Barneby (1952) has been followed. The list of synonyms presented above include only those names belonging to that portion of the complex present in our region.

The O. campestris complex is circumboreal in the arctic and temperate regions of the world. The plants grow in prairies, meadows, and open woodlands in moist or dry soils. The blooming period extends from late May to mid-July.

Oxytropis deflexa (Pall.) DC. (Map 21. Plate XIX, Figs. A-C)

Oxytropis deflexa (Pall.) DC. Astragal. 33 tab. 27. 1802.
Map 21. Range of *Oxytropis campestris* and *O. deflexa*.

Map 22. Range of *Oxytropis lambertii*.
Aragallus deflexus (Pall.) A. Hell. Cat. N. Am. Pl. 4. 1898.
Oxytropis deflexa var. β sericea T. and G. Fl. N. Am. 1:342. 1838.
*Oxytropis retrorsa Fern. Rhodora 30:140. 1928.

Plants 10-40 cm tall, caespitose, caulescent (rarely acaulescent); stems long villous with simple hairs, decumbent to ascending, few to several from a caudex. Leaves 5-20 cm long; leaflets 23-39, 7-20 mm long, 2-8 mm wide, narrowly lanceolate, rounded at the base, villous with fine, simple hairs. Stipules 7-20 mm long, connate around the stems, slightly adnate to the petiole, the free ends lanceolate, villous dorsally. Peduncles 12-26 cm long, villous. Bracts lanceolate, shorter than the calyx tube, villous. Racemes 3-14 cm long, much elongating in fruit, many-flowered. Flowers 6-9 mm long, whitish, pinkish, or bluish. Calyx campanulate, villous; tube 2.5-3.5 mm long; teeth 2.5-4.0 mm long, narrowly lanceolate. Pods 8-18 mm long, spreading or reflexed, narrowly oblong, straight or curved, sulcate on the ventral suture, striglucose.

The members of this species in the north-central states represent only a small part of an enormous complex which occurs from the Altai Mountains of western Mongolia eastward through Siberia to Alaska and then southward along the Rocky Mountains to California and New Mexico. Other parts of the complex extend eastward across Canada to Newfoundland and a relict is also present in arctic Norway (Barneby, 1952).

The figure of Astragalus deflexus Pallas (tab. XV) in the Acta Academiae Scientiarum Imperialis Petropolitanae is clearly that of this species.

According to Barneby (1952) the portion of the complex represented by the material from our region belongs to O. deflexa var. sericea. The evaluation of this variety and its position in relation to the total deflexa complex is beyond the scope of the present paper. However, in order to limit the number of synonyms the list was restricted to those names involved with variety sericea.

The plants grow in wooded areas, along streams, and on lake shores. The flowering occurs during July and August.

The somatic chromosome number of O. deflexa is reported to be 16 (Ledingham, 1957).

Oxytropis lambertii Pursh (Map 22. Plate XX, Figs. A, B)

Astragalus lambertii (Pursh) Spreng. Syst. 3:308. 1826.
Spiesia lambertii (Pursh) Kuntze Rev. Gen. 207. 1891.
Aragallus lambertii (Pursh) Greene Pittonia 3:212. 1897.
Plate XIX. Oxytropis deflexa, A. Plant. B. Flowering raceme. C. Fruiting raceme.
Plants 10-50 cm tall, caespitose, acaulescent, arising from a branching caudex. Leaves 8-23 cm long; leaflets 7-19, 5-40 mm long, 2-6 mm wide, narrowly lanceolate, elliptic, or linear, opposite or scattered, strigose to pilose above and below with malpighian hairs. Stipules persistent, pilose to glabrate dorsally, adnate to the petiole. Scape 6-30 cm long. Bracts lanceolate, pilose dorsally, shorter or longer than the calyx tube. Racemes 4-10 cm long, at first dense, becoming lax in age, 6- to 18-flowered. Flowers 12-25 mm long, pink-purple (rarely white). Calyx cylindric, strigulose; tube 5.0-9.0 mm; teeth 1.5-4.0 mm, narrowly triangular. Pods 8-15 mm long, sessile, oblong to ovoid, extending into a beak, erect, villous, 2-celled or nearly so by the intrusion of the ventral (upper) suture.

O. lambertii is our most widespread species of Oxytropis. It occurs in a number of habitats and is highly variable. An indication of the variability of this complex is found in the number of synonyms which have arisen as the result of the description of minor variants as distinct species. At least a part of the variation is the result of phenotypic expression which is conditioned by the type of habitat in which the plants grow. The plants from better sites often grow to 40 cm in height (including the scapose raceme) and the leaflets are long, broad and thin in texture. However, plants from poor habitats such as overgrazed pastures, or from dry regions where competition is keen, may not exceed 10 cm in height and the leaflets are frequently very small and thick in texture.

The plants also vary in the degree of pubescence, leaflet shape, pod shape and length, and in flower size. Aragallus aven-nelsonii Lunell (isotype, MIN) is a low-growing form of O. lambertii in which the leaflets are narrow and few in number. A. angustatus Rydberg (isotype, MIN) is a depauperate form similar to A. aven-nelsonii. Oxytropis bushii Gandoger and O. falcatus Greene were both based on parts of the same collection. An isotype of those two species (MIN) demonstrates the plant involved to be a part of the O. lambertii complex in which the leaflets are narrow, involute, and stiff. O. involutus A. Nelson likewise possesses
Plate XX. *Oxytropis lambertii*, A. Plant with inflorescence. B. Section of fruiting raceme.
involute leaflets (isotype, MIN). *Aragallus formosus* Greene was based on robust plants with broad leaflets and compact inflorescences (type, US). The type of *A. rigens* is a glabrate, narrow-leaved plant bearing mature pods. The pods are tipped by long attenuate beaks.

If all of the variants of this complex were similarly designated as distinct species the list of synonymy would be endless. Indeed, the plants observed by the writer in a single short-grass prairie pasture in Sioux County, Nebraska would easily constitute several species as described by Greene, Rydberg, and Nelson. The flowers of one plant did not exceed 12 mm in length and the leaflets are short and narrow. Other plants had flowers over 20 mm long, and long, broad leaflets. A population of robust, large-flowered plants was noted in Morrill County, Nebraska. The flowers were more than 20 mm in length and the calyces were densely villous.

Plants which appear to be hybrids between *O. lambertii* and *O. sericea* do occur. They commonly take on the flower color of *O. lambertii*, but have the pubescence characteristics of *O. sericea*.

Beyond our region the species extends from Manitoba and Saskatchewan south to southern Arizona and north-central Texas. The plants are highly ubiquitous. They occur in prairies, badlands, and in the mountains in open woodlands. They grow on all types of soils from seleniferous clays to gravels. The blooming period extends from early May in the southern part of the range to late July in the northern part.

Ledingham (1957) has reported the somatic chromosome number of *O. lambertii* to be 48.

*Oxytropis multiceps* Nutt. (Map 23)


*Oxytropis multiceps* var. minor A. Gray Proc. Am. Acad. 20:2. 1884.

*Spiesia multiceps* (Nutt.) Kuntze Rev. Gen. 207. 1891.

*Aragallus multiceps* (Nutt.) A. Hell. Cat. N. Am. Pl. 4. 1898.


Plants 2-10 cm tall, caespitose, acaulescent, from a branching caudex. Leaves 1-5 cm long; leaflets 5-9, 5-13 mm long, lanceolate, oblanceolate, elliptic, or oblong, acute or rarely obtuse, silky-pilose or silvery. Stipules 4-14 mm long, lanceolate to ovate, membranous, ascending pilose, adnate to the petioles. Scapes 1.5-3.0 cm long, equalling or commonly shorter than the leaves, spreading or prostrate. Bracts herbaceous, ovate to lanceolate. Racemes 1- to 4-flowered. Flowers 17-24 mm long, pink-purple (drying bluish). Calyx swollen at anthesis, in fruit much inflated, densely villous; tube 5.5-10 mm; teeth 2.0-3.0 mm, triangular.
Map 23. Range of *Oxytropis multiceps*, *O. sericea*, *O. splendens*, and *O. viscosa*.

Map 24. Cultivated range of *Robinia hispida*, *R. neomexicana*, and *R. viscosa*.
Pod 6–10 mm long, included in the calyx and falling with it, dorsally compressed and sulcate ventrally, partially 2-celled by the intrusion of the ventral suture, villous, chartaceous; stipe to 1.5 mm long.

This species is included in our flora on the basis of a single collection (Rydberg) from the Upper Lawrence Fork, Kimball County, Nebraska. Its status otherwise in the north-central states is unknown. It is possible that the entity is adventive, but it does occur in eastern Wyoming and Colorado not far removed from the Nebraska location.

Beyond our region *O. multiceps* occurs in southeastern Wyoming and northeastern Colorado. The plants flower during June. They grow on gravelly summits and bare ridges.

**Oxytropis sericea** Nutt. (Map 23. Plate XXI, Figs. A, B)

**Aragallus sericea** (Nutt.) Greene Pittonia 3:212. 1897.
**Aragallus saximontanus** A. Nels. Erythea 7:190. 1899.
**Aragallus saximontanus** var. *condensatus* (A. Nels.) A. Nels. Erythea 7:190. 1899.
**Oxytropis albus** (A. Nels.) E. Schum. Just's Jahresb. 27:496. 1901. non *O. albiflora* Bunge 1874.
**Aragallus pinetorum** var. *vegavan* Ckll. Torreya 2:155. 1902.
Plate XXI. *Oxytropis sericea*, A. Plant with inflorescence. B. Fruit.
Plants 15-50 cm tall, caespitose, acaulescent, from a branching caudex. Leaves 3.5-30 cm long; leaflets 11-25, 10-40 mm long, 4-9 mm wide, pilose to sericeous above and below with simple pubescence, ovate to elliptic or lanceolate. Stipules adnate to the petioles, villous to glabrate dorsally, ciliate, connate. Scapes 11-27 cm long. Bracts narrowly lanceolate, shorter than or equalling the calyx tube, villous dorsally, herbaceous. Racemes 6- to 27-flowered, commonly elongating in fruit. Flowers 15-25 mm long, whitish or yellowish; the keel purple-tipped. Calyx cylindric, villous with dark and light hairs; tube 7.5-9.5 mm; teeth 2.0-3.5 mm, villous with black and white hairs. Pods 10-25 mm long, erect, sessile, oblong to ovoid, coriaceous, or nearly woody, rigid, densely strigulose, 2-celled or nearly so by the intrusion of the ventral (upper) suture.

*O. sericea* as herein interpreted exhibits a wide degree of variation in flower color, stature, leaflet shape and texture, and in the degree to which the vesture is sericeous. The flowers are commonly white or light yellow with purple-tipped keels, but specimens from Nebraska may bear purple flowers. The leaflets are usually thick in texture and densely sericeous. However, plants bearing thin leaflets which are green in color are common. This latter group of plants seem to inhabit more mesophytic situations, such as open woods and north-facing slopes. Those plants with thick, densely sericeous leaves tend to occur in more exposed, xeric situations.

