4192 Denham 2000

INTERIM REPORT
AS TO STATUS OF GRANT FOR THE PURPOSE OF DESCRIBING VEGETATIVE CHARCTERS OF SOME LOCAL PLANTS

ABSTRACT: This is an interim report on the progress in gathering information about the vegetative characters of some local plants.

STATEMENT OF OBJECTIVE AND HYPOTHESIS: My purpose is to attempt to compile partial descriptions of local plants so that they can be recognized in the field by observation supplemented with the use of a hand lens (10X).

It is well recognized that a person who knows a plant can recognize it even when it is without flowers or fruit.

While there is a vast amount of literature relating to the terms used to describe the vegetative appearance of plants, only a few plants have been described in any detail. It is recognized that the majority of plants have only brief descriptions available.

DESCRIPTION OF METHODS: The method used is to go into the field, take photographs of sterile (non-flowering) plants, collect only enough material to take to the laboratory to examine and photograph appropriate details, make written descriptions and scan photographs into the computer for editing reproduction.

Part of the process is an ongoing search of the literature for basic information such as that published by monographers and floras (some of it dating from the days of the first microscopes) and arranging that information with additions from my observations to provide a concise description for each taxon studied.

Attachments:

1. List of photographs
2. Plant descriptions, alphabetical by genus and species
3. Characters available for descriptions of vegetative parts of plants
4. Glossary of vegetative terms
5. Trichome types
6. Vegetative characters bibliography

RESULTS WITH DETAILED DATA ANALYSES: The results will be presented in a loose-leaf notebook format, with the pictures for each taxon presented as a montage and the concise description given for each taxon.

Results are incomplete because the investigation was not begun before last summer's drought, and when rains revived the plants they were blooming and no longer in a vegetative phase.

A notebook with incomplete draft information is submitted with this report.

It is requested that access to Open Space properties be renewed for 2001 for the purpose of continuing this investigation.

CONCLUSIONS, INCLUDING A DESCRIPTION OF HOW THE RESULTS APPLY TO NATURAL RESOURCE MANAGEMENT AND DECISION MAKING FOR OPEN SPACE AND/OR MOUNTAIN PARKS: There is often a need to survey areas for plants that are present at a time when flowers and fruits may not be present. The information compiled by this investigation will assist in a timely identification of some of these plants.

Titles for photos

Acosta diffusa—New rosette at base of blooming plant (in field)

Acosta diffusa—Showing rosette attached to base of blooming stem

Acosta diffusa—Leaf shapes and sizes (6 inch rule)

Acosta diffusa—Enlargement of portion of leaf

Acosta diffusa—Leaf portion showing vesicular hairs and scabrous minute marginal hairs

Astragalus drummondii—Flowering plant in field

Astragalus drummondii—Leaf base and stem

Astragalus shortianus—Leaflets, back above and upper below

Besseya plantaginea—Leaf margin (light area is leaf)

Castilleja integra—Flowering plant

Castilleja sessiliflora—Stem with leaf base

Elaeagnus angutifolius—Short-stalked, tufted hair and almost sessile scales

Erigeron pumilus—Petiole with ciliate margin of tapering hairs of different lengths

Erigeron pumilus—Enlargement of hairs, showing that they are several--uniseriate cells

Erigeron vetensis—Petiole showing scattered long, ciliate hairs with small, short-stalked glandular hairs between

Erigeron vetensis—Enlargement of hairs, showing the curved, ciliate hairs with the small, short-stalked glandular hairs between

Erigeron vetensis—Leaf near tip, showing occasional long, tapered, hairs and many small, short-stalked glandular hairs on back of leaf

Erysimum asperum—Leaf surface with dolabriform hairs (sometimes looking like basting stitches)

Erysimum asperum—Enlargement of hairs showing that they are pointed at both ends

Erysimum asperum—Enlargement of individual dolabriform hairs. They are attached near the middle with the arms more or less equal. Note the sculpturing of the surface, and the occasional Y-shaped hair.

Erysimum repandum—Here with many Y-shaped hairs (attached near the junction of the arms)

Geranium caespitosum—Red-leaved plant in fall

Geranium caespitosum—Back of single leaf with stipules and centimeter rule

Geranium caespitosum—Petiole, showing retrorse hairs

Heterotheca villosa—Enlargement of leaf (both surfaces are similar). This is the plant that had been segregated as *H. horrida*.

Heterotheca villosa—Enlargement to show hairs and vesicles

Lesquerella montana—Single-celled stellate (several-branched) hair. Note hole in center where the hair broke off the leaf

[*Mentzelia*] *Acrolasia albicaulis*—Glochidiate hair

[*Mentzelia* sp.]—Glochidiate hair

Physaria sp.—Two different kinds of single-celled stellate hairs

Oenothera villosa var. *strigosa*--Fall rosette with 6-inch rule

Oenothera villosa var. *strigosa*—Spring rosette just before sending up flowering stalk

Oenothera villosa var. *strigosa*—Upper surface of leaf near tip

Oenothera villosa var. *strigosa*—Marginal leaf hairs

Oenothera villosa var. *strigosa*—Flowering stalk

Oenothera villosa var. *strigosa*—Flower close-up

Oxytropis lambertii—Upper leaf surface showing dolabriform hairs. Note branch of hair marked by arrow. The dark spot on the hair just left of center is the point of attachment with the small, pointed short branch Tip of hair is toward bottom

Oxytropis lambertii—Torn leaf showing eye-lashes on the basal portion. In the original, three small hairs can be seen on the upper half

Oxytropis sericea—Flowering plant in field

Oxytropis sericea—Leaflet bases

Solidago missouriensis—Leaf shapes and sizes with 6-inch rule

Solidago missouriensis—Margin of leaf from lower stem

Solidago missouriensis—Margin of leaf from just below inflorescence

Symphyotrichum porterii—Flowering stem showing elongate cauline leaves with fascicled leaves in axils and short leaves on flowering branches

Symphyotrichum porterii—Cauline leaf showing minute sharp, scabrous hairs on margin

Symphyotrichum porterii—Flower cluster

Verbascum thapsus—Fall rosette

Verbascum thapsus—Magnified leaf cross-section. (Top of leaf is to right)

Verbascum thapsus—Drawing to show thick cell walls and showing several cells

ACOSTA DIFFUSA (Lamarck) Sojak AST

COMMON NAME: diffuse knapweed

DURATION AND HABIT: Biennial or short-lived perennial, flowering stem may produce a new rosette at ground level

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Elongate taproot

HERBAGE: Sparsely scabrous-puberulent under thin,cobwebby (arachnoid) tomentum (rough to touch)

STEM: Erect; angled but not winged; 5-8 dm tall

BRANCHES: Diffusely branched near or above base

LEAVES: DISTRIBUTION: Mostly basal; leaves few and reduced above

PETIOLE: Basal mostly short-petiolate; cauline leaves sessile

SHAPE AND SIZE OF BLADE: Basal leaves bipinnate to pinnatifid; 20 cm long by 5 cm wide; ultimate segments narrowly oblong to elliptic, usually acute and wedge-shaped. Cauline leaves smaller and pinnately lobed; upper may be entire or minutely lobed

MARGIN: Scabrous with minute, short, firm, sharp hairs ca. 0.2 mm long

SURFACE FEATURES: Apparent small (ca. 0.05 mm diameter) vescicular hairs beneath loose arachnoid pubescence (both surfaces; scabrous hairs on lower leaf surface near tip

HABITAT: Introduced noxious weed, common in disturbed areas

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES):

ASTRAGALUS ADSURGENS Pall. var. **ROBUSTIOR** Hooker FAB

COMMON NAME: standing milk-vetch

DURATION AND HABIT: Herbaceous perennial

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Woody taproot with superficial, branching, woody caudex

