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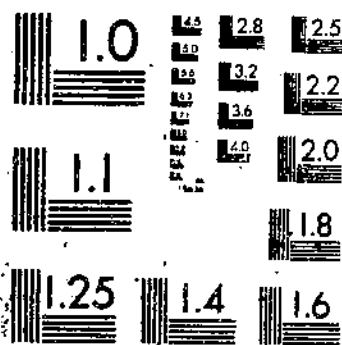
UPDATA

ATLAS OF EPIDERMAL PLANT FRAGMENTS INGESTED BY GRAZING ANIMALS

HOWARD, G. S. ; SAMUEL, M. J.

1 OF 2

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NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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ATLAS OF EPIDERMAL PLANT FRAGMENTS INGESTED BY GRAZING ANIMALS

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UNITED STATES
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ADMINISTRATION

ATLAS OF EPIDERMAL PLANT FRAGMENTS INGESTED BY GRAZING ANIMALS

By Gene S. Howard and Marilyn J. Samuel

Technical Bulletin No. 1582

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ABSTRACT

G. S. Howard and M. J. Samuel. Atlas of Epidermal Plant Species Fragments Ingested by Grazing Animals. U.S. Department of Agriculture Tech. Bul. 1582, 143 pp. 1979.

Four pictures each of epidermal tissue fragments of 2 species of sedges, 30 species of grasses, and 38 species of forbs are shown in an atlas. All the species are used as forages in the Great Plains region of the United States. The atlas is used as a pictorial key for the microhistological identification of plant species in animal diets. The microphotographs are taken at the same scale to facilitate relative size comparisons. A discussion of the identification technique and use of the key is given.

KEYWORDS: microhistological technique; diet identification; pictorial key; atlas key; and forage species.

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ATLAS OF EPIDERMAL PLANT FRAGMENTS INGESTED BY GRAZING ANIMALS

By Gene S. Howard, *horticulturist*, and Marilyn J. Samuel, *botanist*¹

INTRODUCTION

In recent years, interest has grown rapidly in the diet composition of domestic livestock as well as that of wildlife, rodents, and insects. Theurer, Lesperance, and Wallace reviewed and evaluated the methods of botanical analyses of the diet of domestic livestock.² They discussed sampling methods including use of the "bite-count" procedure, the esophageal fistula, and the rumen fistula. They also described botanical analysis by visual appraisal, manual separation, a microscope point technique, and a microhistological technique, and tabulated the results of diet composition on western rangelands from several locations.

Sparks and Malechek described the standard procedure we used for preparing plant tissue and mounting the slides for microhistological identification.³ For ease of scanning, we used a magnification of 125x which still provided us enough magnification to be able to distinguish identifying organs of the epidermal tissue. Phase contrast microscopy is recommended since it achieves

excellent differentiation of plant tissue fragments and eliminates the necessity of tissue staining.

Very few reference keys, either taxonomic or pictorial, are available for diet analysis research. Hansen made drawings of epidermal tissue, but they were not all drawn to the same scale.⁴

Stewart published a taxonomic key for 57 genera of East African grasses, but this is not useful for the species on Western U.S. rangeland.⁵

The pictorial key used in this publication is presented as an aid for those scientists involved in the microscopic identification of plant fragments of species eaten by grazing animals. The photomicrographs in the key, beginning on page 4, were all taken through the same phase-contrast microscope, using 35-mm black and white film at 125x magnification. Printing increased the magnification to approximately 420x. For all species, the epidermal tissues and their identifying organs are in the same scale so that sizes are relative to each other.

¹U.S. Department of Agriculture, Science and Education Administration, High Plains Grasslands Research Station, Route 1, Box 698, Cheyenne, Wyo. 82001.

²Theurer, C.B., Lesperance, A.L. and Wallace, J.D. Botanical composition of the diet of livestock grazing native ranges. *Ariz. Agr. Expt. Sta. Tech. Bul.* 233, 19 pp., illus. 1976.

³Sparks, D.R., and Malechek, J.C. Estimating percentage dry weight in diets using a microscope technique. *Jour. Range Managt.* 21: 264-265, illus. 1968.

⁴Hansen, R.M. Drawings of tissues of plants found in herbivore diets and in the litter of grasslands. *U.S. Internatl. Biol. Program Tech. Rpt.* 70, 69 pp., illus. 1971.

⁵Stewart, D.R.M. The epidermal characteristics of 9 grasses, with special reference to East African plains species. *Bot. Jahrb.* 84: 65-174, illus. 1965.

Four photomicrographs of each species are shown to give some measure of the morphological variation within a species. Such variation may arise because the tissue may be of different phenological age or from different parts of the plant. These morphological variants still resemble each other more than they resemble a different species; however, some species within a genus resemble each other, causing some difficulty in qualitative as well as quantitative analysis of diets.

