The Cruciferae of Montana
by Gerald Clark

A THESIS Submitted to the Graduate Committee in partial fulfillment of the requirements for the degree of Master of Science in Botany at Montana State College
Montana State University
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Abstract:
A survey was made of the Crucifers of Montana; the survey included species known to be within the state as well as those which were thought to be within the state, or that have a chance of migrating into the state. This survey was made by systematically keying out the herbarium specimens included, in the Montana State College Herbarium, Bozeman, Montana, and by reviewing all literature pertaining to distribution.

A key was compiled and presented based upon Herbarium specimens, field notes, and monographs of the genera of the family. The terminology used in this key is as simplified as possible; all specialized terminology is avoided.

The existing and potential economic importance of the various members of the family are given.

ACKNOWLEDGEMENT

The author wishes to acknowledge the encouragement and assistance of Dr. W. E. Booth in formulating the key and in helping surmount the obstacles encountered during work on this problem.

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Approved:

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June 1949

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ABSTRACT

A survey was made of the Crucifers of Montana ; the survey included species known to be within the state as well as those which were thought to be within the state, or that have a chance of migrating into the state. This survey was made by systematically keying out the herbarium specimens included in the Montana State College Herbarium, Bozeman, Montana, and by reviewing all literature pertaining to distribution.

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INTRODUCTION

The family Cruciferae is well established in Montana, with twenty-eight genera and ninety-eight species represented. The family is a rather difficult one taxonomically, since the characteristics used for classification are sometimes minute. Often it is impossible to key a plant in flower, since the distinguishing characters are found in the fruit. A specialized nomenclature has developed around this family: the terms used to describe some of the characters, such as "pubescent type" are seldom used in reference to any other plant family.

The latest toxonomic work covering the Cruciferae of Montana is the NEW MANUAL OF BOTANY OF THE CENTRAL ROCKY MOUNTAINS, first published in 1885 by Dr. J. M. Coulter and revised by A. Nelson in 1937. Although it covers more of the state than any other manual available on the subject, it does not cover the flora of the northeast or western portions of Montana. Coverage of the western region, although incomplete, has been materially aided by such recent manuals as A MANUAL OF THE HIGHER PLANTS OF OREGON, by Peck (1941), and ILLUSTRATED FLORA OF THE PACIFIC STATES, by Abrams (1944).

For these reasons the author has developed a taxonomic key covering all of the crucifers found in Montana. In this key, specialized terminology has been avoided whenever possible. An attempt was made to provide keys that could be used for plants either in flower or in fruit, but this was found to be impossible in some of the genera.

LITERATURE REVIEW

The Cruciferae is a large family of about 200 genera and 1800 species; it is a cosmopolitan family of wide geographic distribution. This family is also called Brassicaceae after the genus Brassica which is probably the most important genus economically.

The Cruciferae are herbs or, rarely, shrubby plants, with alternate leaves and racemose or corymbose flowers. Leaf form, root type, and longevity are extremely variable. The flowers are regular with four petals, four sepals in a single tetramerous whorl, and six stamens arranged in two whorls, the inner whorl of four and the outer of two. The nature of the pistil is controversial, but morphological evidence substantiates the theory of a single pistil made up of four united carpels (Arber 1931), (Saunders 1932), (Eames and Willson 1928, 1930). Some of the genera do not follow this general form. The Lepidia do not always have four petals; they may have four, two, or none and the stamens may be fewer than six. Stanleya does not have tetradynamous stamens; all six are the same length.

In recent years much work has been done on the various genera of this family. Some of the most able taxonomists of the 20th century have expended a great deal of time and effort in monographic studies. It seems fitting that these works, as well as those not of a monographic nature but contributions of value none the less, should be reviewed here.

The most recent work on Stanleya is a monographic study by Rollins (1939a). In this study he points out the relationship between

Stanleya and Thelypodium as well as the relationship of both to the Capparidaceae. Evidence is given to substantiate the theory that the Cruciferae were derived from the Capparidaceae. Preliminary studies of the chromosome complement of the species of Stanleya were conducted and used to further substantiate the proposed theory of development.

Payson (1922a) published a monograph on Thelypodium and its immediate allies. This work was very carefully done and, while it is not recent, the species distinctions and generic limitations which he imposed on the genus are still valid. Thelypodium as treated in this study includes a small homogenous group of limited geographical distribution and monophyletic origin.

No recent monographic study of Cardaria is available, which is unfortunate since this genus is very similar to Lepidium and Hymenophysa. Rollins (1940) separated Lepidium Draba L. and Hymenophysa pubescens C. A. Mey. from their respective genera and combined them under Cardaria. This separation is not considered valid by some authors; therefore the reasons for it will be summarized here. Cardaria differs from Lepidium in the following respects: 1) the siliques of Lepidium are uninflated, those of Cardaria are; 2) the siliques of Lepidium are margined, those of Cardaria are not; 3) the siliques of Cardaria are indehiscent, those of Lepidium are dehiscent; 4) the nectar glands of Cardaria are well developed and surround the base of the single stamens, the glands of Lepidium are poorly developed and do not surround the base of the single stamens. Cardaria shows no characteristic which would separate it from

Hymenophysa; therefore the two are considered congeneric.

Hitchcock (1936, 1945) reviewed the species of Lepidium which occurred in the United States in 1936 and published a review of the species that occurred in Mexico, Central America, and the West Indies in 1945. This creditable work made the compilation of the Lepidia of Montana relative simple. Two species were found that had not been previously reported in Montana. These were L. montanum Nutt. and L. latifolium L. L. latifolium is an introduced species while the occurrence of L. montanum is probably a range extension.

Payson (1926) monographed the species of Thlaspi indigenous to the United States. He divided the genus into six species, two of which, T. glaucum A. Nels. and T. parviflorum A. Nels., occur in Montana. Recent authors include all of these species under one name, T. alpestre L. In this paper, the genus is separated into the species proposed by Payson. The reasons for doing this were twofold: first, field observations indicated that T. glaucum and T. parviflorum are separated by characters which do not intergrade; second, T. alpestre is a European species that would have to be introduced into North America by some carrier and the distribution is much too extensive for such a manner of introduction. There appears to be a need for further work in this genus.