HERBAGE: Grayish-pubescent or strigillose with appressed, unequally-branched (dolabriform) hairs (dolabriform hairs will pivot around the point of attachment when a needle is pushed against the longer segment) or glabrate

STEM: Clustered; decumbent or ascending; simple or branched at base; 1-4 dm tall; internodes shorter than leaves

BRANCHES: Branching only at base or inflorescence

STIPULES: Membranous, ovate, acuminate, joined (connate) 1/3 or more the length; 5-15 mm long

LEAVES: DISTRIBUTION: Stem leafy; odd-pinnate, 5-15 cm long

PETIOLE: Lower leaves petioled, petioles shorter above

LEAFLETS: 9-25

SHAPE AND SIZE OF BLADE: Narrowed at base, narrowly oblong to oblong-ovate; 1-3 cm long 3-8 mm wide

MARGIN: Entire or emarginate at apex

SURFACE FEATURES: Strigillose with dolabriform hairs; sometimes glabrate above

HABITAT: Short-grass prairies and foothills

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): This species is sometimes confused with *A. agrestis*. It is easily separated from that species which has hairs attached at one end (basi-fixed) by the dolabriform hairs of this species. If a young leaflet is torn in half, *A. agrestis* will show "eye-lashes" on only one side of the tear. *A. adsurgens* will have "eye-lashes" on both sides of the tear. Because the branches of the hairs are unequal, the hairs protruding from the tip portion will be much smaller. *A. agrestis* stems originate underground; those of *A. adsurgens* are superficial

ASTRAGALUS AGRESTIS Douglas ex G. Don **FAB**

COMMON NAME: field milk-vetch

INCOMPLETE are hairs appressed, leaf distribution

DURATION AND HABIT: Herbaceous perennial

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Rhizomatous with underground, branching caudex

HERBAGE: Thinly strigulose with hairs attached at one end (basifixed) or glabrate

STEM: Simple or sometimes branched at base; decumbent to weakly erect; 1-3 dm tall

BRANCHES: Branching only at base

STIPULES: Lower stipules connate (joined around stem); linear to ovate, acute; 4-6 mm long

LEAVES: DISTRIBUTION: Alternate, odd-pinnate, 3-12 cm long

PETIOLE: Short petiole or subsessile

LEAFLETS: 11-21; odd-pinnate

SHAPE AND SIZE OF LEAFLET BLADE: Oblong or elliptic

MARGIN: Entire with retuse apex

SURFACE FEATURES: Thinly strigulose with hairs attached at one end (basifixed) or glabrate

HABITAT:

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): This species is sometimes confused with *A. adsurgens*. It is easily separated from that species which has hairs attached a short distance from one end (dolabriform) by the hairs of this species which are attached at one end (basifixed). If a young leaflet is torn in half, *A. adsurgens* will have "eye-lashes" on both sides of the tear (look closely, the hairs projecting from the tip portion of the leaf will be short). *A. agrestis* will show "eye-lashes" on only one side of the tear.

ASTRAGALUS DRUMMONDII Douglas ex Hooker

COMMON NAME: Drummond's milkvetch

INCOMPLETE: What is leaf length; check hairs with microscope

DURATION AND HABIT: Herbaceous perennial

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Heavy root with short-branched caudex

HERBAGE: Grayish villous hirsute with spreading or ascending, simple basifixed hairs with small bulbous base

STEM: Several, erect; hollow, ribbed; 4-7 dm tall

BRANCHES: Unbranched above base

STIPULES: Of two types: subterranean or lower, leafless nodes either joined around stem or partially so; nodes with leaves deltoid and lance-acuminate

LEAVES: DISTRIBUTION: Loosely distributed on stem, alternate, odd-pinnate

PETIOLE: Short, or leaves subsessile

LEAFLETS: Alternate, odd-pinnate; 13-31

SHAPE AND SIZE OF LEAFLET BLADE: Ovate, oblong or linear; 2-3.5 cm long by1.2-10 mm wide

MARGIN: Entire with apex obtuse, truncate or emarginate, somewhat ciliate

SURFACE FEATURES: Villous below and often glabrate above

HABITAT: Fields and meadows

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): *Astragalus dummondii*

is a very distinctive plant. It grows as clusters (short-branched caudex) of erect, stout, white-hairy stems. Even though there are only a few leaves on each stem, the leaves are covered with many leaflets. The long, spreading whitish hairs give a gray-green appearance to the foliage. Because the upper leaflet surface tends to be glabrate, the marginal hairs are accentuated. When back-lighted by the sun, these hairs can give a halo effect.

Locally, this plant can be distinguished from the other erect astragalus plants such as *Astragalus bisulcatus* by the hairiness of *A. drummondii*. *A. bisulcatus* is glabrate.

CASTILLEJA INTEGRA A. Gray

COMMON NAME: Indian paintbrush

DESCRIPTION INCOMPLETE: Check for tips of hairs and correct words for caudex, why do the descriptions say woody crown, rather than caudex; is leaf margin ciliate?

DURATION AND HABIT: Hemiparasitic, herbaceous perennial

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Caudex ? Woody crown ?; root short, easily broken, attached to root of another plant (often parasitic on plants of *Artemisia* or grasses)

HERBAGE: Whitish tomentose or lanate; hairs mostly still living at flowering time, thin-walled and becoming flattened upon drying, uniseriate to few-branched above, curving above basal cell

STEM: Clustered, erect or ascending, sometimes woody toward base; 1-3 dm tall; hairs of stem longer and more dense than on leaves

BRANCHES: Branched above or unbranched except at base

LEAVES: DISTRIBUTION: Essentially cauline with internodes much shorter than leaves; lower leaves being lost as plant sets seed; occasionally next year's flowering stem appears as a short, leafy stem near the base, elongating later

PETIOLE: Leaves sessile

SHAPE AND SIZE OF BLADE: Linear to narrowly lanceolate, 2 to 6 cm long; involute upon drying

MARGIN: Entire

SURFACE FEATURES: Above with curved, short, uniseriate hairs, becoming glabrate; below

HABITAT: Juniper, pinon, or pine meadows

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): Whitish appearance due to hairs

Casual observations may consider the showy bracts of castillejas to be the flowers

(Personal note: A builder in Colorado Springs, seeing many plants of this plant where he was to build a new home, decided to transplant plants with bushel-sized soil clumps into squares in the backyard of his new home. I was asked to look at the plants and suggest why some of the plants had lived and others had died. The conspicuous difference was that the surviving plants were in plots with associated *Artemisia* plants [if I recall correctly, they were *A. frigida*. The dead plants were in plots without surviving artemisias.])