Many earlier workers treated *O. sericea* as an element of the *O. lambertii* complex. There are, however, several consistent distinctions, among them the woody pods and finer, basifixed hairs of the latter species.

Over much of the range of *O. sericea* the whitish flowers with purple-tipped keels can be used as a distinguishing feature. However, where *O. sericea* is contiguous with *O. campestris* there is a series of intermediates which tend to lack the purple-tipped keels, and frequently, where *O. sericea* grows in close contact with *O. lambertii*, there is a series of intermediates which have purple flowers.

Many of the variants of *O. sericea* have been described as either distinct species or varieties. *O. lambertii* var. ochroleuca is based on a form of *O. sericea* with whitish flowers (type, RM). The variety *condensatus* is a dwarf form of the species in which the racemes and scapes are much contracted (type, RM). *Aragallus invenustus* (type, US) is similar to Nelson's variety ochroleuca. *Aragallus majusculus* (type, US), *A. aboriginum* (type, US), and *A. pineorum* (type, US) are all based on extremely robust specimens of *O. sericea*.

The writer has not seen the type of *O. sericea* and has based the typification of the species on the interpretation of Barneby (1952) who cites the type specimen from the New York Botanical Garden.

In order to limit the number of synonyms listed in the present paper the writer has included only those which are involved with *O. sericea* var. *sericea* as per Barneby's treatment.

The species extends from Manitoba and British Columbia south to
Utah and New Mexico. The plants grow in plains, prairies, and foothill areas in our region. They flower during May and June.

The somatic chromosome number of *O. sericea* has been reported by Ledingham (1957) to be 48 (in var. *spicata*).

**Oxytropis splendens** Dougl. (Map 23. Plate XXII, Fig. A)


Spiesia splendens (Dougl.) Kuntze Rev. Gen. 207. 1891.

Aragallus splendens (Dougl.) Greene Pittonia 3:211. 1897.

Aragallus caudatus Greene Pittonia 4:69. 1899.

Oxytropis caudatus (Greene) K. Schum. Just's Jahresb. 27:496. 1901.

Oxytropis richardsonii (Hook.) K. Schum. Just's Jahresb. 27:496. 1901.


Plants 10-35 cm tall, caespitose, acaulescent; stems from a branching woody caudex. Leaves 7-29 cm long; leaflets verticillate on the rachis in 7-15 fascicles (40-70 leaflets); 5-25 mm long, 2-6 mm wide, narrowly lanceolate, rounded at the base. villous throughout; petioles and rachis shaggy villous. Stipules membranous, long pilose dorsally, the free ends triangular to acuminate, adnate to the petioles. Peduncles 9-29 cm long, long-villous. Bracts narrowly lanceolate, shorter than or equaling the calyx, villous dorsally. Racemes 3-10 cm long, little elongating in fruit, many-flowered. Flowers 12-15 mm long, pinkish or bluish. Calyx cylindric, long-villous; tube 5.0-6.0 mm long; teeth 2.0-4.0 mm long. Pods 10-17 mm, ovoid to oblong, sulcate on both sutures, chartaceous, villous; beak 3-4 mm long.

*O. splendens* is a widespread species of the Rocky Mountains and the northern part of North America. Indeed this taxon possibly represents an extension of an old-world complex of related plants which are morphologically similar in having verticillate leaflets. The specimens from our region represent the southern extension of the species in the plains.

*O. splendens* is well marked by its compact, cylindric raceme of
Plate XXII. Oxytropis splendens, A. Plant with inflorescence.
small purplish flowers, whorled leaflets, and fine silky-villous pubescence. It is a rather stable species. The plants vary mainly in two ways; the length of the bracts and the degree of pubescence. Most of the proposed segregates have been based on various combinations of these two characters.

The writer has not seen the type of *O. splendens*, but several Douglas specimens have been examined (OXF). This material is congruent with the original description, and falls within the limits of the taxon as understood in our region.

Beyond our region the plants extend from Ontario to Alaska and south through the mountains to New Mexico. They occur in upland situations in prairies and along river banks. The blooming period extends from late June to late July.

The somatic chromosome number of *O. splendens* has been reported to be 16 (Ledingham, 1958).

**Oxytropis viscida** Nutt. (Map 23)


pro syn.


*Spiesia viscida* (Nutt.) Kuntze Rev. Gen. 207. 1891.

*Aragallus viscis* (Nutt.) Greene Pittonia 3:211. 1897.


*Oxytropis ixodes* Butters and Abbe Rhodora 45:2. 1943.

Plants caespitose, acaulescent, from a branching caudex. Leaves 8-16 cm long; leaflets 31-51, 7-17 mm long, 2-3 mm broad, narrowly lanceolate to linear-lanceolate, glabrous above, sparsely pilose to glandular below. Stipules adnate to the petiole, connate, the free ends acuminate, pilose to glabrous dorsally, ciliate. Scape 12-20 cm long. Bracts linear-lanceolate, equalling or longer than the calyx tube, pilose and glandular dorsally. Racemes 6- to 20-flowered, little elongating in fruit. Flowers 11-16 mm long, pink-purple (fading blue-purple). Calyx cylindric, villous with dark and light hairs; tube 5-6 mm; teeth 2.5-4.0 mm, narrowly lanceolate, the dorsal surface glandular and villous. Pods 13-16 mm long including a beak 4-5 mm long, chartaceous, partially 2-celled by intrusion of the ventral suture, strigose with black hairs, glandular-viscid.
The main range of *Oxytropis viscida* occurs in the western and northwestern parts of North America. However, it is known from localized relict stations as far east as the Gaspe Peninsula, Quebec. Our material has gone under the name of *O. ixodes*. This "species" is known only from Cook County, Minnesota, and adjacent Canada. As herein interpreted *O. ixodes* falls within the limits of the *O. viscida* complex. Had the specimens of *O. ixodes* originated in the west, rather than in a station remote from the main area of the species, they would have been referred without difficulty to *O. viscida*.

Barneby (1952) has included our material in the type variety and for the purpose of limiting the synonymy only those names involved with that variety are included in the present paper.

No type has been seen and the writer has based typification of *O. viscida* on the treatment of Barneby (1952) who cites the type collection (NY, PH).

Beyond our region the species extends from the Gaspe Peninsula, Quebec to northern Canada and Alaska then southward to California and Colorado. The plants in our region grow on rocky hillsides and talus slopes. They flower from late June to mid-July.

### ROBINIA L.

**Robinia L. Sp. Pl. 722. 1753.**


Shrubs or trees. Leaves odd-pinnate; leaflets petiolulate; stipels shorter or longer than the petiolules. Stipules setaceous and caducous or modified into persistent spines. Inflorescences several- or many-flowered. Flowers showy, whitish or pinkish. Calyx campanulate to turbinate; the teeth triangular or triangular-acuminate. Pods elongate, laterally flattened.

*Robinia* is a poorly understood genus of about 15 species which is native to the United States and Mexico. The original distribution of several of the species prior to the arrival of white men is often difficult to determine. These are species which have been cultivated in areas far beyond their native ranges, and to some degree secondarily escaped. These same plants have received the attention of nurserymen and gardeners. Many horticultural forms have been produced.

Several Robinias occur in our area almost entirely as cultivated ornamentals; they are not native to the north-central states. Botanists, unfortunately, have generally avoided collecting cultivated plants unless the plants escape or persist after cultivation. Hence, our herbarium representation of these kinds in this region is fragmentary and any attempt to understand the present distribution must be incomplete.

Our species can be divided into two natural series on the basis of the degree of fusion of the upper two calyx lobes. Both *R. pseudoacacia* and *R. viscosa* have calyces in which the upper two teeth are fused into a lip-like structure. The sinus between the two teeth is very shallow. In *R. hispida* and *R. neomexicana* the upper two teeth are separated by a deep sinus and are similar in shape to the other teeth.
Cytological studies of members of the genus indicate a basic chromosome number of 10 (or 11). Three of our species are reported to be diploids and one is believed to represent a triploid.

Key to the Species of Robinia

1. Upper two calyx teeth coniate, forming a lip; branchlets and peduncles are hispid.
   2. Branchlets and peduncles glandular-viscid; flowers a rose-pink. *R. viscosa*
   2. Branchlets and peduncles glabrous; flowers white. *R. pseudoacacia*

1. Upper two calyx teeth deeply cleft, the lobes triangular-acuminate; branchlets and peduncles or both glandular-hispid.
   3. Branchlets and peduncles densely glandular-hispid; a shrub. *R. hispida*
   3. Branchlets glabrous; peduncles glandular-hispid or glandular-pubescent; a small tree. *R. neomexicana*

*Robinia hispida* L. (Map 24. Plate XXIII, Fig. A)

Robinia hispida L. Mant. 101. 1767.
Robinia hispida var. macrophylla DC. Prodr. 2:262. 1825.
Robinia macrophylla Schrad. ex DC., Prodr. 2:262. 1825. pro syn.
Robinia hispida var. typica Schneider Ill. Handb. Laubh. 2:81. 1907.
*Robinia fertilis* Ashe Rhodora 25:182. 1923.
Robinia hispida var. typica Clausen Gent. Herb. 4:291. 1940.
Robinia hispida var. fertilis (Ashe) Clausen Gent. Herb. 4:291. 1940.

Stoloniferous shrubs to 2 m tall; branchlets and peduncles densely glandular-hispid. Leaves 16-27 cm; leaflets 7-13, 30-60 mm long, 15-40 mm wide, ovate to lance-ovoid, petiolulate, glabrous above, sparingly villous below, obtuse, cuspidate; stipules equaling the petiolules; lower portion of the rachis glandular-hispid. Stipules 9-12 mm long, linear, villous. Peduncles 1-4 cm long. Racemes 4-6 cm long, several-flowered; rachis glandular-hispid. Flowers 18-30 mm long, rose-pink. Calyx broadly campanulate, glandular pubescent; tube 4.5-6.0 mm long; teeth 3.5-7.0 mm long, triangular-acuminate. Pods densely hispid.

Since specimens of this attractive flowering shrub are poorly represented in herbaria it is difficult to determine the extent to which it is cultivated. It is commonly seen in cultivation through the central part of this region.
Plate XXIII. *Robinia hispida*, A. Inflorescence and leaf.
The cytological nature of material which was presumably *R. hispida* has been investigated by Kreuter (1930) and Whitaker (1934). Both have reported the somatic chromosome number as 30. Kreuter noted that meiosis was irregular, and that he was unable to get a gametic chromosome count. In somatic material he found that there were 20 small and 10 large chromosomes (a triploid). Whitaker checked for pollen sterility in *R. hispida* and found that 88% of the pollen was not viable. Possibly because of meiotic failure fruit and seeds are seldom produced by the plant typically known as *R. hispida*.