Payson (1922b) published a monograph on the species of Sisymbrium indigenous to North America in which he defined the limits of the genus and discussed the similarities of Sisymbrium and Thelypodium. This work is still valuable in classification of these indigenous species; however, recent introductions have created a need for a more extensive coverage of the genus.

Specimens of S. Loeselii L. collected in Gallatin and Phillips counties in 1948 were the first collected in Montana. This species is not included in recent publications, but a description of it can be found in FLORA OF THE PRAIRIES AND PLAINS OF CENTRAL NORTH AMERICA, by P. A. Rydberg (1932).

Pearson (1928) and Sun (1946) have presented papers on the taxonomy of Brassica. Both workers have included data on the chromosome number of the species as well as taxonomic keys. The so-called "Brassica alba" is not included in the genus Brassica by these men. Sun has expressed doubt as to the validity of the exclusion and states that the species should be investigated further. Wheeler (1938) has pointed out that "Brassica alba" is a nomenclatural error, that the species should be called Brassica hirta Moench. if it is included in the genus.

In the same publication it is pointed out that Brassica arvensis Rabenh. is an invalid name which should be Brassica kaber (DC.) L. C. Wheeler. The generic limits of Sinapis and Brassica are not well defined. There are no criteria of separation between the two genera that all botanists will accept, and as a result there is much confusion regarding the members of genera. It may be that B. hirta, B. kaber, and perhaps B. nigra (L.) Koch. should be placed in Sinapis. I do not believe it feasible to place one and not the other into Sinapis and am therefore including all of the species under Brassica.

Fernald (1909) published a compreshensive paper on Barbarea which, although carefully prepared, failed to withstand the test of time. Numerous changes have been made since this paper was published, particularly in the western species. The treatment of the genus

in this paper follows that of Abrams.

There has been no recent monographic treatment of Rorippa, but there have been innumerable articles in the literature pertaining to the taxonomy and nomenclature of many of the species as well as articles dealing with the correct name of the genus. Fernald (1940) and Butters and Abbe (1940) have published articles dealing with the synonomy and taxonomy of R. palustris Moench., R. hispida Britt., and R. islandica (oeder ex. Murr.) Borbas. Rollins (1941a) published data that indicates R. columbiae (Suksdorf) Howell to be a synonym of R. calycina (Engelm.) Rydb. Fernald (1929) published proof of the correct name for the genus although Mackenzie (1929) disagreed with the interpretation.

Rollins (1939b) published a monographic work on Physaria which covers the distribution, taxonomy, synonomy, cytology, and phylogeny of the genus. Payson (1918) published a preliminary treatment of the genus which was not nearly so complete as the work published by Rollins; for that reason the views of the most recent author were adopted in this paper.

Payson (1921) published a monograph on Lesquerella; as is characteristic of Payson's work, it is complete in every detail. There has been no subsequent work on the genus other than a few descriptions of new species, none of which occur in this area. This monograph is probably the most complete and thorough of any of Payson's many fine publications on the genera of the Cruciferae. All of the

various methods of investigation at the disposal of a taxonomist are employed in this work except cytology. The section on the phylogeny is excellent; here is shown the supposed area of development, the nearest relatives, and the supposed phylogenetic order of the species. Many of the Lesquerella resemble Physaria, their nearest relative, the two can be told apart easily by the nature of the septum. Lesquerella has a vein extending from the apex to near the center of the septum, Physaria does not have this characteristic. There are, of course, other characters but this is the most easily seen.

Payson (1917) published a treatment of western Drabas which, though helpful, was incomplete because of the scarcity of material at his disposal at that time. Fernald (1934) monographed the Drabas of northeastern America. This work, even though it does not include many of the species indigenous to the west, is of value to the western taxonomist because of the many photographs of species that are found in the west. Hitchcock (1941) revised the Drabas of western North America. As is characteristic of Hitchcock's work, no data on the cytology or phylogeny was given. The keys, descriptions, and interspecific relationships were very well prepared.

In the treatment of D. oligosperma Hook. p. 74, D. oligosperma var. microcarpa Blank., Mont. Agr. Coll. Sci. Stud. 1:59 (1905) type location, Black Butte, Tobacco Root Range, is listed as a synonym of D. oligosperma Hook., Fl. Bor. Am. 1:51, 1833. In Blankinship's publication the following specimens are cited: Black Butte, Tobacco Root Range, 10,000 feet, August 11, 1902; Dewey, June 24, 1902;

Horsefly Pass, Crazy Mountains, 8200 feet, July 20, 1902. Hitchcock (1941) states that the type specimen "is merely a dwarf form such as occurs in many alpine regions in exposed situations," referring, of course, to the Black Butte specimen. Unfortunately the three different collections were mounted on the same Herbarium sheet at the Montana State College Herbarium; the collection bearing the label "type" is not the Black Butte collection but the one from Horsefly Pass; it differs from the other two in having leaves that are more densely imbricate and smaller (3-5 mm. long). The specimen can be matched by the following collections: Hitchcock and Muhlick Nos. 8913, 12091, and 10834; Rydberg and Bessey No. 4181; Blankinship, Summit of Mt. Bridger, 1899, Summit of Mt. Bridger, 1900, Mammoth Hot Springs, 1899; R. S. Williams, Helena, April, 1886, Tiger Butte, 1887, Belt River, 1892. Blankinship's collection from the summit of Mt. Bridger in 1900 contains plants of both D. oligosperma and D. oligosperma var microcarpa indicating that the two grew side by side on the same location. Hitchcock's statement that the apparent variation is due largely to exposure, soil, and elevation is seemingly incorrect; the variation is hereditary.

Draba fladnizensis Wulfen was collected in Carbon county in 1908 by P. H. Hawkins and the identification verified by Hitchcock in 1949. This plant has not been previously reported in Montana and is listed by Hitchcock as rare on the highest peaks of Colorado and southern Utah; it is also found in British Columbia. It is known to occur in Norway and Sweden and is conspecific with those found in the Rocky Mountains.

D. fladnizensis is apparently not found in Artic North America at the present time; therefore the widely separated locatilites where the plants now occur must be relict stands of the species. Hitchcock (1941) postulates "that not only did D. fladnizensis occur in Arctic America at one time, but that it migrated from there down through the Rocky Mountains to its present range in Colorado." The presence of this plant on one of the high peaks (11,000 feet) in Carbon county supports this postulation.