ERIGERON PUMILUS Nuttall

COMMON NAME: low erigeron or low daisy

INCOMPLETE: Check leaf hairs

DURATION AND HABIT: Herbaceous perennial; somewhat caespitose

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Deep taproot with branched caudex covered by old leaf bases

HERBAGE: Hirsute with translucent, spreading hairs, often also glandular; leaf bases and petioles ciliate with tapered, multicellular, uniseriate, stiff, brittle (probably silicified), spreading and somewhat curved hairs 0.2-2 mm long; the longest (resembling the type A hairs of Nesom, 1978, for *E. hessii*) with about 12 cells: the lower cells shorter and broader, then the cells becoming progressively longer and narrower with the end cell being slender, elongat and sharp-pointed

GROSSLY EVIDENT CHARACTERS:

COLOR:
TEXTURE AND TOUCH:
LENGTH AND/OR DENSITY:

CHARACTERS EVIDENT UPON CLOSER EXAMINATION:

LIVING OR DEAD:
LENGTH:
OUTER CELL WALL:
INSERTION:
SHAPE:
POSTURE:
NUMBER OF CELLS:
ARRANGEMENT:
ALIGNMENT OF HAIRS ON ORGAN:
STALKED OR SESSILE:
SURFACE:

STEM: Slender, tufted; 5-30 cm tall; hirsute with spreading hairs, often also with small glandular hairs; and may be slightly viscid near heads

BRANCHES: Simple or branched

LEAVES: DISTRIBUTION: Basal leaves tufted and persistent; cauline leaves reduced upwards in size and distribution. In larger forms, the lower leaves may be fewer and deciduous

PETIOLE: Basal and lower cauline leaves petioled; becoming shorter to sessile above

SHAPE AND SIZE OF BLADE: Basal leaves oblanceolate to narrowly linear-lanceolate; 2.5-10 cm long by 2-4 mm wide

MARGIN: Entire

SURFACE FEATURES: Hirsute

HABITAT:

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): Ciliate margins of leaf bases; many tapered hairs of various lengths

ERIGERON VETENSIS Rydberg

COMMON NAME: La Veta daisy

DURATION AND HABIT: Herbaceous perennial; somewhat caespitose

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Taproot with stout, branching caudex; caudex covered with old leaf bases

HERBAGE: Sparsely hirsute and with short, stalked glandular hairs
Longest hairs: about 2 mm long
No. of cells and/or arrangement: multicellular, uniseriate
Texture: stiff, brittle (probably silicified)
Shape: tapered and pointed, resembling Nesom's Type A, 1976 and 1978
Position: ciliate, especially toward base; spreading and somewhat curved; in dried material many are flattened and slightly twisted; a few also on midvein below toward tip
Other hairs: short-stalked, small-headed glandular hair
Position: prominent along leaf margin between ciliate hairs

GROSSLY EVIDENT TRICHOME CHARACTERS (Taken from dried specimen):
COLOR: Whitish-translucent
TOUCH:
LENGTH AND/OR DENSITY:
TEXTURE:

CHARACTERS EVIDENT UPON CLOSER EXAMINATION:
LIVING OR DEAD:
LENGTH:
OUTER CELL WALL: Thin
INSERTION:
SHAPE:
POSTURE:
NUMBER OF CELLS:
ARRANGEMENT:
ALIGNMENT OF HAIRS ON ORGAN:
STALKED OR SESSILE:
SURFACE:

STEM: 5-25 cm tall; more or less glandular and sparingly hirsute with spreading-ascending hairs

BRANCHES: Unbranched above base

LEAVES: DISTRIBUTION: Mostly basal, a few reduced leaves above

PETIOLE: Blades gradually tapering to an indistinct petiole

SHAPE AND SIZE OF BLADE: Basal leaves oblanceolate, often narrowly so; up to 15 cm long by 7 mm wide, usually smaller; cauline leaves reduced upwards in size and distribution

MARGIN: Sparsely coarsely ciliate with stiff spreading hairs, especially towards base; a number of small, short-stalked, small-headed glandular hairs between the larger, hirsute hairs

SURFACE FEATURES: Upper surface essentially glabrate; lower surface covered with small glandular hairs; a few coarse, stiff spreading hairs are on the midvein near tip

HABITAT:

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): Narrow leaves with ciliate-margined leaf bases and petioles with small glandular hairs between ciliate hairs

ERYSIMUM ASPERUM (Nuttall) DeCandolle

COMMON NAME: western wallflower

DURATION AND HABIT: Herbaceous biennial or short-lived perennial

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Taproot with single or few-branched short caudex

HERBAGE: Silvery strigose with appressed, sharp-pointed, single-celled, dead, calcified, two- or three-branched, sessile hairs; the hairs are attached near their middle with the base embedded in the leaf; where the hairs are two-armed (branched), the hair is straight; where the hairs are two-armed the hair is Y-shaped in face view; the hairs are about 0.5-0.75 mm long and tend to be aligned parallel to the midrib

STEM: Usually single, erect; 15-35 cm tall

BRANCHES: Unbranched or branched in the inflorescence

LEAVES: DISTRIBUTION: Leaves are numerous and crowded; basal leaves are rosulate;

PETIOLE: Short-petiolate below

SHAPE AND SIZE OF BLADE: Linear to lanceolate; 3-12 cm long by 2-10 mm wide

MARGIN: Entire to remotely dentate

SURFACE FEATURES: Strigose hairy

HABITAT:

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): This species is separated from *Erysimum capitatum* primarily by the spreading position of the fruits in *E. asperum*

OENOTHERA VILLOSA Thunberg var. **STRIGOSA** (Rydberg) Dorn

COMMON NAME: common evening primrose

INCOMPLETE: Look at more plants for stalked, forked hairs.

DURATION AND HABIT: Biennial or short-lived perennial

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Somewhat fleshy taproot, that has sometimes been recommended, boiled, as a food; root tends to become somewhat woody by flowering time

HERBAGE: More-or-less densely grayish-strigose to hirsute hairs with longer reddish hairs with a pustulate base on stem;
Conspicuous hairs are whitish-translucent
More-or-less soft to touch
Hairs are flexible
There are several different kinds of hairs longest hairs about 1 mm long, many half as long; shorter hairs more-or-less erect or slightly curved toward tip or toward nearest margin; longer hairs may arise erect from the surface, then arching forward over the shorter hairs; many of the hairs on the upper surface are shorter arching hairs; those of the margin tend to be essentially incurved. One plant examined had a few of the longer hairs branched about half-way, yielding a stalked, forked hair with stalk about 0.2 mm long
Thin-walled, few-celled; cross-walls not evident
Simple, tapered, pointed at tip
GROSSLY EVIDENT CHARACTERS:
COLOR: Hairs are whitish translucent
TEXTURE AND TOUCH: Soft, almost silky
LENGTH AND/OR DENSITY: Scattered
CHARACTERS EVIDENT UPON CLOSER EXAMINATION:
LIVING OR DEAD:
LENGTH: Up to about 1 mm
OUTER CELL WALL: Thin
INSERTION AND POSTURE Erect; longer hairs then curving about 90 degrees; shorter hairs almost erect, only slightly curving
SHAPE: Cylindrical, only slightly tapering to an almost blunt point
NUMBER OF CELLS:
ARRANGEMENT:
ALIGNMENT OF HAIRS ON ORGAN:
STALKED OR SESSILE:
SURFACE:

STEM: Strict, usually single; 0.6 to 1.5 m tall

BRANCHES: Unbranched or branched

LEAVES: DISTRIBUTION: Flat basal rosette the first year, stout flowering stalk the second year; basal rosette leaves dying and being lost by flowering tme; rosettes infrequently collected

PETIOLE: Basal and lower cauline leaves somewhat petiolate, with petioles reduced upward

SHAPE AND SIZE OF BLADE: Lanceolate or lance-oblong leaves 10-30 cm long by 1.2-4 cm wide; with cauline leaves gradually reduced upwards

MARGIN: Often crisped or shallowly sinuate-denticulate; sometimes ciliate with short curved hairs

SURFACE FEATURES: Midvein tends to be whitish above

HABITAT: Often in disturbed areas

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): The leaves of the basal rosette have whitish major veins and tend to feel somewhat soft to the touch, especially when compared with the somewhat similar rosette leaves of *Pterogonum alatum*.