Clausen (1940), after reviewing *R. hispida*, combined *R. fertilis* with the hispida complex. His photograph of the Linnaean type of *R. hispida* removed all doubt as to the typification of that species. His photograph of the type of *R. fertilis* appears to represent a plant which morphologically at least would seem to fall within this complex.

Both Kreuter (1930) and Whitaker (1934) have reported a somatic chromosome number of 30 for *R. hispida*. Whitaker reported the somatic chromosome number of *R. fertilis* to be 20. However, since Whitaker did not preserve voucher specimens (C. E. Wood, Cambridge, Mass., personal communication, 1959) the identity of his material may be open to question. Until further work is done, cytological conclusions must remain in abeyance.

The species is not native to the north-central states; its original range was probably from Virginia and Kentucky to Georgia and Alabama. The flowering time is during June and July.

*R. neomexicana* A. Gray (Map 24. Plate XXIV, Figs. A, B)

*Robinia luxurians* (Dieck) Schneider ex Tarouca and Schneider Uns. Freil.-Laubh. ec. 2. 357. fig. 417. 1922. (fide Rehder, 1949).

Shrubs or small trees to 8 m tall. Leaves 10-20 cm long; leaflets 9-19, 10-40 mm long, 2-20 mm wide, lance-oblong to oblong, obtuse, cuspidate, minutely pubescent above and below; stipels shorter than the petiolules. Stipules 5-15 mm long, persistent as spines or soon deciduous. Peduncles 2-4 cm long, glandular-pubescent to hispid throughout. Bracts broadly ovate, equaling the calyx tube, soon deciduous. Racemes 2-6 cm long, several to many-flowered; the rachis glandular-pubescent. Flowers 15-25 mm long, pink. Calyx campanulate, glandular pubescent; tube 5-8 mm long; teeth 3-5 mm long, triangular-acuminate. Pods 4-8 cm long, glandular-pubescent, glandular-hispid, or rarely glabrous.
Plate XXIV. *Robinia neomexicana*, A. Inflorescence and leaf. B. Fruit.
The southwestern complex to which this species belongs has been variously interpreted. Rydberg (1924) recognized five distinct species, Rehder (1951) at least two. Both Harrington (1954) and Kearney and Peebles (1951) recognize only a single species in Colorado and Arizona.

The segregates from *R. neomexicana* have been based on variations in amount and position of pubescence and on the habit of the plants. *R. rusbyi* (type, US) was based upon material having glabrous pods. *R. breviloba* is a depauperate form of *R. neomexicana* (type, NY) bearing small leaflets and short, curved stipular spines. The type of *R. subvelutina* (NY) demonstrates it to be a pubescent form. *R. luxurians* is described as being a small tree with curved stipular spines, puberulent leaflets and leaf rachis, and calyx lobes longer than the tube (Rydberg, 1924). The variability of these segregates appears to be largely the result of varied phenotypic expressions to the different habitats in which the plants grow. The segregates are herein treated as belonging to a single polymorphic species.

The species is represented in the north-central states only in cultivation. The specimens from our region vary considerably in the degree of pubescence and its location on the pods, peduncles, and branchlets. A specimen collected at Stergis, Meade Co., South Dakota (ISC) is only sparsely glandular pubescent and most of the glands are located in the calyx. The upper two calyx teeth are more connate than in other specimens examined.

The distribution of material examined is indicated in Map 24. Owing to the paucity of available material, this is probably a rather incomplete picture.

The native range of this entity is from Colorado to Nevada, south to Texas, Mexico, and Arizona. The plants flower during May, June, and early July.

The somatic chromosome number of *R. neomexicana* had been reported by Tishler (1938) to be 22.

**Robinia pseudoacacia** L. (Map 25. Plate XXV, Figs. A,B)

Robinia pseudoacacia L. (Map 25. Plate XXV, Figs. A,B)
Plate XXV. *Robinia pseudoacacia*, A. Inflorescence and leaf. B. Fruit.
The species has been widely cultivated throughout the United States and in Europe as well. Many horticultural varieties have been named and are commonly available in nurseries.

The wood of *R. pseudoacacia* is used as fence posts and is extremely durable in contact with the soil. It is also used as an ornamental and as a soil erosion plant.

*R. pseudoacacia* is the most widely distributed of the species of *Robinia* present in the north-central states. The plants are possibly native to southern Indiana, southern Illinois, and much of Missouri (at least the Ozark region). The range of the specimens examined is indicated in Map 25. Beyond our range the plants are presumably native from Pennsylvania to Georgia, Louisiana, and Oklahoma.

The somatic chromosome number has been reported to be 20 by Kreuter (1930) and Whitaker (1934), but Tschechow (1930) reported the somatic number as 22.

**Robinia viscosa** Vent. (Map 24)


Trees to 14 m tall; branchlets, peduncles and petioles glandular-viscid. Leaves 10-15 cm long; leaflets 13-25, 25-35 mm long, 10-18 mm wide, lance-oblong to oblong, minutely pubescent above and below, obtuse, cuspidate; stipels shorter than the petiolules. Stipules none or present and persisting as spines, to 8 mm long. Peduncles 3-4 cm long. Bracts ovoid, acuminate, soon deciduous. Racemes 4-8 cm long, several- to many-flowered. Flowers 18-25 mm long, pink; the standard with a yellow spot. Calyx turbinate, minutely pubescent; tube 4-5 mm long, teeth 2-3 mm long, the upper two connate, the sinus shallow. Pods 4-6 cm long, glandular-hispid.

These plants are cultivated and rarely escape in our region. In some areas they may form extensive growths on abandoned farmsteads or in the strip-mining areas of Indiana.

The species was described by C. Ventenat from materials discovered (Vauquelin, 1799, p.161) "dans la Caroline méridionale, sur les monts Allégani, vers les sources de la rivière Savannah." The writer has not seen the type of this species, but Ventenat's description could hardly apply to any other species of *Robinia*.

The plants are native from Pennsylvania south to Alabama. They flower in June in our region.

The somatic chromosome number of *R. viscosa* has been reported to be 20 by Whitaker (1934).

**Sesbania Scop.**

*Sesbania Scop.* Introd. 308. 1777. nom cons. (homonymum prius *Sesban* Adans).
Map 25. Range of specimens examined of *Robinia pseudoacacia*.

Map 26. Range of *Tephrosia virginiana*.

Sesbania is a genus of about 50 species which is distributed in the warmer parts of both hemispheres. Some of the members of the genus are of importance for use as green manures in soil improvement. In rice growing regions of the southern states the native species have proved to be troublesome weeds.

The genus has been variously interpreted by taxonomists in the past. In a broad sense the group includes the segregates Sesban, Agati, Daubentonnia, Glottidium, and Daubentoniopsis. Rydberg (1924) maintained all of them as distinct genera primarily on the basis of fruit characters. Turner (1955) has suggested, on the basis of cytological investigations, that it is best to treat the genus conservatively. As treated herein, Sesbania is defined on the basis of the single species represented in our area.

**Sesbania exaltata** (Raf.) Cory (Map 20. Plate XVII, Figs. A-C)

**Sesbania exaltata** (Raf.) Cory Rhodora 38:406. 1936.
**Darwinia exaltata** Raf. Fl. Ludov. 106. 1817.
**Sesbania macrocarpa** Muhl. ex Nutt., Gen. 2:112. 1818.
**Sesban exaltatus** (Raf.) Rydb. N. Am. Fl. 24:204. 1924.

Erect annual plants to 3 m tall. Leaves 10-25 cm long, even-pinnate; Leaflets 24-70, 10-20 mm long, 2-5 mm wide, narrowly oblong, mucronate, glabrous. Stipules setaceous. Peduncles 2-5 cm long. Bracts setaceous nearly equalling the pedicels. Racemes 2- to 6-flowered. Flowers 15-20 mm long, yellow within, purple-mottled without. Calyx campanulate, glabrous; tube 4.5-6.0 mm long; teeth 1.5-2.5 mm long, triangular. Pods 10-20 cm long, linear; the tip prolonged as a beak; the seeds separated by transverse partitions.

*S. exaltata* has been used to some extent as a green manure and as a cover plant in wildlife plantings in the southeastern part of the United States. It is also frequently a weed in irrigated rice fields. In our area *S. exaltata* is relegated to the position of a weed of wet alluvial soils.

It is possible that *S. exaltata* is identical to the tropical species *S. emerus* (Aubl.) Urb. However, until it is possible to do further study of this complex and to adequately typify the members it is better to treat our material as a distinct species.

Beyond our region the species extends southwestward to Texas and eastward to Florida. The plants grow in low, moist areas, along streams and in waste lands. They flower during August and September.

Turner (1955) has reported the somatic chromosome number of *S. exaltata* to be 12.
TEPHROSIA Pers.

Tephrosia Pers. Syn. 2:328. 1807. nom. cons. (homonymum prior
Cracca L.).
Cracca L. Sp. Pl. 752. 1753. non Cracca Benth 1853.
Galega L. Syst. ed. 10. 1172. 1759. pro parte.

Perennial herbs with long roots. Leaves odd-pinnate, stipulate. In-
florescences terminal, or if axillary then arising opposite the leaves.
Flowers papilionaceous. Stamens diadelphous (the vexillar-stamen fre-
quently partially fused). A collar-like receptacle present at the base of
the ovary within the staminal tube. Calyx broadly campanulate, the
lanceolate lobes exceeding the tube. Pods linear, dehiscent.

Tephrosia is a large genus of perhaps 250 species which is widespread
in the warm regions of both hemispheres. They are especially numerous
in tropical Africa and in Australia. In this country the bulk of the
species, about 15, are known from the southeastern states.

Several of the species produce rotenone and related compounds and
are thus a potential source of insecticides. The plants have been used
as fish poisons in Australia, Africa, Asia, and America. Tephrosia
species have also been used in tropical agriculture as green manures,
cover-crops, and soil binders.

Only a single species is present in our region.

Tephrosia virginiana (L.) Pers. (Map 26. Plate XXVI, Figs. A, B)

Cracca virginiana L. Sp. Pl. 752. 1753.
Galega virginiana L. Syst. ed. 10. 1172. 1759.
Tephrosia virginiana var. holosericea (Nutt.) T. and G. Fl. N. Am.
1:296. 1838.
Cracca virginiana var. holosericea (Nutt.) Vail Bull. Torrey Club
22:27. 1895.
Tephrosia leucosericea (Rydb.) Cory Rhodora 38:406. 1936.
Tephrosia virginiana var. leucosericea (Rydb.) Herm. Jour. Wash.