A careful revision of the genus Descurainia that occurs in North America was published by Detling (1939). In this work such taxonomic criteria as growth habit, pubescence, glandulosity, leaf form arrangement of seeds and shape of siliques, orientation of pedicels and siliques, size of flowers, and flower color were investigated and incorporated into the keys where possible. Distribution and point of origin of the endemic species is covered very thoroughly. There is no data on cytology or any discussion pertaining to the probable position of Descurainia in relation to the genera of the family. Baldwin and Campbell (1940) investigated the cytology of this genus and found the basic chromosome number to be seven; diploid, tetraploid, and hexaploid plants were found. Polyploidy was found to be intraspecific.

Rollins (1941b) published a monographic study of Arabis. In this work he gives the supposed phylogenetic relationship of the species and includes a discussion on the relationship of the genus to other genera within the family. The nearest related genus to Arabis is

Sibara, a genus that is not indigenous to Montana. The genus Arabis is large and taxonomically very difficult; Rollins has done an exceptionally fine monographic work and far be it from the author to criticize it; however, it seems from the keys and descriptions that some of the species could very well be included under one entity. Unfortunately, there is not sufficient material at hand to prove conclusively that this is the case. As Rollins has said, this monograph is a step in the right direction, but much work yet remains to be completed. Hopkins (1937) has also worked with the genus Arabis. He has revised those species that occur in Eastern and Central North America.

Manton (1932) published a general cytological survey of the Cruciferae in which the chromosome numbers of certain species of 80 genera have been determined. An attempt was made to determine the evolutionary trends and to correlate the chromosomes with taxonomy. It was found that an aneuploid relationship is frequent between the fundamental numbers of genera and that polyploidy between species is frequent. Fundamental numbers of 5, 6, 7, 8, 11, 13, and 15 have been recorded for the family.

MATERIALS AND METHODS

In the preparation of this thesis dealing with the crucifers of Montana, recent monographs of the genera were used. They were checked for distribution, generic and specific characters, and the keys were modified or completely changed to fit Montana species. Any material pertaining to the genus more recent than the monographs was reveiwed, evaluated, and either adopted or discarded depending upon the value and validity of the material. In instances when the genus had not received recent monographic treatment, all articles pertaining to its taxonomy were reviewed, and if of value, included in the treatment of the genus.

In addition to the literature incorporated, the materials available in the Montana State College Herbarium, which consisted of 900 sheets of specimens, was carefully checked.

Field notes obtained during the summer and fall of 1948 and spring of 1949 were used to supplement data obtained from herbarium specimens.

Distribution was determined on the basis of specimens in the Montana State College Herbarium as well as on monographs and published distribution notes. Those species that occurred in bordering states in regions adjacent to Montana were included unless a natural barrier seemed to restrict their distribution or migration into Montana.

The sequence of genera is in accord with the arrangement given by Engler and Prantl (1895). The author is aware that other systems of classification have been offered, but these are not unanimously.

accepted. The "Engler and Prantl" system of classification is still in current use in the newer American manuals.

In writing the key, the indented form was used. In this type of key, the character description is indented a fixed distance from the left margin of the page, similar characters being indented a similar distance.

It will be noted on examination of the key given on page 17 that two alternatives are given for each character or group of characters. The plant must conform to one of the two first alternatives; if it does not, either the wrong genera or family has been selected. Progressing down the key, the same procedure is followed in selecting the proper character, utilizing all the alternatives until the group which is followed by the generic name is reached. If the key used is a species key, the name reached is the species rather than the genus.

Artificial Key to the Genera

Pods more than 4 times as long as broad

Partition of the pod not a thin transparent membrane

Pods splitting transversely into numerous one seeded joints; seeds nearly square - - - - - - - - - - - - - Chorispora 87

Pods not splitting transversely; seeds nearly round - - - Raphanus 40

Partition of the pod a thin transparent membrane

Pods stipitate; anthers exserted beyond the petals; anthers rolled back similar to a ram's horn

Stipe of pod more than 1 cm. long; partition of pod without a longitudinal mid-band; petals yellow -Stanleya 22

Stipe of pod less than 1 cm. long; partition of pod with a longitudinal mid-band; petals violet, rose or white -Thelypodium 24

Pod not stipitate; anthers not exserted or rolled back in the above manner

Pods beaked

Flowers yellow, not purple-veined

Petals 6 mm. or more long; beak 3 mm. or more long; cotyledons folded back on themselves - Brassica 38

Petals less than 6 mm. long; beak less than 3 mm. long; cotyledons folded back

on the hypocotyle and radicle - - - - - - - - - - Barbarea 41

Flowers variously colored, purple-veined -Eruca 37

Pods not beaked, but sometimes tipped with a persistant stigma

Plants pubescent with branched hairs

Pods, stems, and leaves pubescent with 2-branched hairs - Erysimum 83

Pods, stems and leaves pubescent with hairs of more than 2 branches

Leaves compound or lobed nearly to midrib

Alpine plants; stems arising from a branched woody base - - - - - - - - - - - - - Smelowskia 68

Plants of lower altitudes; stems arising from a simple tap-root - - - - - - - Descurainia 69

Leaves entire or toothed, never compound or deeply lobed

Pods less than 2 cm. long

Seeds in 2 rows in each chamber of the pod -Draba 55

Seeds in 1 row in each chamber of the pod - - - - - - - - - - - - - - - - - - Stenophragma 72

Pods more than 2 cm. long

Stigma in flower or in fruit deeply 2-lobed (1 mm. or more) - - - - - - - - - - Hesperis 87

Stigma in flower or in fruit not deeply 2-lobed (less than 0.5 mm.) - Arabis 73

Plants glabrous or pubescent with simple hairs

Mature pod 2 cm. or more long

Pod compressed or cylindrical

Partition with a lonitudinal mid-band due to elongation of the cells in that region; petals never yellow or white - - - - - - - - Thelypodium 24

Partition without a longitudinal mid-band; petals yellow or white

Stigma not distinctly lobed; pod flattened - - - - - - - - - - - - - - - - - Gardamine 46

Stigma lobed; pod scarcely if at all flattened - - - - - - - - - - - - - - - Sisymbrium 34