Still another source of error in identification arises because of differential fragmentation of epidermal tissue within species. It appears that forbs and shrubs, when ground through a 1-mm screen, do not separate into epidermal fragments of one-

cell thickness with the same ease as grasses. There is also a difference in thickness and density of epidermal tissue from various plants. Many of the forbs have thin, almost translucent, epidermal layers with stomata often difficult to locate. These tissues should be stained if other than phase contrast microscopes are used. Prat and Hayden used stains in their methods.^{6,7}

This key is not intended to include all forage species but to show a number of the major native grass and forb species of the Great Plains. Species were collected from the southern, central, and northern Great Plains. Species not found in the key for any area may be photographed at the same magnification and added to the collection.

USE OF THE KEY

The following four kinds of cells and their specific characters were most useful in our species identifications:

- Stomata — size, shape, orientation, and associated guard or subsidiary cells.
- Epidermal cells — size, shape, and amount of undulation.
- Cork cells — size, shape, and bases for trichomes in some species.
- Silica cells — presence, placement, shape, and size.

If the fragment on the sample slide is not immediately recognizable, the pictorial key may best be used by a process of elimination until the correct species is found. The separation of fragments into either the grass-carex group or the forb group can easily be made with great accuracy. Grass and carex epidermal cells have a rectangular shape and undulating cell walls, whereas forb epidermal cells have an irregular shape and are randomly arranged.

The use of organs, primarily trichomes, other than those on and attached to the epidermal fragments may be useful for qualitative analysis but cannot be used for quantitative measure. Many plants are glabrous with few or no trichomes, whereas others have them in abundance; there-

fore, epidermal tissue should be used for quantification. A uniform standard for defining a plant fragment should be set prior to the beginning of identification. Generally, a fragment with a minimum of two or three stomata will make a satisfactory standard, even though forbs are apt to have fewer stomata on the upper leaf surfaces than grasses. In the key, space is provided following each species for the identifier to note resemblances and characters in addition to those given that will be helpful in species identification.

A basic familiarity with the epidermal organs and their distinctive morphological differences plus the use of this key will be an aid to more accurate qualitative and quantitative identification of forage plant fragments in animal diets. Accurate identification of animal diets is needed to determine forage preference on both native and improved pastures. This information will influence management decisions affecting species mixtures for seeded pastures, seasons of use, and utilization.

⁶Prat, H. General features of the epidermis in *Zea mays*. *Ann. Mo. Bot. Gard.* 35: 341-351, illus. 1948.

⁷Hayden, P. Food habits of black-tailed jack rabbits in southern Nevada. *Jour. Mammal.* 47: 42-46, illus. 1966.

KEY TO IDENTIFICATION OF PLANT SPECIES IN ANIMAL DIETS

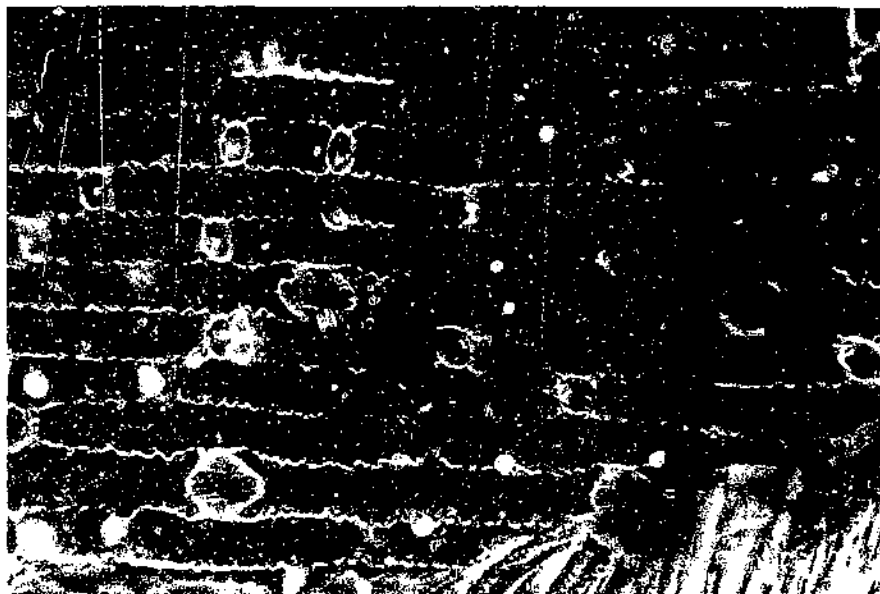
[Grasses and sedges begin on p. 4; forbs begin on p. 68]