Plants perennial; stems 30-60 cm tall, erect, several from a branch-
ing caudex, villous with spreading hairs. Stipules 5-10 mm long, seta-
ceous, caducous. Leaves 8-11 cm long, odd-pinnate; leaflets 17-29,
15-30 mm long, 4-8 mm wide, narrowly oblong to elliptic, mucronate,
villos above and below or glabrous above. Inflorescences terminal or
occasionally axillary, 3-15 cm long. Flowers 15-20 mm long, several
to many, the banner yellowish, the wings and keel pinkish or purplish;
the banner dorsally strigose. Calyx campanulate, densely villous; tube
2.5-4.5 mm long, teeth 3.5-7.0 mm long, lanceolate. Pods 3.5 cm long,
linear-oblong, villous, erect or spreading.
Plate XXVI. *Tephrosia virginiana*, A. Inflorescence and leaves. B. Fruit.
There is a considerable degree of variation in the amount and position of the pubescence in *T. virginiana*. Most of our material is hairy on both leaf surfaces but occasional specimens have glabrous upper leaf surfaces. Wood (1949) has discussed the variability of this species with respect to the varieties which have been proposed. He concluded that *T. virginiana* was a single, widespread, genetically diverse species lacking in both distinct morphological and geographical variations, but which tends to be more pubescent in the northwestern part of its range.

Beyond our region the species extends south to Texas and east to Florida and north to New Hampshire and Ontario. The plants grow in sand dunes, open woods, and in prairies. The blooming period extends from late May to mid-July.

Both Senn (1938) and Wood (1949) have reported the somatic chromosome number to be 22.

ACKNOWLEDGMENTS

The writer wishes to express his deep gratitude to Professor Duane Isely for assistance in selection of the problem and for the constructive criticisms and words of encouragement offered throughout the course of this investigation.

Support through the Iowa Agricultural Experiment Station and through the Industrial Science Research Institute made possible the field work required in this problem.

The cooperation of the librarians at Iowa State University is deeply appreciated. Special thanks are due Dr. G.B. Van Schaack of the Missouri Botanical Garden Library. His enthusiastic assistance in finding rare botanical volumes has proved invaluable in the preparation of this paper.

To the writer’s wife, Stella, deepest appreciation is expressed. Her untiring devotion, hard work, and cooperation have made this work possible.

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The names presented in the following list consist of: (1) the synonyms of the species treated in the foregoing work, and (2) those names of species previously reported from the north-central states (and their synonyms), which are excluded from this treatment on one basis or another.

The names in the left column are the synonyms; those in the column on the right are the names of the species in the present treatment.

<table>
<thead>
<tr>
<th>ARAGALLUS</th>
<th>Oxytropis sericea Nutt.</th>
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<tr>
<td>A. aboriginum Greene</td>
<td>Oxytropis sericea Nutt.</td>
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<td>A. albertinus Greene</td>
<td>Oxytropis campestris (L.) DC.</td>
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<td>A. albilflorus A. Nels</td>
<td>Oxytropis sericea Nutt.</td>
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<td>A. angustatus Rydb.</td>
<td>Oxytropis lambertii Pursh</td>
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<td>A. aven-nelsoni Lunell</td>
<td>Oxytropis lambertii Pursh</td>
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<td>Oxytropis deflexa (Pall.) DC.</td>
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<td>A. lambertii (Pursh) Greene</td>
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<td>A. macounii Greene</td>
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<td>A. monticola (A. Gray) Greene</td>
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<td>A. pinetorum A. Hell.</td>
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<td>A. pinetorum var. veganus Ckll.</td>
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<td>A. richardsonii (Hook.) Greene</td>
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<td>A. rigens Greene</td>
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<td>A. saximontanus A. Nels.</td>
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<td>A. saximontanus var. condensatus (A. Nels.) A. Nels.</td>
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<tr>
<td>A. spicatus (Hook.) Rydb.</td>
<td>Oxytropis sericea Nutt.</td>
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Rejected. This name was applied by Rydberg (1932) to specimens of *Oxytropis sericea* from the Black Hills region.
A. splendens (Dougl.) Greene
A. veganus (Ckll.) Woot. & Standl.
A. villosus Rydb.
A. viscidus (Nutt.) Greene
A. viscidulus Rydb.
A. viscidulus var. depressus Rydb.

Oxytropis splendens Dougl.
Oxytropis sericea Nutt.
Oxytropis campestris (L.) DC.
Oxytropis viscida Nutt.
Oxytropis viscida Nutt.

ASTRAGALUS

A. aboriginum (Richards.) Spreng.
A. aboriginum var. fastigorum M.E. Jones
A. aboriginum var. glabriusculus (Hook.) Rydb.
A. acerbus Sheld.
A. adspersens sensu authors
A. adspersens var. albiflorus Blankin.
A. adspersens var. pauperculus Blankin.
A. adspersens β robustior Hook.
A. agrestis var. polyspermus M.E. Jones
A. albertinus (Greene) Tidestr.
A. albiflorus (A. Nels.) Gand.
A. albiflorus (A. Nels.) Tidestr.
A. alpinus var. americanus (Hook.) Sheld.
A. ammolotus Greene
A. andinus (Nutt.) M.E. Jones
A. angustus M.E. Jones
A. angustus var. ceramicus (Sheld.) M.E. Jones
A. angustus var. imperfectus (Sheld.) M.E. Jones
A. angustus var. picipis M.E. Jones
A. astragalinus (DC.) Sheld.
A. batesii A. Nels.
A. bisonsum Tidestr.
A. bisulcatus forma hedysariformis Gand.
A. bodini Sheld.
A. bourgovii A. Gray

Oxytropis aboriginorum Richards.
Oxytropis aboriginorum Richards.
Oxytropis aboriginorum Richards.
Astragalus tenellus Pursh
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Astragalus americans (Hook.) Jones
Astragalus lotiflorus Hook.
Astragalus alpinus L.
Astragalus ceramicus Sheld.
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Astragalus ceramicus Sheld.
A. caespitosus (Nutt.) A. Gray
A. campestris (Nutt.) A. Gray
A. campestris var. hyophilus (Rydb.) M.E. Jones
A. campestris L.
A. canadensis var. brevidens (Gand.) Barneby
A. canadensis var. carolinianus (L.) M.E. Jones
A. canadensis var. longilobus Fassett
A. canadensis forma monticola Gand.
A. canadensis var. mortoni (Nutt.) S. Wats.
A. carnosus Pursh
A. carolinianus L.
A. caryocarpus Ker
A. ceramicus var. jonesii Sheld.
A. ceramicus var. imperfectus Sheld.
A. ceramicus var. longilobus (Pursh) Rydb.
A. chandonnetii Lunell
A. convallarius Greene
A. convallarius var. hyophilus (Rydb.) Tidestr.
A. crassicarpus var. pachycarpus
A. crassicarpus var. trichocalyx (Nutt.) Barneby
A. crassipes Fraser
A. dasyglottis Nutt.
A. decumbens (Nutt.) A. Gray
A. debilis sensu Jones
A. deflexus Pall.
A. elatiocarpus Sheld.
A. fendleri A. Gray
A. filifolius A. Gray
A. flexuosus Dougl.
A. flexuosus var. elongatus (Hook.) M.E. Jones
A. flexuosus var. fendleri
A. flexuosus var. sierraee-blancae (Rydb.) Barneby
A. foliolosus (A. Gray) Sheld.
A. forwoodii S. Wats.
A. frigidus sensu Gray
A. spatulatus Sheld.
A. miser Dougl. (loc. cit.)
A. canadensis L.
Oxytropis campestris (L.) DC.
A. canadensis L.
A. canadensis L.
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A. canadensis L.
A. ceramicus Sheld.
A. ceramicus Sheld.
Oxytropis deflexa (Pall.) DC.
A. lotiflorus Hook.
A. flexuosus (Hook.) Don
A. flexuosus (Hook.) Don
A. flexuosus (Hook.) Don
A. flexuosus (Hook.) Don
A. flexuosus (Hook.) Don
A. ceramicus Sheld.
Astragalus ceramicus Sheld.
A. ceramicus Sheld.
Astragalus ceramicus Sheld.
Astragalus ceramicus Sheld.
Astragalus ceramicus Sheld.
Astragalus ceramicus Sheld.
Astragalus ceramicus Sheld.
Astragalus ceramicus Sheld.
Astragalus ceramicus Sheld.
A. agrestis Dougl.
Astragalus ceramicus Sheld.
Astragalus bodini Sheld.
Astragalus ceramicus Sheld.
Astragalus flexuosus (Hook.) Don
Astragalus flexuosus (Hook.) Don
Astragalus aboriginorum Richards.
Astragalus americanus (Hook.) Jones
A. frigidus var. americanus (Hook.) S. Wats.
A. galegoides Nutt.
A. gaspensis (Fern. & Kels.) Tidestr.
A. giganteus Sheld.
A. glabriusculus (Hook.) A. Gray
A. glabriusculus var. major A. Gray
A. glabriusculus var. spatiosus Sheld.
A. glycyphyllus L.

A. goniatius Nutt.
A. gracilentus var. fallax (S. Wats.) M.E. Jones
A. gracilis β erectus Hook.
A. gracilis var. parviflorus (Pursh) F.C. Gates
A. grayanus Tidestr.
A. haydenianus forma leiocarpa Gand.
A. hylophilus (Rydb.) A. Nels.
A. hylophilus var. oblongifolius (Rydb.) Macbr.
A. hypoglossis sensu authors
A. hypoglossis var. polyspermus T. & G.
A. incurva (Rydb.) Abrams
A. kentrophyta A. Gray
A. lambertii (Pursh) Spreng.
A. laxmanni Nutt.
A. leptocarpus T. & G.

A. longifolius (Pursh) Rydb.
A. longifolius (Pursh) Gates
A. lotiflorus β brachypus A. Gray
A. lotiflorus var. cretaceus (Buckl.) Gates
A. lotiflorus var. elatiocarpus (Sheld.) Rydb.
A. lotiflorus var. nebraskensis Bates
A. lotiflorus a pedunculosus A. Gray
A. lotiflorus var. reverchonii (A. Gray) M.E. Jones
A. mazama (St. John) G.N. Jones

Astragalus americanus (Hook.) Jones
Astragalus racemosus Pursh
Oxytropis viscosa Nutt.
Astragalus alpinus L.
Astragalus aboriginorum Richards.
Astragalus aboriginorum Richards.
Astragalus aboriginorum Richards.

Rejected. The writer has seen one specimen of this species from our region. It was grown from seed reported to have been produced from adventive plants in Indiana. Astragalus agrestis Dougl.
Astragalus flexuosus (Hook.) Don
Astragalus gracilis Nutt.
Astragalus gracilis Nutt.
Oxytropis campestris (L.) DC.
Astragalus bisulcatus (Hook.) Gray
Astragalus miser Dougl. (loc. cit.)
Astragalus miser Dougl. (loc. cit.)

Astragalus agrestis Dougl.
Astragalus agrestis Dougl.
Astragalus agrestis Dougl.