Pod 4-angled

Leaves entire, clasping - - - - - - - - - - - - Conringia 88

Leaves compound, petioled - - - - - - - - - - - Barbarea 41

Mature pods less than 2 cm. long

Pods compressed; stem and basal leaves entire or dentate

Pods compressed parallel to the partition - Draba 55

Pods compressed contrary to the partition - Thlaspi 32

Pods not compressed; stem leaves, basal leaves or both compound

Pods and pedicels erect, strongly appressed to the rachis; diameter of the pedicels equal to the diameter of the pod - - - - - - - - - - - Sisymbrium 34

Pods and pedicels not strongly appressed to the rachis; diameter of the pedicels not equal to the diameter of the pod - - - - - - - - - - - Rorippa 43

Pods not more than 4 times as long as broad

Pods not compressed

One seed in each chamber of the pod - - - - - - - - - - - - - Cardaria 26

More than one seed in each chamber of the pod

Pubescence of branched hairs

Pods twin-like -Physaria 48

Pods not twin-like

Stem leaves clasping; pods obovoid, glabrous and margined - - - - - - - - - - - - - Camelina 54

Stem leaves not clasping; pods globose, pubescent with branched hairs, not margined - Lesquerella 50

Pubescence of simple hairs or glabrous

Leaves all basal, awl-shaped - - - - - - - - - - - Subularia 26

Leaves not all basal, not awl-shaped - - - - - - - - Rorippa 43

Stem leaves deeply lobed or compound - - - - - - Rorippa 43

Stem leaves not deeply lobed - - - - - - - - - -Camelina 54

Pod compressed

Pod compressed parallel to the partition

One or two seeds in each chamber of the pod - - - - - - - Alyssum 85

More than two seeds in each chamber of the pod

Stem leaves compound and deeply lobed - - - - - Smelowskia 68

Stem leaves not compound or deeply lobed

Plants mostly less than 2 dm. high; seeds not winged - Draba 55

Plants generally more than 2 dm. high; seeds winged - - - - - - - - - - - - - - - - - - - Berteroa 86

Pod compressed contrary to the partition

One seed in each chamber of the pod - - - - - - - - - - - -Lepidium 28

More than one seed in each chamber of the pod

Plants pubescent with forked hairs - - - - - - - - -Capsella 53

Plants glabrous - Thlaspi 32

Stanleya Nutt. Gen. 2:71. 1818

Prince's Plume

Annual or perennial, usually herbaceous plants; stems and leaves glabrous or pubescent with simple hairs; stems simple or branched, basal leaves absent or present in the form of a rosette; stem leaves petiolate or sessile and clasping, dissected to entire; inflorescence racemose; buds club-shaped; sepals linear, reflexed or spreading at anthesis; petals yellow to white; filaments of stamens nearly equal, glandular tissue usually surrounding base of single stamens, rudimentary or on under side of paired stamens only; siliques borne on a long (1-3 cm.) stipe, linear, flattened parallel to septum or nearly terete; stigma sessile or the style only slightly developed; seeds oblong, marginless. Stanleya is an indicator of selenium bearing soils. It is found in heavy clay soils and is not adapted to mountainous conditions. The nearest relative of Stanleya is Thelypodium. The morphology of the flower, fruit, and leaves of these two are so similar that they could be considered congeneric. Stanleya is distinguished from Thelypodium by greater stipe length, club-shaped buds, and sepals that are spreading at anthesis rather than being erect.

Key to Species

Middle and upper stem leaves petioled

Inner surface of petal-claw densely pubescent, petals bright yellow; lower stem leaves compound or if entire less than 2 cm. wide ---------- 1. S. pinnata

Inner surface of petal-claw glabrous, petals pale yellow or white; lower stem leaves 3-10 cm. wide, usually entire - - - - - - - - - - - - - - - - - 2. S. tomentosa

Middle and upper stem leaves sessile - - - - - - - - - - - - - - - 3. S. viridiflora

1. Stanleya pinnata (pursh) Britt. Trans. N.Y. Acad. 8:62. 1889

Golden Prince's Plume (Desert Plume)

Cleome pinnata Pursh Fl. Amer. Sept. 2:739. 1816

Stanleya pinnatifida Nutt. Gen. 2:71. 1818

Stanleya heterophylla Nutt. Torr. & Gray, Fl. N. Amer. 1:97. 1838

Distribution: Fergus and Powder River counties.

2. Stanleya tomentosa Parry, Am. Naturalist 8:212. 1874

Hairy Prince's Plume

Distribution: northern Wyoming but may occur along the sourthern border of Montana.

3. Stanleya viridiflora Nutt. Torr. & Gray, Fl. N. Amer. 1:98. 1838

Green Prince's Plume

Stanleya collina M.E. Jones, Zoe. 3:284. 1893

Distribution: Shinberger's Canyon, Montana; local inquiries concerning the exact location of this site have not been successful.

Thelypodium Endl. Gen. 876. 1839

Thelypody

Biennial or perennial herbs with simple or branched stems; hairs absent or unbranched; stem leaves frequently clasping at the base; flowers purple, lilac, rose or white; sepals scarcely if at all swollen at the base; petals linear, oblong or oblanceolate, entire; anthers frequently tapered to a point; inflorescence usually racemose, rarely corymbose; pods round or slightly flattened parallel to the partition, distinctly stipitate or sessile, 1.5-10 cm. long, 1-2 mm. wide, horizontal to erect; style short, stigma small, entire or very slightly 2-lobed; cells of the septum elongated parallel to the framework of the pod, usually more or less contorted, cells shorter, and walls usually less closely compacted near the margin; the central region of the septum composed of elongated cells frequently appearing under a hand lens as a broad midvein; seeds not winged. Members of Thelypodium prefer a saline soil. They are usually found on bottom lands where the soil is very wet in the spring. They are found only in the western portion of the United States and none of the species are adapted to alpine conditions. The pods of Thelypodium do not show characters which lend themselves to species separation but they are important in generic separation. The septum of the pod has a characteristic cellular pattern consisting of a broad region composed of cells elongated parallel to the marginal framework and extending through the middle of the septum. Species are not admitted to Thelypodium unless they have this type of septum.

Key to Species

Stem leaves not clasping the stem at the base - - - - - - - 1. T. integrifolium

Stem leaves clasping the stem at the base - - - - - - - - - 2. T. Sagittatum

1. Thelypodium integrifolium (Nutt.) Endl. Walp. Rep. 1:172. 1842

Entire-leaved Thelypodium

Pachypodium integrifolium Nutt. Torr. & Gray, Fl. N. Amer. 1:96. 1838

Thelypodium lilacinum Greene, Pl. Baker. 3:9. 1901

Thelypodium rhomboideum Greene, Pittonia 4:314. 1901

Thelypodium affine Greene, Pittonia 4:314. 1901

Distribution: Gallatin, Lewis and Clark, Madison, Park, and Silver Bow counties.