Botanical Name*Agropyron cristatum* (L.) Gaertn.**Common Name**

Crested wheatgrass

Code

AGCR

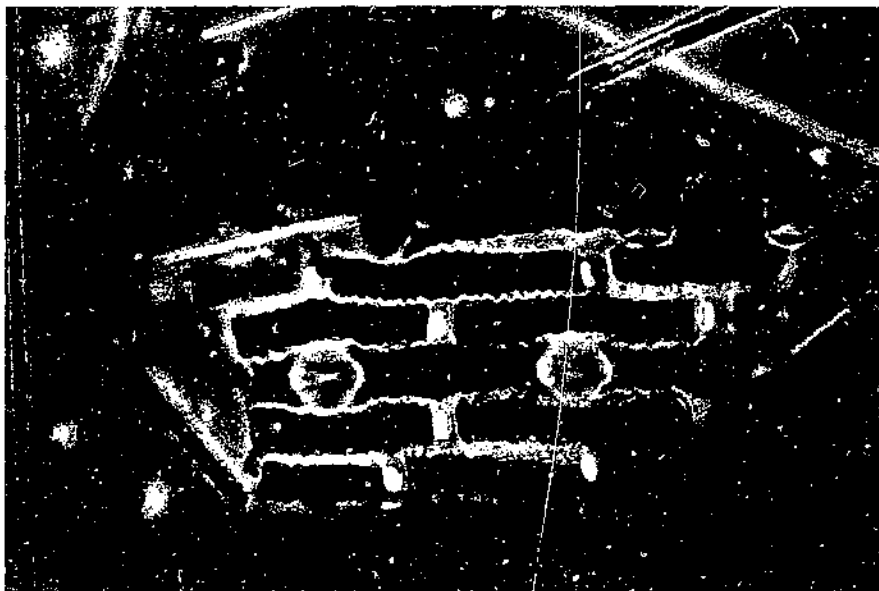


PN-5960

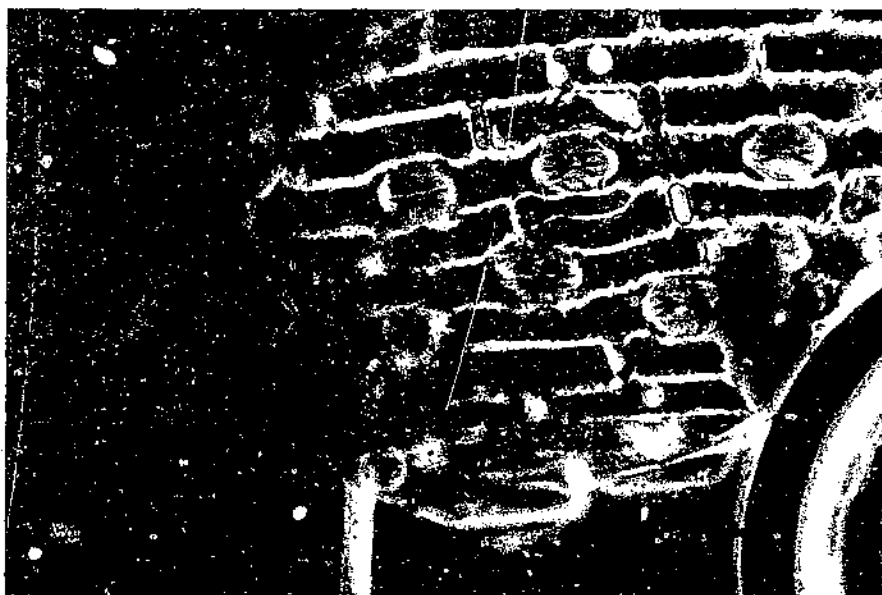


PN-5961

Resembles: Other Agropyrons



PN-5962



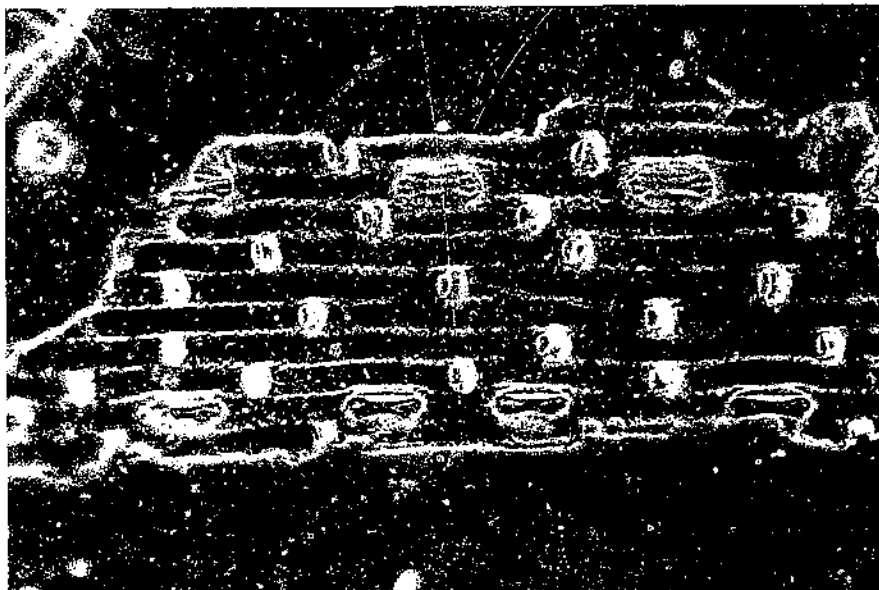
PN-5963

Characters: Some cork cells without silica cells; large epidermal cells and stomata.