Astragalus purshii Dougl.
Astragalus tegetarius S. Wats.
Oxytropis lambertii Pursh
Astragalus striatus Nutt.
Rejected. This species was reported from Kansas (Rydberg, 1932), but no specimens have been seen from that state. Astragalus ceramicus Sheld.
Astragalus ceramicus Sheld.
Astragalus lotiflorus Hook.
Astragalus lotiflorus Hook.
Astragalus lotiflorus Hook.
Astragalus lotiflorus Hook.
Astragalus lotiflorus Hook.
Oxytropis campestris (L.) DC.
A. melanocarpus Nutt.
A. mexicanus A. DC.

A. mexicanus var. trichocalyx (Nutt.) Fern.
A. microlobus A. Gray
A. microphacos Cory
A. miser Dougl.

A. miser var. hylophilus (Rydb.) Barneby
A. miser var. oblongifolius (Rydb.) Cronq.
A. missouriensis β Nutt.
A. missouriensis forma leucophaea
A. missouriensis forma longipes Gand.
A. missouriensis forma microphylla Gand.
A. mitophyllus Kearney
A. montanus (Nutt.) M. E. Jones
A. mortoni Nutt.
A. mortoni forma brevidens Gand.
A. mortoni forma rydbergii Gand.
A. multiflorus (Pursh) A. Gray
A. nebraskensis (Bates) Bates
A. neglectus (T. & G.) Sheld.
A. neglectus forma limonius (Farwell) Fern.
A. nigrescens (Hook.) A. Gray
A. nitidus Dougl.
A. nitidus var. robustior (Hook.) M. E. Jones
A. pachycarpus T. & G.
A. pachystachys Rydb.
A. parviflorus (Pursh) MacMil.
A. parviflorus var. microlobus (A. Gray) M. E. Jones
A. parvifolius Nutt.
A. pauciflorus Hook.
A. pectinatus var. platyphyllus M. E. Jones
A. pictus A. Gray
A. pictus var. angustus M. E. Jones

Astragalus missouriensis Nutt.
Rejected. This name was long used in place of A. trichocalyx Nutt.
See discussion under that species.

Astragalus trichocalyx Nutt.

Astragalus gracilis Nutt.
Astragalus gracilis Nutt.
Rejected. The writer has seen a single sheet of this species from the Black Hills of South Dakota. It was collected in 1895 by A. Pratt, but has not been collected since that time even though the region has been botanized by numerous collectors.

Astragalus missouriensis Nutt.

Astragalus ceramicus Sheld.
Astragalus tegetarius S. Wats.
Astragalus canadensis L.
Astragalus canadensis L.
Astragalus canadensis L.
Astragalus tegetarius S. Wats.
Astragalus canadensis L.
Astragalus plattensis Nutt.
Astragalus canadensis L.
Astragalus gracios Nutt.
Astragalus gracios Nutt.

Astragalus gracios Nutt.
Astragalus vexilliflexus Sheld.
Astragalus pectinatus Dougl.

Astragalus ceramicus Sheld.
Astragalus ceramicus Sheld.
| A. pictus var. filifolius (A. Gray) | Astragalus ceramicus Sheld. |
| A. pictus var. foliolosus A. Gray | Astragalus ceramicus Sheld. |
| A. pictus var. magnus M. E. Jones | Astragalus ceramicus Sheld. |
| A. plattensis var. missouriensis (A. Gray) | Astragalus tennesseensis A. Gray |
| A. plattensis var. tennesseensis | Astragalus tennesseensis A. Gray |
| A. prunifer Rydb. | Astragalus crassicarpus Nutt. |
| A. purshii var. incurvus (Rydb.) | Astragalus purshii Dougl. |
| A. purshii var. interior M. E. Jones | Astragalus racemosus Pursh |
| A. racemosus var. brevisetus M. E. Jones | Astragalus racemosus Pursh |
| A. racemosus var. longisetus M. E. Jones | Astragalus racemosus Pursh |
| A. racemosus var. treleasei C. L. Porter | Astragalus racemosus Pursh |
| A. racemosus var. typicus C. L. Porter | Astragalus racemosus Pursh |
| A. reverchoni A. Gray | Astragalus lotiflorus Pursh |
| A. richardsoni Sheld. | Astragalus aboriginorum Richards. |
| A. rydbergianus Tidestr. | Oxytropis campestris (L.) DC. |
| A. saximontanus (A. Nels.) Tidestr. | Oxytropis sericea Nutt. |
| A. scobatinatulus Sheld. | Rejected. Specimens (MO) bearing this name as annotated by Sheldon are A. racemosus Pursh. |
| A. setosus Pursh | Astragalus missouriensis Nutt. |
| A. shortianus Nutt. | Rejected. This species has been reported from Nebraska and So. Dakota, but no specimens of it have been seen from those states. Specimens bearing that name from Nebraska are Astragalus lotiflorus Hook. |
| A. simplex Tidestr. | Astragalus spatulatus Sheld. |
| A. simplicifolius var. caespitosus (Nutt.) M. E. Jones | Astragalus spatulatus Sheld. |
| A. simplicifolius var. spatulatus (Sheld.) M. E. Jones | Astragalus spatulatus Sheld. |
| A. spatulatus var. simplex Tidestr. | Astragalus spatulatus Sheld. |
| A. spicatus Nutt. | Astragalus canadensis L. |
| A. splendens (Dougl.) Tidestr. | Oxytropis splendens Dougl. |
| A. splendens var. richardsonii (Hook.) Tidestr. | Oxytropis splendens Dougl. |
| A. striatus forma chandonnetti (Lunell) Moore | Astragalus striatus Nutt. |
| A. succulentus Richards. | Astragalus crassicarpus Nutt. |
| A. succulentus var. paysoni Kels. | Astragalus crassicarpus Nutt. |
| A. sulphurescens Rydb. | Astragalus striatus Nutt. |
| A. tenellus var. strigulosus (Rydb.) Herm. | Astragalus tenellus Pursh |
A. tenellus forma acerbus (Sheld.) Macbr.
A. tenellus var. clementis (Rydb.) Macbr.
A. tenellus forma strigulosa (Rydb.) Macbr.
A. triphyllus Pursh
A. torreyi Rydb.
A. vaginatus sensu authors
A. virgulatus Sheld.
A. viridis (Nutt.) Sheld.
A. viscidus (Nutt.) Tidestr.

ASPALATHUS
A. caragana (L.) Kuntze
A. frutescens (L.) Kuntze

ATELOPHRAGMA
A. aboriginum (Richards.) Rydb.
A. alpinum (L.) Rydb.
A. elegans (Hook.) Rydb.
A. forwoodii (S. Wats.) Rydb.
A. glabriusculum (Hook.) Rydb.
A. wallowense Rydb.

BATIDOPHACA
B. cretacea (Buckl.) Rydb.
B. lotiflora (Hook.) Rydb.
B. nebraskensis (Bates) Rydb.

CARAGANA
C. arborescens var. typica Schneider
C. arenaria Dippel
C. argentea Lam.
C. caragana Karsten
C. cuneata Moench
C. digitata Lam.
C. frutescens (L.) DC.
C. frutescens angustifolia DC.
C. frutescens var. grandiflora

Oxytropis viscida Nutt.
C. frutescens a latifolia DC.
C. frutex var. grandiflora Koehne
C. frutex var. macrantha Rehder
C. frutex var. typica Schneider
C. glomerata Hort.
C. halodendron Hoff.
C. inermis Moench
C. microphylla Lam.

C. parvifolia Hoff.
C. pygmaea (L.) DC.

C. pygmaea var. arenaria Maxim
C. sibirica Medic.

CNEMIDOPHACOS
C. pectinatus (Dougl.) Rydb.

COLUMEA
C. astragalina (DC.) Poir.

CRACCA
C. holosericea Britt. & Baker
C. leucosericea Rydb.
C. virginiana L.
C. virginiana var. holosericea (Nutt.) Vail

CTENOPHYLLUM
C. pectinatum (Hook.) Rydb.

CYTOSPORA
C. elatiocarpa (Sheld.) Lunell
C. lotiflora (Hook.) Lunell

DALEA
D. parviflora Pursh

Caragana frutex (L.) Koch
Caragana frutex (L.) Koch
Caragana frutex (L.) Koch
Caragana frutex (L.) Koch
Caragana frutex (L.) Koch
Halimodendron halodendron (Pall.) Schneider
Caragana arborescens Lam.
Rejected. The writer has seen only a single specimen of this species. It was collected from the Iowa State University campus prior to 1900.
Caragana frutex (L.) Koch
Rejected. The writer has seen only a single specimen of this species. It was collected from the Iowa State University campus prior to 1900.
Caragana aurantiaca Koehne
Caragana arborescens Lam.

Astragalus pectinatus (Hook.) Don
Astragalus alpinus L.

Tephrosia virginiana (L.) Pers.
Tephrosia virginiana (L.) Pers.
Tephrosia virginiana (L.) Pers.
Tephrosia virginiana (L.) Pers.

Astragalus pectinatus (Hook.) Don
Astragalus lotiflorus Hook.
Astragalus lotiflorus Hook.

Astragalus gracilis Nutt.
DARWINIA
D. exaltata Raf.

DIOHOLCOS
D. bisulcatus (Hook.) Rydb.
D. decalvans (Gand.) Rydb.

ERVUM
E. multiflorum Pursh

GALEGA
G. officinalis L.
G. virginiana L.
G. virginica J.F. Gmel.

GEOPRUMNON
G. crassicarpus (Nutt.) Rydb.
G. mexicanum sensu Rydb.
G. pachycarpum (T. & G.) Rydb.
G. plattense (Nutt.) Rydb.
G. succulentum (Richards.) Rydb.
G. tennesseensis (A. Gray) Rydb.
G. trichocalyx (Nutt.) Rydb.

GLYCYRRHIZA
G. glutinosa Nutt.
G. lepidota var. glutinosa (Nutt.) S. Wats.

HALIMODENDRON
H. argenteum (Lam.) Fisch.
H. argenteum subvirescens Fisch.
H. argenteum a vulgare Fisch.
H. cuspidatum Jaubert & Spach
H. emarginatum Jaubert & Spach

Sesbania exaltata (Raf.) Cory
Astragalus bisulcatus (Hook.) Gray
Astragalus bisulcatus (Hook.) Gray

Rejected. The writer has seen two sheets of this species. Both were collected prior to 1900. It might occur occasionally as a weed
Tephrosia virginiana (L.) Pers.
Tephrosia virginiana (L.) Pers.

Astragalus crassicarpus Nutt.
Astragalus crassicarpus Nutt.
Astragalus trichocalyx Nutt.
Astragalus plattensis Nutt.
Astragalus plattensis Nutt.
Astragalus tennesseensis A. Gray
Astragalus tennesseensis A. Gray
Astragalus trichocalyx Nutt.