2. Thelypodium sagittatum (Nutt.) Endl. Walp. Rep. 1:172. 1842

Sagittate Thelypodium

Strepthanthus sagittatus Nutt. Journ. Acad. Phila. 7:12. 1834

Thelypodium Nuttallii S. Wats. Bot. King. Expl. 26. 1871

Thelypodium torulosum Heller, Bull. Torrey Club 25:265. 1898

Thelypodiopsis sagittata O.E. Schulz. Bot. Jahrb. 66:99. 1933

Distribution: Madison county and Yellowstone National Park.

Subularia L. Sp. Pl. 642. 1753

Awlwort

Small, submerged, aquatic, annual herbs with basal awl-shaped leaves and small white flowers borne on a leafless scape; stamens 6; style none; pod short-stipitate, ovoid to spherical; valves convex, ribbed dorsally; the partition broad; seeds few in each cell, marginless. This plant is found growing in shallow water along the shores of mountain lakes from British Columbia to the Sierra Nevada, California, east to Newfoundland, Maine, and Wyoming. Specimens of this genus have not been examined by the author, but collections have been made in Missoula county.

1. Subularia aquatica L. Sp. Pl. 642. 1753

Water Awlwort

Distribution: rare aquatic crucifer found only in cold mountain lakes in Montana, Idaho, and Wyoming; reported in Montana's mountainous region.

Cardaria Desv. Journ. Bot. 3:163. 1813

Whitetop

Perennial, erect herbs; leaves alternate, toothed, the upper clasping; flowers pervect, in terminal panicles; petals white; stamens 6; ovary sessile; styles slender, short; pod ovate, heart-shaped at the base, acute at the apex, neither winged nor matched at apex; valves strongly convex; seeds solitary in

each cavity. The members of this genus have given taxonomists trouble for over a century. Cardaria Draba has been placed in five genera other than Cardaria: Nasturtium, Lepidium, Draba, Cardiolepis and Physolepidion. Abrams, Hitchcock, and Peck still refer to this species as Lepidium Draba. The other species present in Montana, Cardaria pubescens, is still called Hymenophysa pubescens by several authors. Cardaria differs from Lepidium in that it has inflated, indehiscent pods and nectar glands that completely surround the single stamens and subtend the paired stamens. Hymenophysa differs from Cardaria only in the degree of pubescence and the inflorescenee type. C. Draba is an introduced species. The oldest collection was made near Yreka, California in 1876. The plant prefers and alkaline soil but it is not restricted to this type of habitat. C. pubescens is also an introduced species. The seeds were believed to have been introduced as impurities in alfalfa seed. Its distribution is still incomplete but will probably parallel that of C. Draba. Both of these plants are serious weeds in grain fields, hay meadows, and pastures. Both are very resistant to 2,4-D.

Key to Species

Pods glabrous - 1. C. Draba

Pods pubescent -2. C. pubescens

1. Cardaria Draba (L.) Desv. Journ. Bot. 3:163. 1813

Pepperweed (Whitetop)

Lepidium Draba L. Sp. Pl. 645. 1753

Distribution: Beaverhead, Bighorn, Carbon, Cascade, Deerlodge, Fergus, Flathead, Gallatin, Granite, Jefferson, Judith Basin, Lake, Lincoln, Madison, Park, Phillips, Pondera, Ravalli, Roosevelt, Rosebud, Sanders, Silver Bow, Stillwater, Teton and Valley counties.

2. Cardaria pubescens (Meyer) Rollins, Rhodora 42:305. 1940

Hoary Cress (Hairy Whitetop)

Hymenophysa pubescens C.A. Mayer, Ledeb. Fl. Alt. 3:181. 1831

Distribution: Gallatin and Park counties; Yellowstone National Park.

Lepidium (Tourn.) L. Sp. Pl. 643. 1753

Pepperweed (Pepperwort)

Annual biennial, or perennial herbs; leaves compound or entire; pubescence, if any, of simple hairs; petals small, white or greenish, rarely wanting; stamens often less than 6; stigmas sessile or nearly so; pods oblong or nearly round, flattened contrary to the partition, winged at the apex; valves keeled, dehiscent; seeds 1 in each cell, flattened. This genus is adapted to a wide variety of habitats. One species, Lepidium latifolium, thrives best on a wet saline soil while others inhabit soils of normal pH and become pests in gardens and cultivated fields. Some, such as L. campestre,

are found in range land and pastures. None of the members of this genus afford much feed for either livestock or wild game and most of them are considered serious weed pests.

Key to Species

Woody based perennials, or if annuals the upper stem leaves W-shaped at the base or the basal lobes of the leaves encircling the stem

Stem leaves either W-shaped at base or the basal lobes encircling the stem

Stem leaves W-shaped at base, fruit conspicuously winged at tip - - - - - - - - - - - - - - - - - 1. L. campestre

Stem leaves with basal lobes encircling the stem, fruit not conspicuously winged at tip - - - - - - - - 5. L. perfoliatum

Stem leaves neither W-shaped at base nor the basal lobes encircling the stem

Leaves entire or dentate, 4-8 cm. broad, style obsolete - 3. L. latifolium

Leaves entire or pinnate, if entire not as broad as above, style 0.3 mm. or more long - - - - - - - - - 4. L. montanum

Annuals or perennials, but never woody-based; upper stem leaves neither W-shaped at the base nor the basal lobes of the leaves encircling the stem

Petals 2 mm. or more long; fruits 5-7 mm. long - - - - - - - 7. L. sativum

Petals less than 2 mm. long, or if over 2 mm. long, fruits less than 5 mm. long

Racemes numerous, axillary and terminal, congested, 2-4 cm. long - - - - - - - - - - - - - - - - - - 6. L. ramosissimum

Racemes mostly terminal, not congested, over 4 cm. long

Pods ovate, upper half averaging more in width than the lower half; apical notch of pod as deep or deeper than broad - 2. L. densiflorum

Pod nearly round, upper half averaging less in width than the lower half; apical notch of pod not as deep as broad - 8. L. virginicum

1. Lepidium campestre (L.) R. Br. Ait. f. Hort, Kew. 4:88. 1812

Field Pepperweed

Distribution: Cascade, Gallatin and Madison counties.