Botanical Name
Agropyron smithii Rydb.

Common Name
Western wheatgrass

Code
AGSM

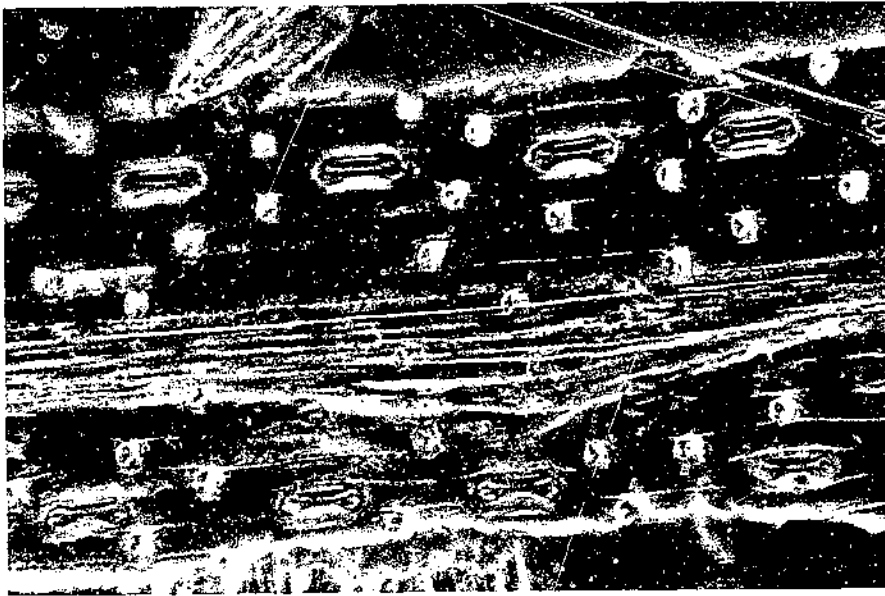


PN-5964

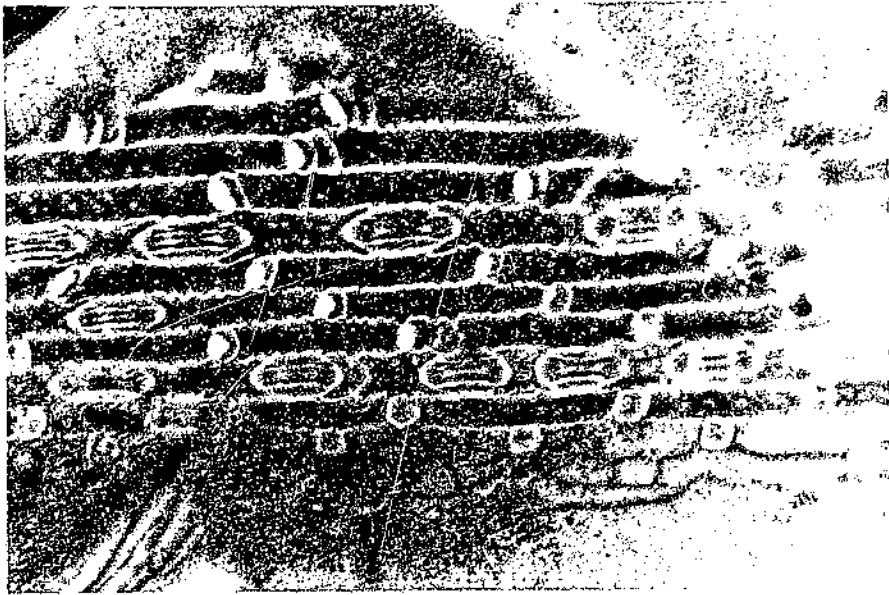


PN-5965

Resembles: Other Agropyrons



PN-5966



PN-5967

Characters: Long, narrow stomata; distinct silica cells recessed into cork cells; large epidermal cells and stomata.