OXYTROPIS LAMBERTII Pursh

COMMON NAME: Lambert's or purple locoweed

DURATION AND HABIT: Caespitose, herbaceous perennial

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Stout taproot with a "knobby" or branching caudex; caudex covered with old stipules and leaf bases

HERBAGE: Silvery sericeous with appressed strigose hairs; at least some of the hairs are dolabriform often with very unequal branches; hairs are flexible, long, slender, tapered and sharp-pointed, attached near base (not stalked); surface is minutely sculptured (probably silicified); no cell divisions are evident. (With a needle, the long end of the hair can be pushed and the short end of the hair can be seen to pivot at the point of attachment.)

STEM: Essentially acaulescent; covered with stipules

BRANCHES: Only caudex branched

STIPULES: Adnate to petioles; 1-4 mm wide

LEAVES: DISTRIBUTION: Basal

LEAVES: Odd-pinnate; 10-17 cm long

PETIOLE: About as long as leafy portion of the leaf

LEAFLETS: 7-17

SHAPE AND SIZE OF LEAFLET BLADE: linear to oblong, occasionally nearly orbicular; 5-40 mm long, 1-3 mm wide

MARGIN: Entire

SURFACE FEATURES: Lower rather densely covered with dolabriform trichomes; upper somewhat more sparsely covered

HABITAT:

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): Dolabriform hairs identify this species. This species is known to poison horses and is sometimes listed as seleniferous. Species of *Oxytropis* have the two lower petals somewhat united into a keel and with a distinct point at the tip. When the wide wings are turned back, the tip of the keel can resemble a bird's head and beak. Where populations of *O. lambertii* come into contact with populations of *O. sericea,* putative hybrid populations are formed with a wide range of flower color.

OXYTROPIS SERICEA Nuttall

COMMON NAME: white locoweed

DURATION AND HABIT: Caespitose herbaceous perennial

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Stout taproot with much-branched caudex

HERBAGE: Gray or silvery with appressed, basifixed (attached by the base of the hair) hairs, silky pilose with flexible, long, slender, tapered, sharp-pointed hairs; cell divisions are not evident, and surface is minutely sculptured (probably silicified)

STEM: Essentially acaulescent; stem covered by stipules

BRANCHES: Branched only at the base

STIPULES: Adnate to the petioles, joined around stem (connate), but quickly ruptured; caudex and stem covered with stipules

LEAVES: DISTRIBUTION: Clustered at base

PETIOLE: About as long or shorter than the leafy portion of the leaf

LEAVES: Odd-pinnately compound

LEAFLETS: 11-21 leaflets

SHAPE AND SIZE OF LEAFLET BLADE: Oblong to lanceolate or sometimes linear; 5-25 mm long by 2-10 mm wide

MARGIN: Entire

SURFACE FEATURES: Silvery sericeous with appressed-ascending hairs; upper surface less densely hairy than lower surface

HABITAT:

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): Distinctive by the silvery hairs; reported to be poisonous to livestock. Where *Oxytropis serices* populations meet populations of *O. lambertii*, putative hybrid populations are formed with a wide range of flower color. Species of *Oxytropis* have the two lower petals somewhat united into a keel and with a distinct point at the tip. When the wings are turned back, the tip of the keel can resemble a bird's head and beak.

PTEROGONUM ALATUM Torrey

COMMON NAME: winged eriogonum or winged buckwheat

DURATION AND HABIT: Herbaceous perennial monocarp

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Taproot with unbranched or few-branched woody caudex

HERBAGE: Strigose to long-tomentose at least below with with appressed or ascending, slender, whitish-translucent (probably silicified), slightly contorted hairs; the hairs are about 1 mm long and maintain their diameter to near tip, then gradually reducing to an acute tip; the hairs arise from the epidermis then immediately curve to create an appressed to ascending hair; no crosswalls are evident; when stroked, especially from the apex of the leaf toward the base, the hairs feel rough

STEM: Perennial rosette, essentially acaulescent; one or few flowering stems to 1 m or more tall

BRANCHES: Branching in inflorescence

LEAVES: DISTRIBUTION: Mostly basal, a few cauline, smaller

PETIOLE: Blade gradually tapers to a petiole shorter than blade

SHAPE AND SIZE OF BLADE: Linear-oblanceolate, up to 15 cm long by 1 cm wide

MARGIN: Entire; margins and midribs with long, flexible hairs

SURFACE FEATURES: Lower surface strigose; upper surface may be strigose or glabrate except at margins

HABITAT:

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): Strigose hairs of leaves give a rough feel to touch, especially when stroked from apex of leaf toward base. The rosette of *Oenothera villosa* var. *strigosa* may be confuse with *Pterogonum alatum,* but those of *O. villosa* are more silky to the touch and have whitish veins.

SOLIDAGO MISSOURIENSIS Nuttall

COMMON NAME:

DURATION AND HABIT: Herbaceous perennial; stems sometimes clustered from a caudex

ROOT AND/OR RHIZOME: Long, creeping rhizome with stout branches (branching caudex

STEM: Erect from branching caudex; glabrous or nearly so; may have small amounts of puberulence in inflorescence

LEAVES: DISTRIBUTION: Broader, larger leaves toward base, becoming progressively smaller upwards (occasionally cauline leaves better developed and basal ones deciduous)

PETIOLE: relatively short, longer toward base, leaves becoming sessile above

SHAPE AND SIZE OF BLADE: Basal leaves lanceolate, tending to be three-nerved, up to 30 cm long by 3 cm wide; cauline leaves progressively smaller

SURFACE FEATURES: Glabrous

HABITAT: Dry open places

NOTE (SPECIAL CHARACTERISTIC OF THIS SPECIES): Rhizome, glabrous surface and gradual reduction of leaves upward

VERBASCUM THAPSUS L.

COMMON NAME: woolly or common mullein

INCOMPLETE: Make new photos of hairs; and size of leaves

DURATION AND HABIT: Biennial from taproot; forming a somewhat tufted rosette the first year and producing a stout blooming stalk, fruiting and dying the second year

UNDERGROUND STRUCTURE: ROOT AND/OR RHIZOME: Taproot

HERBAGE: Densely tomentose-woolly with yellowish, stellate-, dendritic-, candelabra-branched, silicified, dead hairs, feeling like sand-paper

Trichomes are several-celled

STEM: Flowering stem erect, winged by decurrent leaf bases

BRANCHES: Sometimes branched above

LEAVES: DISTRIBUTION: Stem well-covered with leaves gradually reduced above

PETIOLE: Basal leaves tapering to short petiole, leaves sometimes persisting into second year; 8-50 cm long by 2.5-14 cm wide; cauline leaves sessile with decurrent leaf bases

SHAPE AND SIZE OF BLADE: Basal oblancolate to obovate with obtuse tip; cauline leaves oblanceolate, progressively reduced upward

MARGIN: Entire to shallowly crenate

SURFACE FEATURES: Densely covered with stellate, dendritic, or candelabra hairs

HABITAT: Dry, disturbed areas, introduced from Eurasia

NOTE: (SPECIAL CHARACTERISTIC OF THIS SPECIES): The dead silicate-covered hairs can act as sandpaper, and the leaves have been used by children to make red cheeks to avoid going to school. The dried fruiting stalks are persistent through the winter and are reported to have been dipped in tallow by the Romans to make a torch. The abundant hairs on closely packed, dried, open capsules aided in holding a large quantity of tallow.

CHARACTERS AVAILABLE FOR DESCRIPTIONS OF VEGETATIVE PARTS OF PLANTS

THIS LIST OF CHARACTERS IS PRIMARILY FOR HERBACEOUS BIENNIALS OR HERBACEOUS PERENNIALS

PERENNATING ORGANS:

Biennials: Many Colorado biennials form a ground-hugging rosette during their first growing season, with the over-wintering bud near ground level and often protected by sometimes over-arching small leaves. Typically, these biennials then send up a flowering stem which flowers, fruits and dies.