2. Lepidium densiflorum Schrad. Ind. Sem. Hort. Gottin. 4. 1832

Prairie Pepperweed (Common Pepperweed)

Lepidium pubicarpum Nels. Bot. Gaz. 30:189. 1900

Lepidium Bourgeauanum Thell. Monog. Lepid. 237. 1906

Distribution: well established in Montana.

3. Lepidium latifolium L. Sp. Pl. 644. 1753

Bog Pepperweed

Distribution: Gallatin county.

4. Lepidium montanum Nutt. Torr. & Gray, Fl. N. Amer. 1:116. 1838

Mountain Pepperweed

Lepidium corymbosum Hook. & Arn. Bot. Beech. 323. 1840

Lepidium utahiense Regel, Acta. Hort. Petrop. 1:42. 1871

Lepidium scopulorum f. nanum Thell. Monog. Lepid. 211. 1906

Lepidium brachybotryum Rydb. Bull. Torr. Bot. Club 34:427. 1907

Lepidium philonitrum Nels. & Macb. Bot. Gaz. 56:474. 1913

Distribution: Beaverhead county.

5. Lepidium perfoliatum L. Sp. Pl. 643. 1753

Clasping Pepperweed (Round-leaved Pepperweed)

Distribution: Carter, Cascade, Gallatin, Ravalli,and Silver Bow counties.

6. Lepidium ramosissimum Nels. Bull. Torr. Bot. Club. 26:124. 1899

Congested Pepperweed

Lepidium divergins Osterhout Bull. Torr. Bot. Club 30:237. 1903

Lepidium Fletcheri Rydb. Bull. Torr. Bot. Club 34:428. 1907

Distribution: Well established throughout the state.

7. Lepidium sativum L. Sp. Pl. 644. 1753

Garden Pepperweed (Garden Cress Pepperweed)

Distribution: Gallatin and Lewis and Clark counties.

8. Lepidium virginicum L. Sp. Pl. 645. 1753

Virginia Pepperweed (Wild Pepperweed)

Lepidium Menziesii DC. Syst. 2:539. 1821

Lepidium intermedium var. pubescens Greene, Bot. Gaz. 5:157. 1881

Lepidium medium var. pubescens (Greene) Robinson, Gray. Syn. Fl. N. Amer. 1: 127. 1895

Lepidium occidentale Howell, Erythea 3:32. 1895

Lepidium bernardinum Abrams, Bull. Torr. Bot. Club 37:149. 1910

Lepidium hirsutum Rydb., Bull. Torr. Bot. Club 39:322. 1922

Distribution: Gallatin county.

Thlaspi (Tourn.) L. Sp. Pl. 645. 1753

Penny Cress

Erect, glabrous, annual or perennial herbs; basal leaves forming a rosette, entire or toothed; stem leaves W-shaped at base and clasping; flowers racemose, white or purple; pods triangular or nearly round, generally emarginate, flattened contrary to the partition, winged; valves dehiscent; seeds

2 or more in each cell; reticulate. Many botanists today have combined the indigenous species of Thlaspi into one species, T. alpestre, which is a European species. It is probable that Thlaspi entered America by way of Siberia and the Aleutian Islands and would seem to be related to the species of Asia rather than to those of Europe. Payson (1926) states that specimens of T. cochleariforme, a Siberian species, are very similar to T. glaucum, one of the common plants found in Montana. If T. cochleariforme and T. alpestre are separate entities, then it would be preferable to call this plant by the former name. The author has not seen either of the species in question, and it is more logical to choose the entities used by Payson. They seem to be separated on valid taxonomic characters which as a rule are not variable. These entities are T. parviflorum and T. glaucum and their separation is based on style and petal length. T. arvense is a European species introduced into North America. Its classification presents no problem to the taxonomist for it is very easily distinguished from the other members of this genus that occur in Montana. T. glaucum and T. parviflorum are usually found in wooded sub-alpine situations. T. arvense is a common weed in cultivated fields and gardens.

Key to Species

Annual, pod flat and round, broadly winged and deeply notched - 1. T. arvense

Biennial or perennial, pod wedge-shaped, ob-

scuredly winged and shallowly or not at all notched

Style 1 mm. or more long; petals usually over 4 mm. long -2. T. glaucum

Style less than 0.5 mm. long; petals less than 4 mm. long -3. T. parviflorum

1. Thlaspi arvense L. Sp. Pl. 646. 1753

Field Penny Cress (Fanweed, Stinkweed)

Distribution: entire state.

2. Thlaspi glaucum A. Nels. Bull. Torr. Club 25:275. 1898

Blue Penny Cress

Thlaspi alpestre var. glaucum A. Nels. Wyo. Exp. Station Bull. 28:84. 1902

Thlaspi Nuttallii Rydb. Bull. Torr. Club 20:235. 1902

Distribution: Cascade, Gallatin, Madison, Meagher, and Missoula counties.

3. Thlaspi parviflorum A. Nels. Bull. Torr. Club. 27:265. 1900

Thorowort Penny Cress

Distribution: Beaverhead county.

Sisymbrium L. Sp. Pl. 657. 1753

Tumbleweed

Annual, biennial or perennial herbs with branching, erect or decumbent stems; hairs absent or if present, unbranched; stem leaves frequently clasping entire or compound; flowers various; sepals scarcely swollen at the base; petals entire, white or yellow; nectar glands usually enlarged around the solitary stamens, reduced below the double stamens; inflorescence usually short and corymbose, elongating and lax in fruit; pods round, stipitate or sessile; style short or lacking; stigma subentire or distinctly 2-lobed, the lobes extended over the septum; septum thin and cell pattern usually undifferentiated into a central region of elongated cells; seeds not winged. The species of Sisymbrium seem to have originated in Arizona since it is here that the genus is best represented. The most primitve species of the group is S. ambiguum and is closely related to Thelypodium. It differs only by the less differentiated cell pattern of the septum and by the slightly 2-lobed stigma with the lobes extended over the septum. From a morphological point of view, it can be seen that Sisymbrium and Thelypodium are very closely related. S. salsugineum and S. linifolium are the only representitives of the genus that are indigenous to Montana. S. linifolium is a very common weed while S. linifolium has been collected only once in Montana and four times in all of North America. S. officinale, S. altissimum, and S. Loeselii are European introductions. S. Loeselii was first collected in Montana, June 10, 1948, and is abundant along roadsides in Gallatin county. S. altissimum is a common weed in grain fields in Montana.