Botanical Name*Agropyron trachycaulum* (Link) Malte**Common Name**

Slender wheatgrass

Code

AGTR



PN-5968

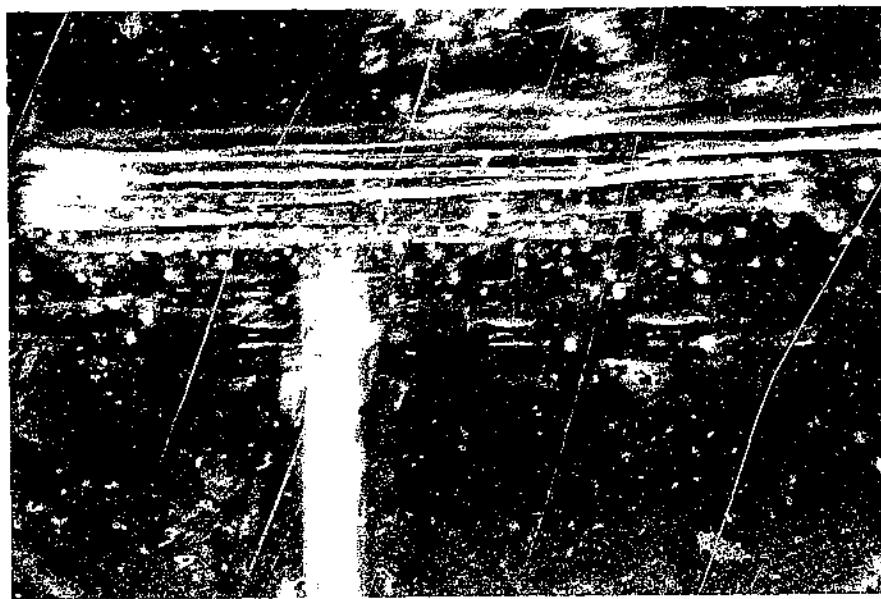


PN-5969

Resembles: Other Agropyrons



PN-5970



PN-5971

Characters: Small, slender stomata; less distinct stomata and silica cells.

Botanical Name
Andropogon halli Hack.

Common Name
Sand bluestem

Code
ANHA



PN-5972



PN-5973

Resembles: Other Andropogons



PN-5974



PN-5975

Characters: Most epidermal fragments light refractive; large stomata.