Short-lived perennials: Short-lived perennials may be of two types. One, the rosette may persist and grow for more than one year, eventually sending up a flowering stem which then fruits and dies. The other may initiate a new rosette at the base of the flowering stem and the new rosette may have the likelihood of blooming the following year.

Leaves of rosettes have all the character types of other leaves for identification in a sterile state.

Perennials: Perennials have a variety of perennating structures. A system of classification for over-wintering buds has been developed to describe the position of the over-wintering bud such as under or above ground, etc.

More useful, for the purposes of this project, is the description of the type of new growth that is initiated one season to produce the flowering stem(s) for the next season. These vegetative structures are particular to each kind of plant, but are seldom noted in the literature. Sometimes these perennating structures can be used to separate closely related species such as *Symphyotrichum ericoides* and *S. falcatus*. Terms such as cryptophyte, hemicryptophyte, geophyte, and phanerophyte can sometimes be used to describe the position of the perennating bud.

UNDERGROUND STRUCTURES:

Roots:

- Fibrous roots
- Taproots

Underground stems:

- Caudices:
  - Diameter
    - Slender or stout
  - Length
    - Short or elongate
- Rhizomes:
  - Diameter
    - Slender or stout
  - Length
    - Short or elongate (try to specify lengths found)

HERBAGE: The general character of the surfaces of stem and leaves, whether glabrous or with an indumentum

STEMS:
- **Direction of growth**
- **Branching**
- **Diameter**
  - Size and shape
- **Length (height)**
- **Arrangement and distribution of leaves**
- **Surface characters**

STIPULES:
- **Absent**
- **Present**
  - Size and shape
  - Persistence

LEAVES:
- **Arrangement**
- **Insertion**
- **Simple**
  - Petiole
  - Blade
    - Size and shape
    - Apex
    - Base
    - Venation (This is an underused character)
    - Margin
    - Surface features (including color)
    - Duration
    - Vernation (position in bud)
- **Compound**
  - Petiole
  - Blade
    - Number of leaflets
    - Arrangement of leaflets
      - Palmate
      - Pinnate

GLOSSARY OF VEGETATIVE TERMS

This is a limited glossary with terms defined primarily as they relate to leaf and stem surfaces. Many sources (given in Bibliography) were consulted for this list.

abscission layer zone of separation as in leaf fall for deciduous plants
acuminate margins changing from straight to concave and converging gradually to a point; somewhat attenuate

acute two almost straight lines converging at an angle of less than 90°

adpressed, appressed (*ad*, to; *pressus* from *premo, premere* press) position tending to parallel the attached surface

annual plant germinating, growing, flowering, fruiting and dying in one season

appressed, adpressed (*ad*, to; *pressus* from *premo, premere* L. press) position tending to parallel the attached surface

ascending [hair] positioned so that the hair tends to point toward the tip of the organ (leaf or stem); directed upwards with an oblique base

biennial plant germinating, growing (often forming a rosette) during one season, producing flowers, fruiting and dying the second season (many biennials produce a basal rosette the first year, then send up a flowering stem which fruits the second year, then the whole plant dies)

biseriate cells arranged in two series, two rows of cells

bract a modified, often reduced, sometimes colored leaf at the base of a flower (subtending the flower)

bristle a sharp-pointed, straight, rigid hair

caespitose forming dense patches

caudex a short, thick vertical (or branched) perennial stem at or below ground level

cauline arising from the stem

chamaephyte perennating bud formed at ground level

cleft margin cut 1/4-1/2 distance to midrib

comose with a tuft of hairs

crenate with rounded (convex) teeth; scalloped

crisped curled

cryptophyte perennating buds deeply buries

deciduous falling at the end of the growing season as in leaf fall

decumbent lying on the surface (reclining) with tips rising

decurrent running downwards as a leaf base running down the stem

dentate margin with sharp teeth at right angles to midrib

denticulate small teeth at right angles to midrib

diminutives are terms derived from Latin or Greek that make the meaning of the term including the diminutive smaller—examples are:

-culus, -cula, -culum	Latin	
-idius, -a, -um	Latin and Greek	
-illus, -a, -um	Latin	strigillose
-iscus, -a, -um	Latin and Greek	
-olus, -a, -umb	Latin	strigulose; puberulous
-ullus, -a, -um	Latin	
-ulus, -a, um	Lating	
-unculus, -a, -um	Latin	

dolabriform derived from ax-shape; originally attached in middle with one end broad and flat and the other round and pointed; by extension it is used to refer to T-shaped hairs with a short stalk and a straight, horizontal crosspiece which is rounded and tapered to each end: the branches of the T-top may be equal or unequal

emarginate a notch at the apex with an acute sinus

entire margin without indentations; smooth [may have hairs]

erect pointed upwards

falcate scimitar -shaped

fasciculate in a cluster from a common point; in leaves, where the primary leaf persists after the axillary stem but produces a cluster of new leaves without the internodes elongating

fruticose shrubby [from *frutex* shrub; not from fruit]

geophyte plant with underground bud to produce perennial development

glabrate becoming glabrous, especially when mature

glabrous without hairs, sometimes erroneously equated with smooth;

glochid with barbs

hemicryptophyte perennial plant with bud at ground level

herbaceous soft and succulent [not woody]

hirsute covered with long, rather stiff hairs

hispid covered with very long, rigid hairs

indument, indumentum the hairy covering of a surface, see **vesture**

involute rolled upwards (exposing the abaxial surface of a leaf)

lanate, lanuginose woolly or cottony with long, intertwined hairs

lanceolate narrowly lance-shaped, widest below middle; originally narrowly elliptic, tapering toward both ends

lepidote surface with small, scurfy scales, compare with squamose

linear narrow with essentially parallel sides

monocarp plant flowering only once, dying after first flowering; can be used as:

> **annual monocarp**, **biennial monocarp**, or **perennial monocarp;** this last can persist in the rosette form for several to many years before sending up the flowering stalk

mucronate abruptly terminating in a hard, sharp point

multiseriate cells arranged in three or more series, three or more rows of cells

ob- prefix meaning inversely

oblancolate narrowly lance-shaped, widest above middle

oblong elliptical, rounded at both ends

obtuse terminating gradually in a rounded end so that a 90° angle will fit inside

ovate egg-shaped, widest below middle

pappilose covered with minute tubercles

perennial plant persisting for three or more years

phanerophyte woody plants with perennating buds protected by leaves

pilose with soft, shaggy hairs

pinnate pinnate leaf with leaflets arranged on both sides of the main axis [from **pinna** feather]

polycarp plant flowering and fruiting for two or more years

position position or posture of an organ relative to a different organ's surface, terms such as **appressed, ascending,** or **spreading**, which see

puberulent, puberulous minutely pubescent

pubescence hairiness of plants

pubescent with soft, short, straight, slender hairs

punctate dotted with minute impressions or depressions

retrorse turned backward

retuse rounded with a slight notch at the tip

revolute rolled backward

rhizome horizontal below ground stem [root-like]

scabrous, (scaberulous) harsh (or slightly so) to the touch, often with short, sharp hairs

serrate saw-toothed, with teeth pointing toward tip

sessile [sitting] without a stalk

setose bristle-like

simple opposed to compound, simple leaf—a single blade, simple stem—not branched

sinuate with uneven margins; undulating

spreading positioned away from the attaching surface, standing outward

squamose covered with small scales, coarser than **lepidote**

stellate with arms attached at a central point; usually arms may parallel the surface (radiating as points of a star) or sometimes tufted with two or more arms pointing upward

strict stiff and rigid

sub- prefix meaning under, less than, not quite

trichome from the Greek, *trichos*, hair, not from the Latin *tri,* three; **trichome** is the term used to describe hair-like structures arising from the plant surface; trichomes come in a very large diversity of shape, which shapes can be described; see attached form with some basic classifications as to shape, number of cells, and surface features