Glycyrrhiza lepidota Pursh
Glycyrrhiza lepidota Pursh

Halimodendron halodendron (Pall.) Schneider
Halimodendron halodendron (Pall.) Schneider
Halimodendron halodendron (Pall.) Schneider
Halimodendron halodendron (Pall.) Schneider
Halimodendron halodendron (Pall.) Schneider
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H. halodendron forma purpureum Schneider
H. halodendron (Pall.) Voss
H. speciosum Carr.
H. subvirescens (Fisch.) Don

HOLCOPHACOS
H. distortus (T. & G.) Rydb.

HOMALOBUS
H. aboriginorum (Richards.) Rydb.
H. aboriginum (Richards.) Rydb.
H. acerbus (Sheld.) Rydb.
H. brachycarpus Nutt.
H. caespitosus Nutt.
H. campestris Nutt.
H. canescens Nutt.
H. clementis Rydb.
H. decumbens Nutt.
H. dispar Nutt.
H. fendleri (A. Gray) Rydb.
H. flexuosus (Hook.) Rydb.
H. glabriusculus (Hook.) Rydb.
H. hylophilus Rydb.
H. montanus (Nutt.) Britt.
H. multiflorus (Pursh) T. & G.
H. nigrescens Nutt.
H. oblongifolius Rydb.
H. spatiosus (Sheld.) A. Hell.
H. stipitatus Rydb.
H. strigulosus Rydb.
H. tenellus (Pursh) Britt.

KENTROPHYTA
K. montana Nutt.
K. viridis Nutt.

LIQUIRITIA
Liquiritia lepidota Nutt.

LIQUIRITIA
Liquiritia lepidota Nutt.

MICROPHACOS
M. gracilis (Nutt.) Rydb.

H. halodendron forma purpureum Schneider
H. halodendron (Pall.) Voss
H. speciosum Carr.
H. subvirescens (Fisch.) Don

HOLCOPHACOS
H. distortus (T. & G.) Rydb.

HOMALOBUS
H. aboriginorum (Richards.) Rydb.
H. aboriginum (Richards.) Rydb.
H. acerbus (Sheld.) Rydb.
H. brachycarpus Nutt.
H. caespitosus Nutt.
H. campestris Nutt.
H. canescens Nutt.
H. clementis Rydb.
H. decumbens Nutt.
H. dispar Nutt.
H. fendleri (A. Gray) Rydb.
H. flexuosus (Hook.) Rydb.
H. glabriusculus (Hook.) Rydb.
H. hylophilus Rydb.
H. montanus (Nutt.) Britt.
H. multiflorus (Pursh) T. & G.
H. nigrescens Nutt.
H. oblongifolius Rydb.
H. spatiosus (Sheld.) A. Hell.
H. stipitatus Rydb.
H. strigulosus Rydb.
H. tenellus (Pursh) Britt.

KENTROPHYTA
K. montana Nutt.
K. viridis Nutt.

LIQUIRITIA
Liquiritia lepidota Nutt.

LIQUIRITIA
Liquiritia lepidota Nutt.

MICROPHACOS
M. gracilis (Nutt.) Rydb.
M. microlobus (A. Gray) Rydb.  
Astragalus gracilis Nutt.
M. parviflorus (Pursh) Rydb.  
Astragalus gracilis Nutt.

OROBUS

O. dispar Nutt.  
Astragalus tenellus Pursh
O. longilobus Nutt.  
Astragalus ceramicus Sheld.

OROPHACA

O. argophylla (Nutt.) Rydb.  
Astragalus hyalinus M.E. Jones
O. caespitosa (Nutt.) Britt.  
Astragalus gilviflorus Sheld.
O. sericea (Nutt.) Britt.  
Astragalus sericoleucus A. Gray

OXYTROPIS

O. albiflora (A. Nels.) K. Schum.  
Oxytropis sericea Nutt.
O. angustata (Rydb.) A. Nels.  
Oxytropis lambertii Pursh
O. aven-nelsoni (Lunell) A. Nels.  
Oxytropis lambertii Pursh
O. bushii Gand.  
Oxytropis lambertii Pursh
O. campestris var. chartacea (Fassett) Barneby  
Oxytropis campestris (L.) DC.
O. campestris var. dispar (A. Nels.) Barneby  
Oxytropis campestris (L.) DC.
O. campestris var. gracilis (A. Nels.) Barneby  
Oxytropis campestris (L.) DC.
O. campestris var. viscida (Nutt.) S. Wats.  
Oxytropis viscida Nutt.
O. cascadensis St. John  
Oxytropis campestris (L.) DC.
O. caudata (Greene) K. Schum.  
Oxytropis sericea Nutt.
O. chartacea Fassett  
Oxytropis campestris (L.) DC.
O. condensata (A. Nels.) A. Nels.  
Oxytropis sericea Nutt.
O. deflexa var. culminia Jeps.  
Oxytropis deflexa (Pall.) DC.
O. deflexa var. sericea T. & G.  
Oxytropis deflexa (Pall.) DC.
O. dispar (A. Nels.) K. Schum.  
Oxytropis campestris (L.) DC.
O. falcata (Greene) A. Nels.  
Oxytropis lambertii Pursh
O. gaspensis Fern. & Kels.  
Oxytropis viscida Nutt.
O. gracilis (A. Nels.) K. Schum.  
Oxytropis campestris (L.) DC.
O. hookeriana Nutt.  
Oxytropis lambertii Pursh
O. involuta (A. Nels.) K. Schum.  
Oxytropis lambertii Pursh
O. ixodes Butters and Abbe  
Oxytropis viscida Nutt.
O. lambertii β Hook.  
Oxytropis campestris (L.) DC.
O. lambertii γ T. & G.  
Oxytropis lambertii Pursh
O. lambertii forma mixta Gand.  
Oxytropis lambertii Pursh
O. lambertii var. ochroleuca A. Nels.  
Oxytropis sericea Nutt.
O. lambertii var. sericea (Nutt.) A. Gray  
Oxytropis sericea Nutt.
O. luteola (Greene) Piper & Beattie  
Oxytropis campestris (L.) DC.
O. luteola (Greene) A. Nels.  
Oxytropis campestris (L.) DC.
O. macounii (Greene) Rydb.

Rejected. The taxon represented by this name occurs to the north and west of our range. Rydberg (1932) cited this series as occurring in the north-central states. It was probably applied to O. sericea material.

O. mazama St. John
O. minor (A. Gray) Ckll.
O. mollis Nutt.
O. monticola A. Gray
O. multiceps var. minor A. Gray
O. okanoganea St. John
O. olympica St. John
O. oxyphylla sensu Richards.
O. pinetorus (A. Hell.) K. Schum.
O. plattensis Nutt.
O. retrorsa Fern.
O. retrosa var. sericea (T. & G.) Fern.
O. richardsonii (Hook.) K. Schum.
O. richardsonii (Hook.) Woot. & Standl.
O. saximontana (A. Nels.) A. Nels.
O. splendidens forma nelsoni Gand.
O. splendidens β richardsonii Hook.
O. splendidens forma strigosa Gand.
O. splendidens a vestita Hook.
O. vegana (Ckll.) Woot. & Standl.
O. villosus (Rydb.) K. Schum.
O. viscidula (Rydb.) Tidestr.

Oxytropis campestris (L.) DC.
Oxytropis multiceps Nutt.
Oxytropis viscida Nutt.
Oxytropis campestris (L.) DC.
Oxytropis multiceps Nutt.
Oxytropis campestris (L.) DC.
Oxytropis campestris (L.) DC.
Oxytropis splendens Doug.
Oxytropis sericea Nutt.
Oxytropis lambertii Pursh
Oxytropis deflexa (Pall.) DC.
Oxytropis deflexa (Pall.) DC.

PHACA

P. aboriginorum Hook.
P. adsurgens sensu Piper
P. agrestis (Dougl.) Piper
P. alpina (L.) Piper
P. americana (Hook.) Rydb.

Astragalus aboriginorum Richards.
Astragalus striatus Nutt.
Astragalus agrestis Doug.
Astragalus alpinus L.
Astragalus americanus (Hook.) Jones

P. andina Nutt.
P. argophylla Nutt.
P. astragalina DC.
P. bisulcata Hook.
P. bodini (Sheld.) Rydb.
P. caespitosa Nutt.
P. canadensis MacMil.
P. caryocarpa MacMil.
P. cretacea Buckl.
P. elatiocarpa (Sheld.) Rydb.
P. elongata Hook.

Astragalus alpinus L.
Astragalus hyalinus M. E. Jones
Astragalus alpinus L.
Astragalus bisulcatus (Hook.) Gray
Astragalus bodini Sheld. (loc. cit.)
Astragalus gilviflorus Sheld.
Astragalus canadensis L.
Astragalus crassicarpus Nutt.
Astragalus lotiflorus Hook.
Astragalus lotiflorus Hook.
Astragalus flexuosus (Hook.) Don
P. fendleri A. Gray
P. flexuosa Hook.
P. frigida var. americana Hook.
P. glabriuscula Hook.
P. gracilis (Nutt.) MacMil.
P. hypoglottis sensu MacMil.
P. longifolia (Pursh) Nutt.
P. lotiflora (Hook.) T. & G.
P. mollissima Nutt.
P. neglecta T. & G.
P. neglecta forma limonia Farwell
P. parvifolia Nutt.

P. pectinata Hook.
P. pectinatus (Hook.) Don
P. pectinatus (Hook.) Don
P. pectinatus (Hook.) Don
P. pectinatus (Hook.) Don
P. pectinatus (Hook.) Don
P. pectinata Hook.
P. picta A. Gray
P. plattensis (Nutt.) MacMil.
P. purshii (Dougl.) Piper
P. reverchoni (A. Gray) Rydb.
P. sericea Nutt.
P. triphylla (Pursh) Eaton and Wr.
P. villosa James
P. viridis (Nutt.) Britt.

PHYSOCALYX

P. multiceps Nutt.

PHYSONDRA

P. dispar (Nutt.) Raf.
P. longifolia (Pursh) Raf.

PISOPHACA

P. elongata (Hook.) Rydb.
P. flexuosus (Hook.) Rydb.
P. ratonensis Rydb.
P. sierrae-blancae Rydb.

PSEUDOACACIA

P. halodendron (Pall.) Moench
P. hispida (L.) Moench
P. odorata Moench

Astragalus flexuosus (Hook.) Don
Astragalus flexuosus (Hook.) Don
Astragalus americana (Hook.) Gray
Astragalus aboriginorum Richards.
Astragalus gracilis Nutt.
Astragalus agrestis Dougl.
Astragalus ceramicus Sheld.
Astragalus lotiflorus Hook.
Astragalus purshii Dougl.
Astragalus cooperi A. Gray
Astragalus cooperi A. Gray

Oxytropis multiceps Nutt.

Astragalus tenellus Pursh
Astragalus ceramicus Sheld.