Botanical Name*Andropogon scoparius* Michx.**Common Name**

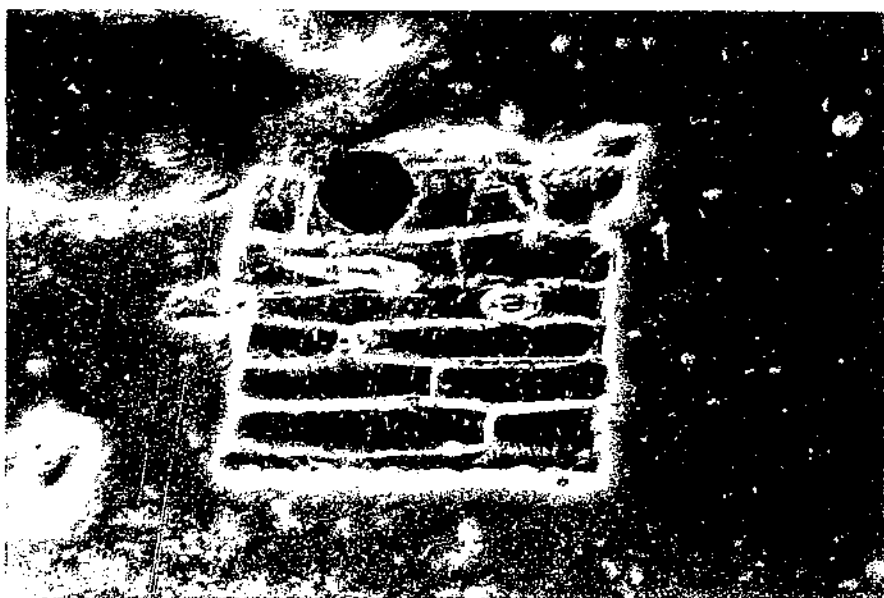
Little bluestem

Code

ANSC

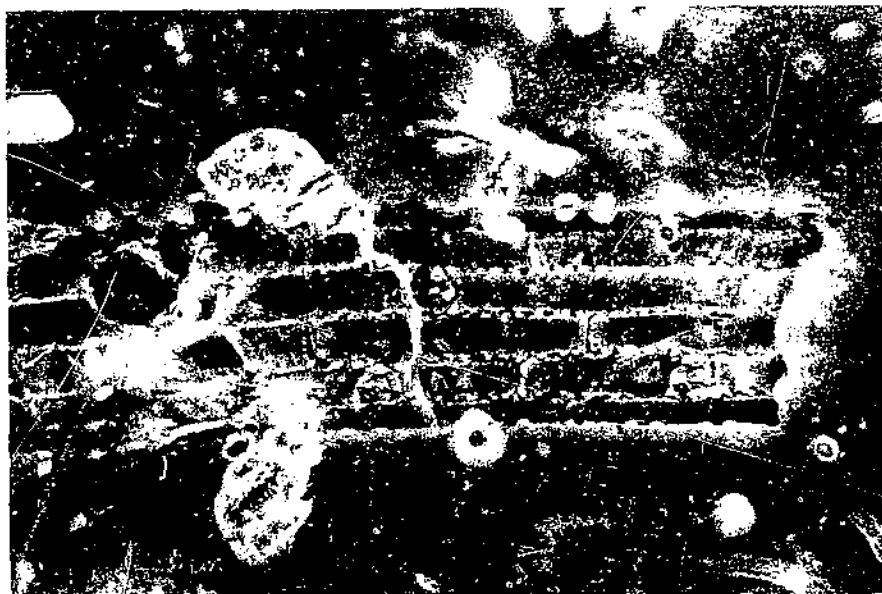


PN-5976



PN-5977

Resembles: Distinct



PN-5978



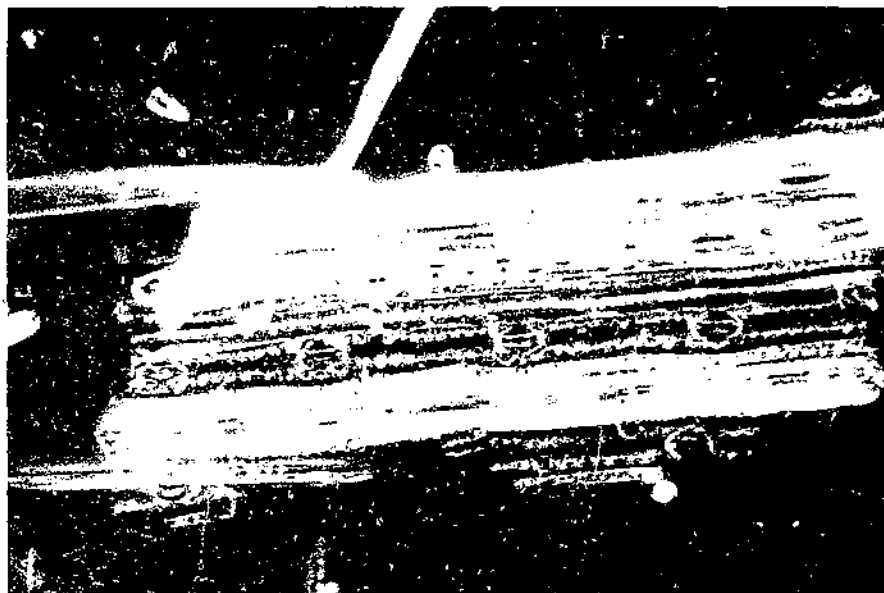
PN-5979

Characters: Very large, wide cells; round or elliptical stomata; cell ends mostly a refractive line.

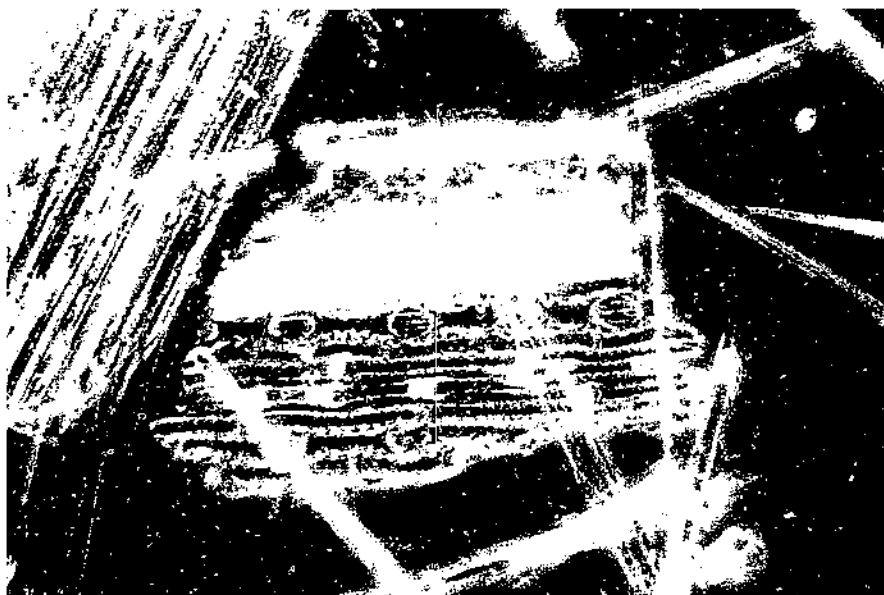
Botanical Name
Aristida longiseta Steud.