Terms relating to trichomes

arachnoid like a spider-web

biseriate cells arranged in two series, two rows of cells

bristle a stiff, sharply pointed hair, usually with a somewhat swollen base

capitate head-like

dendroid branched, as the branches of a tree

dolabriform

glochid, glochidiate minutely barbed hair or bristle

multiseriate cells arranged in three or more series, three or more rows of cells

peltate attached to the lower surface of a somewhat broadened head

stellate with arms attached at a central point; usually arms may parallel the surface (radiating as points of a star) or sometimes tufted with two or more arms pointing upward

uniseriate cells in a single series [as beads on a string]

urent stinging hairs

therophyte dependent upon seed for surviving adverse conditions

uniseriate cells in a single series [as beads on a string]

vesture, vestiture, indument, indumentum the hairs clothing the plant; a better term than pubescence to describe the general character of plant hairs

Types of vesture

arachnoid like a spider web

barbed, barbate with short, rigid point, sometimes hooked or bent backward

bristle, bristly stiff strong hairs, resembling a hog's bristle

canescent gray or white with dense fine hairs

ciliate fringed with hairs, resembling eyelashes

downy with short, soft, weak hairs

fimbriate fringed

floccose with tufts of soft, woolly hairs, usually rubbing off easily

glabrate becoming glabrous, especially when mature

glabrous without hairs, sometimes erroneously equated with smooth;

glochid, glochidiate minutely barbed hair or bristle

hirsute (hirtellous) with rather stiff, distinct hairs (minutely hirsute)

hispid rough with very long, stiff hairs or bristles

indument, indumentum hairy covering, see **vesture**

lanate, lanuginose woolly or cottony with long, intertwined hairs

lepidote surface with small, scurfy scales

papillose, papillate covered with minute tubercles

pilose shaggy with soft, distinct hairs

puberulent, puberulous minutely pubescent

pubescence hairiness of plants

pubescent with soft, short, straight, slender hairs

scabrous, (scaberulous) harsh (or slightly so) to the touch, often with small sharp hairs

sericeous silky, with long (mostly straight) appressed hairs

setose with bristle-like hairs (**seta**)

smooth surface not rough or hairy, compare with **glabrous**

squamose covered with small scales, more coarse than **lepidote**

stellate with arms attached at a central point; arms may parallel the surface or be tufted

strigose with sharp, coarse hairs often with a bulbous base, sometimes bent to approximately parallel surface, sometimes inserted at an angle to parallel surface

tomentose dense, intertwined hairs

trichome (from *trichos*, Gr. hair) a plant hair

velvety, velutinous

villous long, soft, crooked [not matted] soft hairs

villous long, soft, crooked [not matted] soft hairs

woolly with long, intertwined hairs

Tentative categories (not exhaustive and not including most indumentum terminology)

TRICHOME TYPES (Most of the following can be unicellular, bicellular, or multicellular; trichomes can be living or dead at the maturity of the leaf; more than one term may be required to describe trichome)

Simple hairs (unbranched clothing hairs)

Papillate--Papillas or nipples (simple protrusion of epidermal cell)
Vesiculate--Vesicles (bladder-like)
Elongate, villi (narrower than vesicles and somewhat longer than papillose)
Straight
Curved
Twisted, coiled
Conical
***Cannabis* can contain crystal =Conical angled**
***Humulus* =Conical hooked**
Cylindrical
Barrel-shaped (broader than cylindrical, somewhat wider near middle)
Club-shaped, clavate (narrower toward base)
Tapering (narrowing from base toward tip)
Filiform (thread-like)
Bristle
Falcate (curved as a scythe)
Hooked, uncinate (hooked at tip
Plumose (feathery)
Shag(gy) (with outer cell tips free and curving backward)
[Unnamed] (similar to preceding, with outer cell tips free, but not turning backward)
Barbellate (hooked protrusions or retrorse cells along sides)
Glochidiate (hooked at tip acting like a grapnel)
***Mentzelia* =Glochidiate and barbellate [pagodaform with roof corners turned down]**

Branched

Forked
Bifid (two-armed)
Turritis glabra and many other mustards
Trifid (three-armed)
Many mustards
T-or Y-shaped, dolabriform, malpighiaceous

Some mustards
Some *Astragalus*

Several-armed to Many-armed

Stellate if flattened

Physaria

Tufted (fasciculate)

Many mallows (Malvaceae)

Echinoid

Peltate (shield-shaped, more or less flattened and attached at center with rays more-or-less fused)

Physaria and Lesquerella

Shepherdia canadensis

Dendritic (with central stalk and tree-like or antler-branches)

***Alyssum saxatile* (single-celled)**

***Many mints* (uniseriate, multicellular)**

Candelabra

Verbascum thapsus

When more than one cell is involved, additional terms will be used

Number of cells and cell size

Arrangement of cells

Uniseriate (cells in one row)

Moniliform (like a string of pearls)

Petrocosmea kerrii, underside of leaf

Biseriate (cells in two rows)

Multiseriate (cells in more rows)

***Begonia* multicellular, multiseriate trichomes, cells relatively small**

***Eucodonia* sp. multicellular, uniseriate trichomes, cells relatively large**

Plumose

Compound forms

Porrect-stellate

Solanum rostratus

Presumed function

Non-glandular

Glandular (include shape of gland, sometimes the directions of cell divisions are important—periclinal or anticlinal); glands may be any shape from capitate [spherical] to peltate; material may be secreted from gland or not; cytoplasm is frequently darker [denser])

Sessile (no stalk)

Stalked (short or long [long can usually be seen as separate cells at 10X magnification sometimes number of cells])

- uniseriate
- multiseriate

Stinging, urent

Urtica, Tragia

Other considerations

Mode of attachment

Position relative to surface to which attached

Posture of entire trichomes

Outer cell wall features

- **ornamentation**
- **calcification**
- **silicification (opalescent)**
- **sclerification**

Textures

- **soft**
- **stiff**
- **villous (soft, wavy hairs)**
- **arachnoid (cobwebby [like spider threads])**
- **silky, sericeous (mostly long, straight and appressed)**
- **woolly, lanate (entangled)**

Margins

- **ciliate with often larger trichomes (like eyelashes)**
- **frimbriate (fringed)**