Astragalus flexuosus (Hook.) Don
Astragalus flexuosus (Hook.) Don
Astragalus flexuosus (Hook.) Don
Astragalus flexuosus (Hook.) Don

Halimodendron halodendron (Pall.) Schneider

Robinia hispida L.
Robinia pseudoacacia L.
### PSORALEA

<table>
<thead>
<tr>
<th>Species</th>
<th>Author</th>
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<tbody>
<tr>
<td>P. longifolia Pursh</td>
<td></td>
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<tr>
<td>P. parviflora (Pursh) Poir.</td>
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<td>Astragalus ceramicus Sheld.</td>
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<tr>
<td>Astragalus gracilis Nutt.</td>
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### ROBINIA

<table>
<thead>
<tr>
<th>Species</th>
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<tbody>
<tr>
<td>R. acacia L.</td>
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<td>R. breviflora Rydb.</td>
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### SESBAN

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<td>Oxytropis multiceps Nutt.</td>
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<td>Astragalus cooperi A. Gray</td>
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T. tenella (Pursh) Kuntze  
T. triphylla (Pursh) Kuntze

Astragalus tenellus Pursh
Astragalus gilviflorus Sheld.

XYLOPHACOS

X. incurvus Rydb.
X. missouriensis (Nutt.) Rydb.
X. purshii (Dougl.) Rydb.

Astragalus purshii Dougl.
Astragalus purshii Dougl.
Astragalus purshii Dougl.
OBSERVATIONS ON THE OCCURRENCE OF COPPER(I) FLUORIDE
AS THE ACID-STABILIZED FLUOALUMINATE

Samuel von Winbush and John D. Corbett

Institute for Atomic Research and Department of Chemistry
Iowa State University, Ames, Iowa

ABSTRACT

Although copper(I) fluoride is unknown in the solid state there is some published evidence for its formation in solution in molten CuF$_2$. Since the addition of halide acids has been shown to stabilize lower oxidation states in similar systems, the Cu-CuF$_2$ reaction has been studied in the presence of AlF$_3$. The diamagnetism of the very inert, reddish-purple copper aluminum fluoride obtained at 996° has led to its formulation as a copper(I) fluoaluminate, possibly Cu$_3$AlF$_6$.

INTRODUCTION

It is commonly recognized that solid copper(I) fluoride is not thermodynamically stable. On the other hand, von Wartenberg (1) observed that CuF$_2$ apparently lost fluorine on fusion to give a solution of 8 to 10% CuF in CuF$_2$, and in the presence of copper metal the CuF concentration increased to 60 to 80%, with considerable depression of the freezing point. On solidification the presumed monofluoride usually disproportionated to metal and difluoride; however, in one instance a deep red, transparent solid was obtained that reverted to the original components before it could be examined structurally. In contrast, Ebert and Woitnek (2) had reported earlier that reaction of copper metal with a mixture of fluorine and chlorine gave, in addition to CuF$_2$, a layer next to the metal surface that was alleged to be CuF in the zinc sulfide structure. More recently, Crabtree, Lees and Little (3) were unable to find any evidence for the formation of CuF from a variety of reactions of the metal, copper(I) or copper(II) halides. They also noted that the lattice dimension reported for "CuF" (4.253 Å) was suspiciously close to that of Cu$_2$O (4.261 Å), a conceivable impurity on the metal employed by Ebert and Woitnek.

The apparent existence of CuF in a solution of CuF$_2$ but not in the solid state thus appears to be another example of the formation of the slightly-stable, lower halides that have been proposed to account for the apparent solution of a number of other metals in their molten halides (4). The instability of solid CuF (like aqueous Cu$^+$) can be attributed primarily to the much larger lattice (or hydration) energy of the dipositive state.

1 Contribution No. 905. Work was performed in the Ames Laboratory of the U. S. Atomic Energy Commission.
Therefore, the formation of a larger anion through complexing of the halide ion by an appropriate acid should materially reduce the difference in lattice energies of the compounds in the two oxidation states and hence the tendency to disproportionate. This approach has, for example, been recently employed in the isolation of solid cadmium(I) and gallium(I) tetrachloroaluminates. Accordingly, the reduction of CuF$_2$ by Cu has been investigated in the presence of the fluoride acid AlF$_3$, principally according to the stoichiometry required for the reaction

$$3 \text{Cu} + 3 \text{CuF}_2 + 2 \text{AlF}_3 = 2 \text{Cu}_3\text{AlF}_6.$$  

**EXPERIMENTAL**

The starting materials were Baker's 99.99% Reagent copper turnings and anhydrous CuF$_2$ and AlF$_3$ obtained from A.D. MacKay, New York. The "CuF$_2" as received had a pale green tint, and an X-ray powder pattern showed it to be mainly Cu(OH)F · CuF$_2$ together with small amounts of unidentified material and possibly copper chlorides. It was therefore hydrofluorinated in a copper boat in Inconel apparatus for 6 hrs. at 425 to 500°, after which the powder pattern data of the dull-white product agreed line for line with that reported for CuF$_2$. The AlF$_3$ was also hydrofluorinated when the presence of HF was noted on opening the reaction containers. Its powder pattern agreed very well with that reported for AlF$_3$. The fluorides were stored in evacuated containers.

The principal problem associated with the execution of the Cu-CuF$_2$-AlF reaction was a container sufficiently inert to the three components above 950°. Only copper itself was found to be suitable, and its melting point restricted reaction temperatures to those below 1084°. Graphite reduced CuF$_2$ to metal at 1150° while tantalum as well as tantalum coated with its carbide gave copper and the blue TaF$_3$ at 1100°. For use up to 1000-1050° a short length of hard copper tubing, 3/8 to 5/8" in diameter, was cleaned with HNO$_3$, pinched shut at one end, welded, and then loaded in the dry box with the weighed salts. After being crimped shut it was removed in a sample container and evacuated, and subsequently transferred to an argon- or helium-filled box where it was electrically welded. The sealed copper container was then enclosed in a stainless steel crucible with a welded lid. Failure of experiments was most commonly a result of rupture of the copper tube due to the internal pressure of inert gas, particularly when heated above 1050°. This was overcome to some extent by the use of 1 x 2" copper block in which a 3/8 x 1-7/8" hole had been drilled and, after being filled with the salts, was welded shut with a thick plug; this was in turn enclosed in a tightly-fitting tantalum crucible and a quartz tube.

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2 Compare the effect of increasing size of the halide ion in isostructural series (7). The increase in the extent of reduction in the melt can also be interpreted in terms of the related decrease in the electrostatic and/or complexing interactions of the higher oxidation state with the anion.
RESULTS AND DISCUSSION

In spite of a considerable number of container failures, particularly above 1000°, a product was obtained from the reaction of CuF₂ with the metal in the presence of AlF₃ that had properties strongly suggestive of a copper(I) compound. After the reaction mixture had been heated at 996° for about 30 hours, small shiny, reddish-purple spheres were found on and near the copper turnings in the white matrix of unreacted salts. The product was found to be apparently unaffected by all common reagents, hot as well as cold, and, although an analysis was therefore not attempted, major amounts of copper and aluminum were found upon spectrographic examination. The most powerful evidence that the product was a copper(I) compound was its diamagnetism, since all known copper (II) compounds are paramagnetic. In fact, a ruby-red, paramagnetic product, readily soluble in dilute acids, was obtained from the reaction of CuF₂ and excess AlF₃ without reduction. The X-ray powder pattern of the copper(I) compound was also unique, except for possibly a very minor AlF₃ content, and differed from known alkali metal fluoaluminates (9, 10). Although the evidence supports only a copper(I) fluoaluminate of the general type CuₓAlF₃₊ₓ, its formulation as Cu₃AlF₆ might be favored both by the similarity in radius of Cu⁺ to Na⁺, where NaAlF₄ and Na₂AlF₅ are unknown (11), and by the unfavorable effect of small, acidic cations on complex anion structures (13). Reaction was not observed with mole ratios of CuF₂ and AlF₃ other than that corresponding to the formation of AlF₆⁻.

After the above work had been completed it came to the attention of the authors that Sharp and Sharpe (14) had recently prepared toluene solutions of copper(I) fluoborate and hexafluophosphate, among others, by reduction of the corresponding silver salts with copper metal; they noted only disproportionation when the solvent was evaporated. As this effectively demonstrates the existence of copper(I) fluoride stabilized with other acids, albeit only in a weakly coordinating solvent, no further investigation of the fluoaluminates has been undertaken.

ACKNOWLEDGMENT

The authors are indebted to John Walker and Dr. A.H. Daane for the use of the hydrofluorination apparatus and the welding dry box, respectively.

3 The principal distances obtained, with relative intensities in parentheses, were: 5.71(2), 5.57(3), 2.84(2), 2.81(7), 2.44(5), 2.37(10), 2.13(4), 1.877(4), 1.726(3), 1.605(7), 1.428(5), 1.410(3), 1.397(5).

4 NaAlF₄ reportedly forms on rapid condensation of gaseous mixtures of NaF and AlF₃; however, the compound is unstable above 470° (or less) and does not appear in the phase diagram (12).
REFERENCES

SOME NOTES ON THE USE OF ROSA LAXA AS A SOURCE OF HARDINESS IN ROSE BREEDING

Griffith J. Buck

Department of Horticulture
Iowa State University
of Science and Technology
Ames, Iowa

The major objective of rose breeders since the introduction into Europe in 1792 of the everblooming clones of the southern Chinese R. chinensis-R. gigantea complex has been the development of everblooming roses capable of surviving the coldest winters without protection. To further this goal, various rose species indigenous to the colder areas of the northern hemisphere have been combined with the everblooming clones. The current classes of everblooming garden roses are the result.

Although hardier than their everblooming ancestors, current garden roses are not dependably winter-hardy in many sections of the country. Little improvement in this respect can be expected within existing rose groups, for the ancestral species do not contain factors for superior winter hardiness. The only recourse is the introduction into breeding programs of one or more rose species carrying factors for superior hardiness.

The tetraploid species, Rosa laxa, Retzius (4), which is indigenous to the dry steppes of central Siberia, is such a species. It has never been a popular garden subject, for it is lacking in many of the qualities demanded of ornamentals. The plants of R. laxa which are currently available in the United States have been derived by seed and asexual propagation from plants grown from seed collected by Hansen in the Altai region of Siberia in 1913. This collection was given the name 'Semi' to distinguish it from earlier ones (3). This species is closely allied to R. cinnamomea and is included in the section Cinnamomeae. The name 'laxa' has been given erroneously to two other roses; one, a form of R. blanda and the other, a form of R. canina.