Common Name
Red threeawn

Code
ARLO

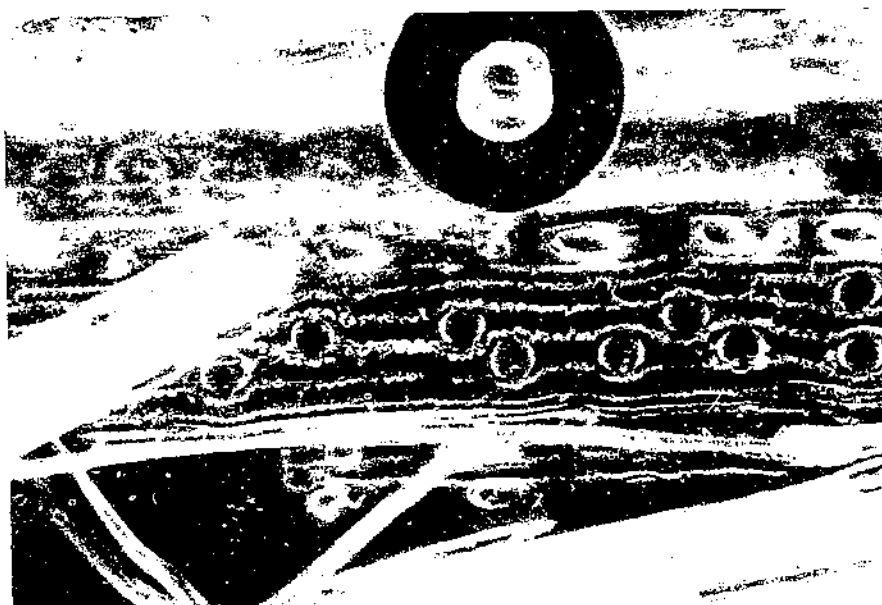


PN-5980



PN-5981

Resembles: *Sporobolus cryptandrus*



PN-5982



PN-5983

Characters: Round to diamond-shaped stomata; some midrib attached to epidermal fragments.