VEGETATIVE CHARACTERS BIBLIOGRAPHY

Author(s)	Year	Title
Amarasinghe, Vindhya and Watson, Leslie	1990	Taxonomic significance of microhair morphology in the genus *Eragrostis* Beauv. (Poaceae). Taxon 39(1):59-65 Correlations of microhair morphology.
Anderson, Loran C. and Creech, Jessica B.	1975	Comparative leaf anatomy of *Solidago* and related Asteraceae. Amer. J. Bot. 62(5): 486-493
Behnke, H.-Dietmar	1984	Plant trichomes - structure and ultrastructure: General terminology, taxonomic applications, and aspects of trichome-bacteria interaction in leaf tips of *Dioscorea*.
Berry, Paul E. and Gaskin, John F.	1998	A new *Croton* (Euphorbiaceae) from the Western Guayana Shield and its anomalous sectional placement. Systematic Botany 23(2):171-175. SEM dentate-lepidote trichome from leaf; transitional stellate-lepidote trichome from sepal of female flower, [porrect-multiradiate trichomes on capsule (multiseriate stalk).
Borror, Donald J	1960; 1988	Dictionary of word roots and combining forms. Mayfield Publishing Co., Mountain View, CA 94041
Carlquist, Sherwin	1961	Comparative Plant Anatomy. Holt, Rinehart and Winston, NY. p. 33 compare "the trichome complement." Summarizes work of earlier authors.
Cooper, D. C.	1932	The develpment of the peltate hairs of *Shepherdia canadensis*. American Journal of Botany 19:423-428 [not seen]
Correl, Donovan Stewart	1962	The potato and its wild relatives. Texas Research Foundation: Contributions, Volume 4.
Cronquist, Arthur, Arthur H. Holmgren, Noel H. Holmgren, James L. Reveal. (Patricia Holmgren)		Intermountain Flora. Vol. 1 Vol. After 1 by New York Botanical Garden, Bronx, NY 10458 Vol. 3A 1997 Subclass Rosidae (except Fabales) Vol .3B 1989 Fabales by Rupert C. Barneby Vol .4 1984. Asterideae (Except Asteraceae) Vol .5 1994. Asterales Vol. 6 1977 The Monocotyledones Also Patricia Holmgren
Cutter, Elizabeth G.	1969	Plant anatomy: experiment and interpretation. Addison-Wesley Publishing Co. Reading, Mass., London. Hairs and trichomes pp. 12, (*Helianthus* trichomes—"hair-bearing epidermal cells follow the pattern of the underlying vascular tissue...", 34 cystoliths in trichomes, 65 cotton hairs, 76 value of cuticular impressions of underlying structures, e.g. stomata and hairs, 77-80 hairs120-124 glandular trichomes.
Davis, P. H. & V. H. Heywood	1963	Principles of Angiosperm Taxonomy. C. Van Nostrand Co. Princeton, N. J. Especially Chapter 4, The concept of characters.

Dickison, W. C.	1974	In Radford et al., pp. 198-202.
Dilcher, D.	1994	Approaches to the identification of Angiosperm Leaf Remains. Bot. Rev. 40:1-157
Dunn, David B.	1954	A method of mounting pressed flowers for study and preservation. Rhodora 56(671:258-259. Glycerin and mucilage used to mount boiled flower. Archer's coating recommended for covering.
Dunn, David B.	1960	Have modern botanistts forgotten the herbarium? Plant Science Bulletin, January, 1960.
Dunn, David B.	1960's	See Hess, et al. See Sharma and Dunn. See Walker and Dunn.
Esau, Katherine	1960	Anatomy of seed-plants. Epidermis Chapter. (Trichomes pp. 72-74) Use of trichomes [sometimes] for taxonomic purposes.
Esau, Katherine	1963	Plant Anatomy. John Wiley and Sons, Inc. NY. Chapter 7. The epidermis. Trichomes on aerial parts: pp 153-159.
Evans, Timothy M., Faden, Robertt B., Simpson, Michael G., Systma, Kenneth J.	2000	Phylogenetic Relationships in the Commelinaceae: I. A Cladistic Analysis of Morphological Data. Systematic Botany 25(4): 668-691. Appendix 1. P. 690. Character 44. Hook hairs; Character 45: Microhairs (glandular, Tomlinson, 1966)
Fahn, A.	1967	Plant anatomy. Pergamon Press, NY Trichomes, illus. Pp. 154-155.
Gathercoal, Edmund N. & Wirth, Elmer H.	1947	Pharmacognosy. Lea & Febiger, Philadelphia, Penn. Many line drawings of plant fragments, incl. Trichomes.
Goodspeed, Thomas Harper	1954	The genus *Nicotiana*. Chronica Botanica Co. Waltham, Mass. Many detailed line drawings of trichomes found. Trichomes not used in keys to sections.
Great Plains Flora Committee		Flora of the Great Plains
Green, Elizabeth Lauren, Blankenship, Lytle H., Cougar, Virinia F., and McMahon, Terra	1985	Wildlife food plants: A microscopic view. Caesar Kleberg research program in wildlife ecology. Department of Wildlife and Fisheries Sciences. The Texas Agricultural Experiment Station. The Texas A&M University System. "This manual presents a simplified micro-histological plant identification procedure." There are brief descriiptions and micro-photographs of plants studies.
Haberlandt,		Anthocyanin and trichomes.
Hansen, Richard M.	ca. 1970	Colorado State University. Mimeographed trichome line drawings of animal food plants.
Harrington, Harold	1954	Manual of the plants of Colorado. Sage Books. Denver,

David		Colorado.
Hardin, James W.	1976	Terminology and classification of *Quercus* trichomes. The Journal of the Mitchell Society. 92:151-161
Hardin, James W. and Stone. Donald E.	1983	Atlas of foliar surface features in woody plants, VI,. *Carya* (Juglandaceae) of North America. Brittonia 36(2):140-153.
Harrington, Harold D.	1957	How to identify plants. Swallow Press. Chicago. Chapter on leaf surfaces.
Harris, James G. and Melinda Woolf Harris	1994	Plant identification terminology. Spring Lake Publishing. Spring Lake, Utah.
Heintzelman, Charles Edward, Jr. and Howard, Richard Alden	1948	The comparative morphology of the Icacinaceae. V. The pubescence and crystals. American Journal of Botany 35(1):42-52. Line drawings of trichomes and appellation.
Hess, Lloyd W., Dunn, David B., and Leddicotte	1968	Potential of activation anaylsis for the comparison of trace minerals in plant species. Transactions, Missouri Academy of Science 2:91-99. Seeds, not trichomes, examined. [Dunn and his students were looking at environmental factors.]
Hewson, Helen J.	1988	Plant indumentum, A handbook of terminology. Australian Flora and Fauna Series, Number 9. Australian Government Publishing Service. Canberra. An attempt to standardize descriptions, morphology, anatomy, spacing and orientation of trichomes.for the Flora of Australia.
Holmgren, Arthur H., Shulta, Leila M. and Lowrey, Timothy E.	1976	*Sphaeromeria*, a genus closer to *Artemisia* than to *Tanacetum* (Asteraceae: Anthemideae). Brittonia 28(2):252-262. Page 256. Hairs dolabriform.
Hummel, Karl, and Staesche, K.	1962	Die Verbreitung der Haartypen in den naturlichen Verwandtschaftsgruppen, in Encyclopedia of Plant Anatomy, Band IV, Teil 5:209-250.
Isely, Duane	1998	Native and naturalized Leguminosae (Fabaceae) of the United States (exclusive of Alaska and Hawaii.) Monte L. Bean Life Science Museum. Brigham Young University, Provo, Utah. 84602
Jackson, Benjamin Daydon	1928 Reprnt 1960	A glossary of botanic terms. 4th Ed. Hafner, NY
Jakowska, Sophie	1949	The trichomes of *Physaria geyeri, Physaria australis* and *Lesquerella sherwoodii*: Development and morphology. Bulletin of the Torrey Botanical Club 76(3):177-195. Development and "morphology of adult trichomes".
Judd, Walter S. et al.	1999	Plant systematics. Sinauer Associates, Inc., Sunderland, Mass. Chapter 4, Taxonomic Evidence...
Linsbauer, K., ed.	1932	Handbuch der Pflanzenanatomie 41-253. Gebruder Borntrager, Berlin