Key to Species

Pods awl-shaped, appressed to the rachis - - - - - - - - - - - 4. S. officinale

Pods not awl-shaped, not appressed to the rachis

Plants with rhizomes - 2. S. linifolium

Plants without rhizomes

Pods 4-8 cm. long; pedicels as thick as the pods - 1. S. altissimum

Pods 2-4 cm. long; pedicels less than half as thick as the pods

Leaves entire, plants glabrous, petal white - - - - 5. S. salsugineum

Leaves toothed, plants hirsute, petals yellow - 3. S. Loeselii

1. Sisymbrium altissimum (L.) Britt. Sp. Pl. 659. 1753

Tumble Mustard

Norta altissima Britt. in Britt. & Brown, Ill. Fl. ed. 2. 2:174. 1913

Distribution: Cascade, Daniels, Flathead, Gallatin, Lake, Musselshell, Ravalli, Roosevelt, Sherdan, Stillwater, Wibaux, and Yellowstone counties; Yellowstone National Park.

2. Sisymbrium linifolium Nutt. Torr. & Gray, N. Amer. Fl. 1:91. 1838

Flax-leaf Plains-mustard

Nasturtium linifolium Nutt. Journ. Acad. Phila. 7:12. 1834

Schoenocrambe linifolia (Nutt.) Greene, Pittonia 3:127. 1896

Schoenocrambe pinnata Greene, Pittonia 3:127. 1896

Distribution: Beaverhead, Gallatin, Lewis and Clark, and Silver Bow counties.

3. Sisymbrium Loeselii L. Cent. Pl. i. 18

Small-poded Tumbleweed

Distribution: Gallatin and Phillips counties.

4. Sisymbrium officinale (L.) Scop. Sp. Pl. 660. 1753

Hedge Mustard

Erysimum officinale L. Sp. Pl. 660. 1753

Sisymbrium officinale Scop. Fl. Carn. ed. 2. 2:26. 1772

Sisymbrium leoicarpum Jordan Diag. 1:139. 1864

Distribution: Gallatin, Lincoln, and Missoula counties.

5. Sisymbrium salsugineum Pallas, Reise 2 app. 114. t 5. 1773

Sisymbrium glaucum Nutt. in T & G. Fl. N. Amer. 1:93. 1838

Distribution: Beaverhead county.

Eruca (Tourn.) Mill. Gard. Dict. Abr. ed. 4. 1754

The genus is represented in Montana by a single species, Eruca sativa. It was collected in Flathead county in 1889 and listed as an escape from cultivation. This is the only record of this species in Montana.

1. Eruca sativa Mill. Gard. Dict. ed. 8. no. 1. 1768

Rocket Salad (Garden Rocket)

Brassica Eruca L. Sp. Pl. 667. 1753

Eruca Eruca Britt. in Britt. & Brown, Ill. Fl. ed. 2. 2:192. 1913

Distribution: Flathead county.

Brassica (Tourn.) L. Sp. Pl. 666. 1753

Mustard

Annual, biennial, or perennial herbs; stem erect; basal leaves compound; stem leaves entire or toothed; petals yellow; inflorescence racemose; pods elongated, round or four-sided, sessile, tipped with a persistant flat, angular, or round beak; valves 1-3 nerved; stigma round or 2-lobed; seeds in one row in each cell. This genus is native of Europe, Asia and northern Africa, all of our species have been introduced. B. campestris and B. kaber are very common weeds in cultivated fields. B. nigra is less common but a potential weed hazard. B. hirta and B. juncea are the cultivated mustards of agriculture. This crop is valued at almost $1,500,000 yearly in Montana.

Key to Species

Upper leaves clasping by a W-shaped base - - - - - - - - - - - - 1. B. campestris

Upper leaves not clasping by a W-shaped base

Valves strongly 3-nerved; beak not cone-shaped

Pods hirsute; beak flattened - - - - - - - - - - - - - - - 2. B. hirta

Pods glabrous, beak angular - - - - - - - - - - - - - - - - 4. B. kaber

Valves strongly 1-nerved; beak cone-shaped

Pods closely appressed to the rachis; less than 2 cm. long - 5. B. nigra

Pods not closely appressed to the rachis, more than 2 cm. long - 3. B. juncea

1. Brassica campestris L. Sp. 666. 1753

Bird Rape (Common Mustard, Birdseed Rape)

Distribution: Daniels and Gallatin counties.

2. Brassica hirta Moench Suppl. Meth. 84. 1802

White Mustard (Yellow Mustard)

Sinapis alba L. Sp. Pl. 668. 1753

Brassica alba Rabenhorst Fl. Lusatica 1:184. 1839

Distribution: cultivated and sometimes found as an escape.

3. Brassica Juncea (L.) Cosson Bull. Soc. Bot. Fr. 6:609. 1859

India Mustard (Brown Mustard)

Sinapis juncea L. Sp. Pl. 668. 1753

Distribution: cultivated and sometimes found as an escape.

4. Brassica kaber (DC.) L.C. Wheeler Rhodora 40:306. 1938

Charlock (Field Charlock)

Sinapis arvensis L. Sp. Pl. 668. 1753

Brassica arvensis Rabenhorst Fl. Lusatica 1:184. 1839

Brassica sinapistrum Boiss. Voy. Espag. 2:39. 1839-45

Distribution: Daniels, Gallatin, Lewis and Clark, Madison, Powder River, and Wibaux counties.

5. Brassica nigra (L.) Koch in Roehl, Deutsch. Fl. ed. 3. 4:713. 1833

Black Mustard

Sinapis nigra L. Sp. Pl. 668. 1753

Distribution: Bighorn, Cascade, Flathead, and Jefferson counties.

Raphanus (Tourn.) L. Sp. Pl. 669. 1753

Radish

Annuals or biennials; stems erect or widely branching from the base; leaves deeply toothed or compound; petals white, pale yellow, or purple; pod elongate, linear, fleshy or corky, constricted or continuous and spongy between the seeds, indehiscent, tapering above into the persistent slender style; seeds round. Introduced from Europe and temperate Asia. R. sativus

is the common cultivated garden radish. One form exists as an adventive weed.