Seedling populations of R. laxa show variation in plant height, degree of armature, presence and degree of pubescence on the foliage, and degree of remontance. Plant habit, flower color, foliage retention, disease tolerance, and hardiness are remarkably constant characteristics. The plants are very hardy, having survived, without protection of any kind, -30°F without injury (1). The plants are erect, vigorous, and range in height from four to eight feet. The young canes are yellow-green, changing to greenish-yellow with maturity. Bristles are plentiful on the basal portion of the canes. The flowering canes are free of bristles.
but have paired, curved infrastipular spines. Suckering is moderate. The large foliage is moderately susceptible to rose black spot and tolerant of powdery mildew. However, the foliage matures and is lost early so that the plants are bare, except for the immature growth at the tips of the canes, by mid-September. The two-inch, five-petalled, white flowers are borne in clusters of five, terminally on lateral shoots arising from canes of the previous season's growth. Flowers later in the season are borne on secondary laterals from stems bearing the June bloom. Although the plants flower profusely in late May and continue intermittently until frost, the small size of the flower and flower cluster contribute to the effect of sparseness.

Beginning with 1951, the clone listed in the literature as _R. laxa_ Morden (2) was used in combination with garden roses of several classes, both June-blooming and everblooming. Although Skinner (3) has used _R. laxa_ in combination with _R. spinosissima_ to produce June-blooming shrub roses, no reports have been found in the literature on the extensive use of this species in rose breeding to develop everblooming garden roses. It is thought that observations on the characteristics of these _F_₁ and later hybrids and a comparison with both the garden rose and species parents may be of interest to other breeders.

Although _R. laxa_ has been used as a parent in crosses in most of the years since 1951 in combination with other species, shrubs, and everblooming garden roses, this report is based upon crosses in which the Hybrid Tea cultivars 'Crimson Glory,' 'Mrs. Sam McGredy,' 'Happiness,' and 'Josef Rothmund,' a derivative of _R. eglanteria_ (5), were used as seed parents. Like most of the species comprising the Cinnamomeae, _R. laxa_ does not set seed readily with foreign pollen.

**Plant and Flower Characteristics of the _F_₁ Hybrids**

The _F_₁ seedlings resulting from the use of _R. laxa_ pollen on the cultivars 'Crimson Glory,' 'Mrs. Sam McGredy,' 'Happiness,' and 'Josef Rothmund' have, with the exception of certain seedlings, been fully hardy in normal Iowa winters. Some nonhardy seedlings coming from one of the Hybrid Tea cultivars, 'Crimson Glory,' display none of the characteristics of the pollen parent, leading to the assumption that they resulted from accidental self-pollination of the seed parent. The cultivars of the Hybrid Tea class survive winters here only with careful winter protection. 'Josef Rothmund' is half-hardy, retaining sufficient wood in most winters, without protection, to permit a limited flowering the following June (1). Resistance to high summer temperatures and drought have been satisfactory. The plants, as well as both parents, continue normal growth and retain their foliage through periods of deficient rainfall.

The development of disease tolerance has received considerable attention in the breeding program and is perhaps the greatest problem, next to hardiness, in areas where roses are grown. Most garden roses, including the ones used as seed parents in these crosses, are very susceptible to black spot and powdery mildew, _R. laxa_ is highly resistant to powdery mildew and is moderately susceptible to the strains of black spot.
peculiar to the Ames area. The F₁'s have proved to be no more resistant to blackspot infection than the garden rose parents. Powdery mildew has not been noticed on the F₁'s, even when conditions resulting in heavy infection on plants growing in adjacent rows are present.

Premature defoliation is a serious fault in _R. laxa_, which limits its use as an ornamental to those areas with a short growing season. The foliage of the F₁'s is intermediate in appearance to that of the parents. With the exception of a few seedlings, the foliage is lost as early as that of the species parent. In the case of the few individuals which retain their foliage until frost, the leaves take on autumnal coloring in bright scarlet, maroon and orange tones. This characteristic has not been noted in either parent.

In plant growth, the F₁'s are vigorous to very vigorous, more closely approaching their _R. laxa_ parent in this respect. In growth habit and height they are intermediate to the parents with no individuals closely approaching either parent.

Time of bloom is late May and early June, as in the _R. laxa_ parent. Neither the everblooming habit of the Hybrid Tea parent nor the remontant bloom habit of _R. laxa_ has been recovered in the F₁'s.

In the crosses with the Hybrid Teas, the flowers are intermediate to the parents in size, with none as small as those of the _R. laxa_ parent or as large as the flowers of the Hybrid Tea parent. There is a complete range in petalage from single flowers with five petals to very double blooms having more than 75 petals and petaloids. Flower form and texture are usually poor. Malformed pistils and stamens are the rule. Pollen, when it can be collected, is viable and is instrumental in obtaining a seed set on a wide range of garden rose cultivars.

The cross with 'Josef Rothmund' produced, with one exception, F₁ progeny whose appearance can be best described as dwarf forms of _R. laxa_. The influence of 'Josef Rothmund' is evident in the reduced size of the plant, freedom from suckering, smaller leaf size, and the presence of red pigmentation in the immature foliage and stems. The primocanes are sparsely bristly at the base. The infrastipular spines on the floracanes are lacking. Those spines which are present are straight or slightly hooked, as in _Rosa laxa_. Although it has the plant habit of the rest of the F₁'s of this cross, the exception mentioned above has the light salmon-pink, double flowers of 'Josef Rothmund.' This seedling was selected for further use in breeding.

**Plant and Flower Characteristics of Advanced _R. laxa_ Hybrids**

Several selections were made from the F₁ hybrids of the _R. laxa_-garden rose combinations. These were used in further breeding with garden roses. The progeny obtained by backcrossing two of the F₁ selections to garden roses are typical of the results obtained from the F₁-garden rose backcrosses and are described below. The first is derived from the cross of 'Crimson Glory' x _R. laxa_ and is typical of those F₁'s coming from crosses with the Hybrid Teas. Growth is vigorous and erect. The green canes are thickly covered with spines at the base and relatively free of spines on the flowering stems, as in the _R. laxa_ parent.
The foliage is large, leathery, free from powdery mildew and very susceptible to blackspot. Armature is intermediate in placement and type to that of the parents. The flowers are pale rose-pink, moderately double, with deformed pistils and stamens, but viable pollen is produced occasionally. The flowering period lasts for six weeks in late May and June. The second selection is the one referred to previously in the discussion of the F1 progeny of 'Josef Rothmund' and _R. laxa_. The progenies of these two selections back-crossed to garden roses are typical of those which result from back-crossing other F1's from crosses of this type to garden roses.

Pollen from the 'Crimson Glory'-_R. laxa_ seedling was effective in producing viable seed on a wide range of cultivars of the Hybrid Tea, Floribunda, and Grandiflora garden classes. The seedlings segregate into two sharply defined groups of approximately equal numbers. One group bears a pronounced resemblance to _R. laxa_ in growth habit, foliage and prickle characteristics. The flowers, which are borne only in June, are single, two to three inches in diameter, and are in the lighter tones of pink, salmon, and yellow. All the plants in this group are as hardy as the species parent. The plants of the second group resemble the garden rose parent in floral and foliage characteristics. The plants are June-blooming; the everblooming habit of the Hybrid Tea and the remontance of _R. laxa_ being absent. All plants of this group winter-killed during the winter of 1958-59, even though they had been given winter protection. All the seedlings retained the freedom from powdery mildew and the susceptibility to blackspot of the 'Crimson Glory'-_R. laxa_ parent.

The 'Josef Rothmund'-_R. laxa_ seedling produces abundant pollen, which is effective in producing seed pods on a wide range or garden and shrub roses. Of chief interest are combinations involving everblooming roses of the Hybrid Tea and Floribunda roses classes. The Hybrid Tea cultivars 'Crimson Glory,' 'Happiness,' 'Dean Collins,' 'Pink Princess,' and 'Lady Alice Stanley' were the principal seed parents involved. The Floribunda cultivars used as seed parents were 'Kordes' Harmonie,' 'Florence Mary Morse,' 'Feuermeer,' and 'Herrenhausen.' The first three are derivatives of _R. eglanteria_; the last, a Floribunda of the European type.

The seedlings resulting from combining this selection with the Hybrid Teas bear a strong resemblance to that group in appearance of foliage and floral characters. The flowers are large, ranging from four to five inches in diameter, and double with 25-35 petals. Dark colors are absent, in spite of the use of the cultivars 'Dean Collins,' 'Happiness' and 'Crimson Glory' which are noted for producing progeny in the dark pink and red color range. The effect of the species parent can be seen in the semi-folded leaflets, the placement and type of armature, and early defoliation. Although the plants range in hardiness from those which kill back to within six inches of the ground to those which lose only the immature tips of the canes, they are hardier than the Hybrid Tea parent.

The progeny from the Floribunda combinations are vigorous shrubs ranging in height from four to six feet. The abundant foliage is large and is held until late in the season. There is the same level of resistance
to foliar diseases noted in the F1 populations. The flowers, ranging from five to 45 petals in the lighter tints of pink, apricot, salmon, and yellow, vary in size from 3½ to 5 inches and are borne in clusters of five to seven. The plants continue growth until late in the season, resulting in tip killing of the immature wood. While the general appearance of the plants is that of the Floribunda parents, R. laxa influence is evident in the location and shape of the spines, shape of leaflets and stipules, and superior hardiness. Remontant segregates, which retain the basic hardiness of the pollen parent, are obtained from the garden rose-'Josef Rothmund'-R. laxa progeny.

It is believed that the most valuable characteristics of R. laxa which appear to be transmitted to its progeny in crosses with selected garden rose varieties are (a) cold-hardiness, (b) resistance to powdery mildew, and (c) adaptability to areas of high temperatures and humidities and low summer rainfall. It should be possible to incorporate these features of R. laxa into our everblooming garden roses and develop cultivars adapted to culture in those areas where most cultivars now in existence can be grown only with careful attention to winter protection.

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Certain summaries and indices are of interest in a survey of the publications of members of the staff of an educational and research institution such as the Iowa State University. The publications are listed in alphabetical order under the names of the senior authors. Junior authors are also listed alphabetically with cross reference to senior author.

SUMMARY

Number of individuals listed .................................................. 792
Number of publications .......................................................... 787
Number of publications with single author .............................. 338
Number of publications with joint authorship ........................ 449
Number of departments or fields represented in publications ...... 49
Number of individuals who serve as editors or on the editorial staff of one or more scientific or technical periodicals .............. 46

Individuals thus serving are: Aronoff; Ayres; Black; Buchanan; Buehler; Burchinal; Carlander; Dahm; Diehl; Duncan; Eppright; Fassel; Gilman; Grabe; Heath; Heer; Hofstad; Hoyt; Kemphorne; Kenkel; Kirkham; Kuetemeyer; Larson; Lockhart; Loomis; Mahlstede; Melampy; Nordskog; Packer; Pederson; Phillips, Richard; Pierre; Roth; Rothenbuhler; Royer; Rundle; Stahl; Staniforth; Swanson; Thompson, Leon E.; Tintner; Weber; Weller; Werkman.

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