Luteyn, James and O'Brien, Mary, Eds.	1978	Contributions toward a classification of *Rhododendron*. See Almut Seithe *ne'e von Hoff. Pp. 89-116*
Metcalfe, Charles R.	1968	Chapter 5. Current developments in systematic plant anatomy. In Heywood, V. H., Ed. Modern methods in plant taxonomy.
Metcalfe, Charles R. and Chalk, L.	1950	Anatomy of the dicotyledons. Clarendon Press. Oxford. Diagnostic features (trichomes pp. 1326-1329).
Metcalfe, Charles R. and Chalk, L.	1965	Anatomy of the dicotyledons.
Meyen, F J. F	ca. 1836	
Nesom, Guy L.	1976	A new species of *Erigeron* (Asteraceae) and its relatives in southwestern Utah. Brittonia 28(2):263-272 *E. proselyticus* nov. sp. compared with *E. flagellaris*. Line drawings of trichomes. Silhouettes of leaf shapes of *E. sionis, E. proselyticus, E. religiosus* (latter with population variation and 3 plants' variation)
Nesom, Guy L.	1978	*Erigeron hessii* sp. nov. and *Erigeron kuschei* Eastwood (Compositae), two closely related narrow endemics from the southwestern United States. Brittonia 30(4):440-446. Line drawings of trichomes from *E. hessii.*
Netolitzky, F.	1932	Die Pflanzenhaare. In K. Linsbauer, ed. Handbuch der Pflanzenanatomie 41-253. Gebruder Borntrager, Berlin.
Pant, D. D. and Banerji, Rina	1965	Ontogeny of stomata and hairs in some Cucurbits and allied plants. The Journal of the Indian Botanical Society. 44(2):191-248
Payne, Willard W.	1978	A glossary of plant hair terminology. Brittonia 30(2):239-255 Listing of about 300 terms used to describe trichomes
Pirani, Jose Rubens	1993	A new species and a new combination in *Zanthoxylum* (Rutaceae) from Brazil. Brittonia 45(2): 1993:154-158.
Price, Robert A.	1980	*Draba streptobrachia* (Brassicaceae), a new species from Colorado. Brittonia 32(2):160-169 SEM, leaf surfaces.
Radford, Albert E., et al.	1974	Vascular plant systematics. Harper & Row, NY Comprehensive introduction to systematics.
Rechinger (Karl?)	1899	Trichome der Gesneraceen. In Wettstein, Richard R. Ed.
Rickett, H. W.	1954 [1953]	Materials for a dictionary of botanical terms—i. Bulletin of the Torrey Botanical Club, 81(1):1-15.
Rodriguez, Eloy, Healey, Patrick L. and Mehta, Indira	1984	Biology and chemistry of plant trichomes. Plenum Press. NY. Comprehensive review to that date.
Roe, Keith E.	1971	Terminology of hairs in the genus *Solanum*. Taxon 20(4):501-508. Terms and a brief classification system.

Rollins, Reed Clarke	1955	The Archer method for mounting herbarium specimens. Rhodora 57:294-299. Formulas for Archer's adhesive. Archer's is also suitable for plastic peels of leaves and stems.
Rollins, Reed C.	1993	The Cruciferae of continental North America; systematics of the mustard family from the Arctic to Panama. Stanford University Press, Stanford CA.
Rollins, Reed C. and Banerjee, Umesh	1975	Atlas of the trichomes of *Lesquerella* (Cruciferae) [BRA]
Rollins, Reed C. and Banerjee, U. C.	1976	Trichomes in studies of the Cruciferae. In Vaughan, J. G. and Macleod, A. J., The biology and chemistry of the Cruciferae. Academic Press, London, NY. Pp. 145-166, including 6 plates of SEM micrographs.
Rollins, Reed C. and Shaw, Elizabeth A.	1973	The genus *Lesquerella* (Cruciferae) in North America. Harvard University Press, Cambridge, Mass. Keys to the species, descriptions of the species, geographic distribution maps, and some photographs. Trichomes are used extensively in the keys.
Schulz, Otto Eugen [sic]	1936	Cruciferae. In Engler and Prant. Die Naturlichen Pflanzenfamilien ed. 2. 17b:[227]-658.
Scott, G., and Dahl, B. E.	1980	Plant species of Texas. Occasional papers Museum Texas Tech University. [Key to selected plant species of Texas using plant fragments. Occasional papers, the Museum, Texas Tech University 64:1-35 (my pages go to 37)] Diagrams plus photographs of plant epidermis recovered from animal fecal material and compared with reference slides.
Seithe, Almut, nee von Hoff	1978	*Rhododendron* Hairs and Taxonomy in Luteyn, James & O'Brien, Mary, Eds. Contributions toward a classification of *Rhododendron*. Pp. 89-116.
Semple, John C., Blok. Vivian C., and Heiman, Patricia	1980	Morphological, anatomical, habit, and habitat differences among the goldenaster genera *Chrysopsis, Heterotheca,* and *Pityopsis* (Compositae—Astereae). Canadian Journal of Botany 58(2):147-163. SEM leaf surfaces and trichomes. Page 161 "...the consequences of 'burying' a phylogenetic group in a nonphylogenetic assemblage. As long as *Pityopsis* is considered to be a part of *Chrysopsis* or *Heterotheca*, the possibilities of aligning it with other genera are greatly reduced."
Sharma, Gopal K. and Dunn, David B.	1968	Effect of environment on the cuticular features in Kalanchoe Fedschenkoi. Bulletin of the Torrey Botanical Club, 95(5):464-473. September.

Sharma, Gopal K. and Dunn, David B.	1969	Environmental modification of leaf surface traits in *Datura stramoniium.* Canadian Journal of Botany 47:1211-1216. Plate 1. Reliable traits:...kind of trichomes...were consistent.
Sinclair, Clarence B.,	1968	Leaf surface studies of the erect tradescantias. Transactions, Missouri Academy of Science, vol. 2: 45-52
Solereder, Hans	1899	Systematische Anatomie der Dicotyledonen. Stuttgart. Massive work with trichomes illustrated for many dicotyledous plant families.
Solereder, Hans, translated by Boodle. L. A., and F. E. Fritsch, revised by D. H. Scott	1908	English translation of the preceding.
Stearn, William. T.	1995	Botanical Latin. 4th Ed. Timber Press, Portland, OR
Steussy, T. S.	1990	Plant Taxonomy. The systematic evaluation of comparative data. Columbia University Press. NY
Strasburger, Ed.	1882	Den Bau and das Wachsthum der Zellhaute. Verlag von Gustav Fischer, Jena.
Tomlinson,, P. B.	1966	Anatomical data in the classification of Commelinaceae. Botanical Journal of the Linnaean Society 59: 371-395. See Evans, 2000, for reference.
Uphof, J. C. Th.	1962	Plant hairs, in Encyclopedia of Plant Anatomy, Band IV, Teil 5. Gebruder Borntraeger, Berlin.
Van den Borre, An and Watson, Leslie	1994	The infrageneric classification of *Eragrostis* (Poaceae). Taxon 43(3):383-422. Extensive use of morphology, including microhairs and macrohairs.
Vesque, J.		Pp. 310-317 and Pl. 14, fig. 10 & 14.
Walker, Nancy E. and Dunn, David B.	1967	Environmental modification of cuticular characteristics of Alaska pea plants. Study of environmental effects on a glabrous leaf.
Walters, D. R. & Keil, D. J.	1995	Vascular Plant Taxonomy. 4th Ed. Kendall/Hunt. Dubuque, IA
Weber, Willia A. & Wittman, Ronald C.	1996	Colorado Flora. Eastern Slope. Revised Ed. University Press of Colorado. Niwot, CO 80544
Webster, G. L. Del-Arco-Aguilar, M. J. and Smith, B. A.	1996	Systematic distribution of foliar trichome types in *Croton* (Euphorbiaceae). Botanical Journal of the Linnaean Society 121:41-57. "Webster et al. (1996) standardized the terminology of trich-ome morphology in *Croton*..." See Berry and Gaskin 1998.
Wettstein, Richard R. v.	1899	Osterreichische Botanische Zeitschrift. Verlag und druck von Carl Gerold's Sohn, Wien.