Key to Species

Pods longtudinally grooved, strongly constricted between the 4-10 seeds when dry - - - - - - - - - - - - - - - - 1. R. Raphanistrum

Pods not longitudinally grooved, slightly constricted between the 2 to several seeds - - - - - - - - - - - - - - - - - 2. R. sativus

1. Raphanus Raphanistrum L. Sp. Pl. 669. 1753

Wild Radish (Jointed Charlock)

Raphanistrum inocuum Moench, Meth. 217; Medic. in Usteri, Ann. Bot. 8. 1794

Distribution: Stillwater county.

2. Raphanus sativus L. Sp. Pl. 669. 1753

Garden Radish

Distribution: occassional adventive

Barbarea R. Br. in Ait. Hort. Kew ed. 2. 4:109. 1812

Wintercress

Biennial or perennial herbs; stems erect, angular, generally purple near

the base; leaves compound; petals yellow; inflorescence racemose; pods elongated, linear, 4-angled; valves keeled or ribbed; style less than 3 mm. long; stigma round or 2-lobed; seeds in 1 row in each cell, flat, oblong, and slightly reticulate. This genus is generally found in wet places near swamps and along irragation ditches. Because of this growth habit, it probably will never become a serious weed. The genus is often confused with Brassica and is often identified as B. campestris. Petal and beak length as well as seed type make the two genera easily distinguishable.

Key to Species

Pods ascending, not appressed to the rachis - - - - - - - - - 1. B. americana

Pods ascending, strongly appressed to the rachis - - - - - - -2. B. stricta

1. Barbarea americana Rydb., Mem. N.Y. Bot Gard. 1:174. 1900

American Wintercress

Barbarea orthoceras var. dolichocarpa Fern. Rhodora 11:140. 1909

Distribution: Cascade, Gallatin, Jefferson, Missoula, and Stillwater counties.

2. Barbarea stricta Andrz. in Bess. Enum. Pl. Volh. 72. 1822

Erect-pod Wintercress

Barbarea orthoceras Ledeb. Rhodora 11:140. 1909

Distribution: Carbon, Gallatin, and Yellowstone counties.

Rorippa Scop. Fl. Carn. 520. 1760

Marsh Cress (Water Cress)

Annual, biennial, or perennial; aquatic or semi-aquatic herbs; leaves simple, lobed or compound; petals yellow or white; style short and slender; stima 2-lobed or entire; pods short and round, slightly if at all, compressed parallel to the partition; valves nerve-less or one-nerved; seeds very small, in 2 rows in each cell. This genus has been called Sisymbrium, Radicula, Roripa, and Rorippa. It has been subdivided into Armoracia, Rorippa, and Nasturtium by some authors.

Key to Species

Flowers white

Upper leaves pinnately divided; pods linear ---------- 5. R. Nasturtium-aquaticum

Upper leaves simple; pods ovoid ---------- 1. R. Armoracia

Flowers yellow

Plants with rootstocks; petals much exceeding the sepals

Pods glabrous or nearly so ---------- 7. R. sinuata

Pods pubescent ---------- 2. R. calycina

Plants without rootstocks; petals scarcely

equaling the sepals

Pods spherical, or if oblong-ellipsoid,

the pod shorter than the pedicels - - - - - - - - - 4. R. islandica

Pods oblong to linear cylindrical, equal-

ing or longer than the short pedicels

Style about 1 mm. long - - - - - - - - - - - - - - - 6. R. obtusa

Style minute; 0.5 mm. long or less - - - - - - - - 3. R. curvisiliqua

1. Rorippa Armoracia (L.) A.S. Hitchc. Sp. Fl. Manhattan 18. 1894

Horseradish

Cochlearia Armoracia L. Sp. Pl. 648. 1753

Nasturtium Armoracia Fries ex A. Gray Man-ed. 2:31 1856

Radicula Armoracia Robinson Rhodora 10:32. 1908

Armoracia Armoracia Britt. in Britt. & Brown, Ill. Fl. ed. 2 2:163. 1913

Distribution: escape from cultivation.

2. Rorippa calycina (Engelm.) Rydb. in Mem. N.Y. Bot Gard. 1:175. 1890

Columbia Yellowcress

Rorippa columbiae (Suksdorf) Howell Fl. N.W. Amer. 1:40

Nasturtium columbiae Suksdorf Deutsch. Bot. Monatss. 16:211. 1898

Radicula columbiae Greene Leaflets Bot. Obs. 1:114. 1905

Distribution: Chauteau, Custer, and Gallatin counties.

3. Rorippa curvisiliqua (Hook) Bessey Mem. Torrey Club 5:169. 1894

Western Yellowcress

Sisymbrium curvisiliqua Hook. Fl. Bor. Amer. 1:61. 1830

Nasturtium curvisiliqua Nutt. in Torr. & Gray. Fl. N. Amer. 1:73. 1838

Nasturtium lyratum Nutt. in Torr. & Gray, Fl. N. Amer. 1:73. 1838

Radicula curvisiliqua Greene Leaflets Bot Obs. 1:113. 1905

Distribution: Cascade, Gallatin, Madison, and Silver Bow counties and Yellowstone National Park.

4. Rorippa islandica (Oeder ex. Murr.) Borbas, Bal. Tav. es Partmell., 392. 1900

Obtuse Fieldcress

Sisymbrium amphibium var. palustre L. Sp. Pl. 657. 1753

Radicula palustris Moench. Meth. 263. 1794

Nasturtium terestre R. Br. in Ait. Hort. Kew. ed. 2. 4:110. 1812

Brachylobus hispidus Desv. Journ. Bot. 3:183. 1814

Nasturtium palustre DC. Syst. 2:191. 1821

Rorippa palustris (L.) Bess, Enum. Pl. Vol h. 27. 1821

Rorippa hispida (Desv.) Britt. Mem. Torrey Club 5:169. 1894

Radicula hispia Britt. Torreya 6:30. 1906

Radicula palustris var. hispida Robinson Rhodora 10:32. 1908

Distribution: Cascade, Flathead and Madison counties.

5. Rorippa nasturtium-aquaticum (L.) Schinz. & Thell. Fl. Schweiz. ed. 3:240. 1909