Botanical Name*Bouteloua curtipendula* (Michx.) Torr.**Common Name**

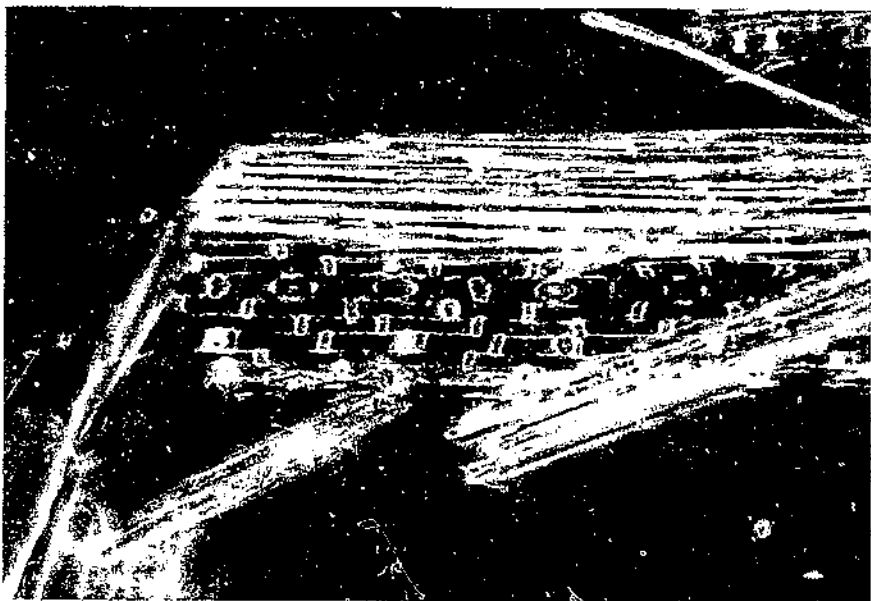
Sideoats grama

Code

BOCU

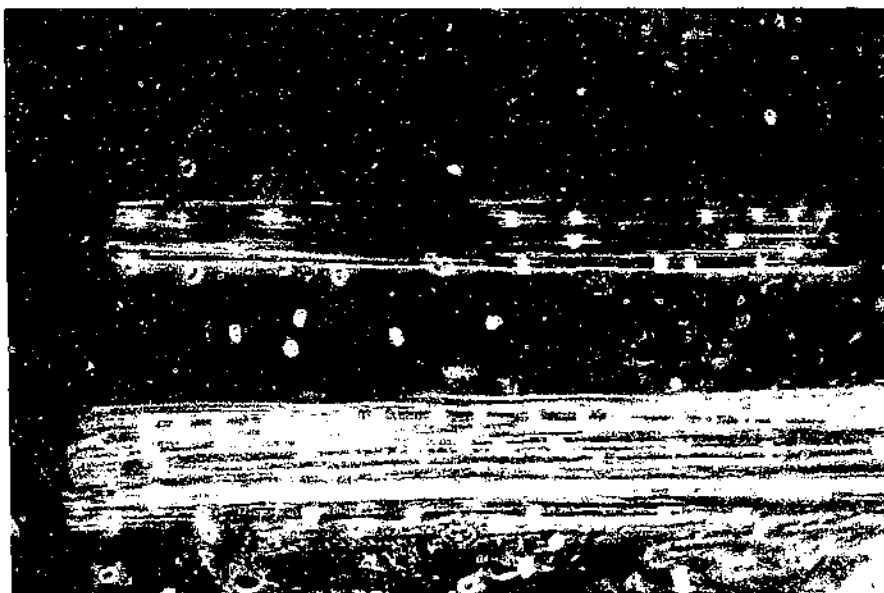


PN-5984

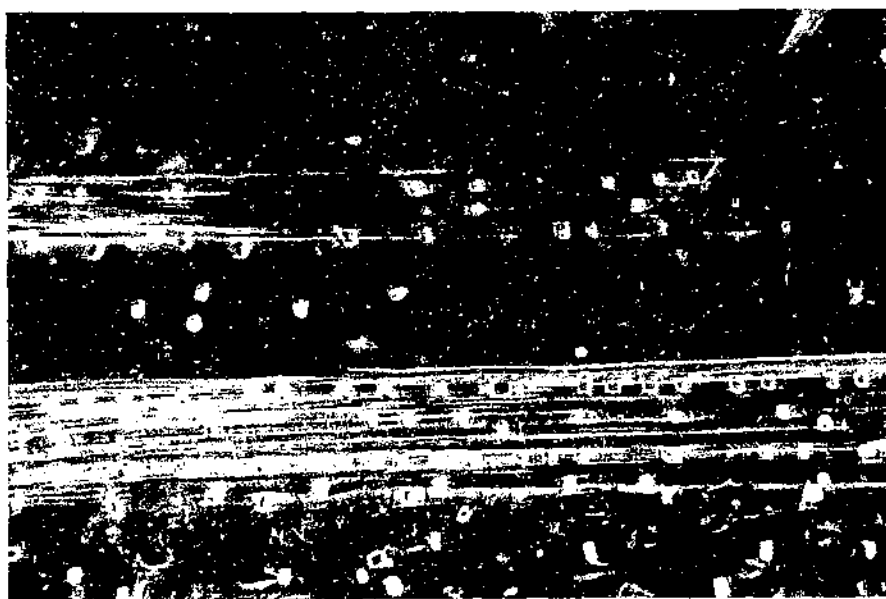


PN-5985

Resembles: Distinct



PN-5986



PN-5987

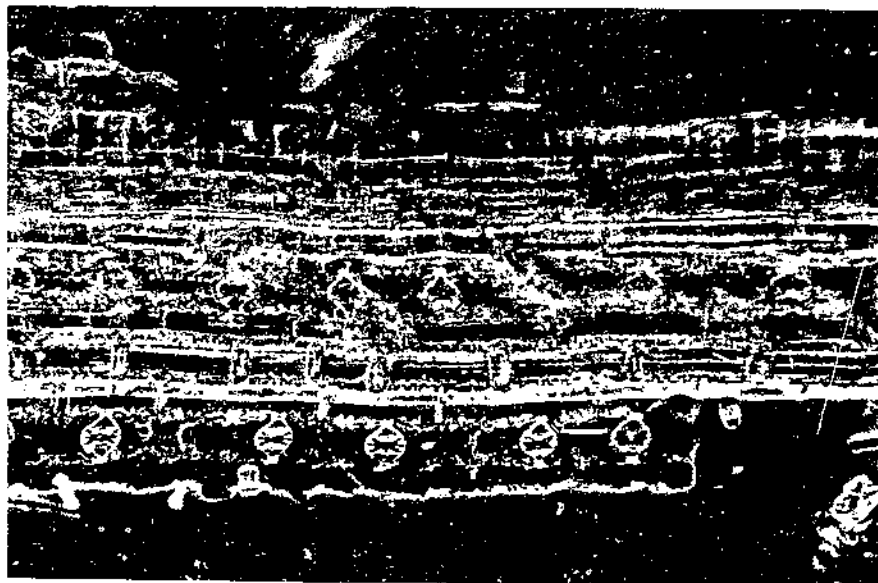
Characters: Most leaf edge cork cells terminate in a short, spiny hair; most silica cells rectangular with slight center constriction.

Botanical Name*Bouteloua eriopoda* (Torr.) Torr.**Common Name**

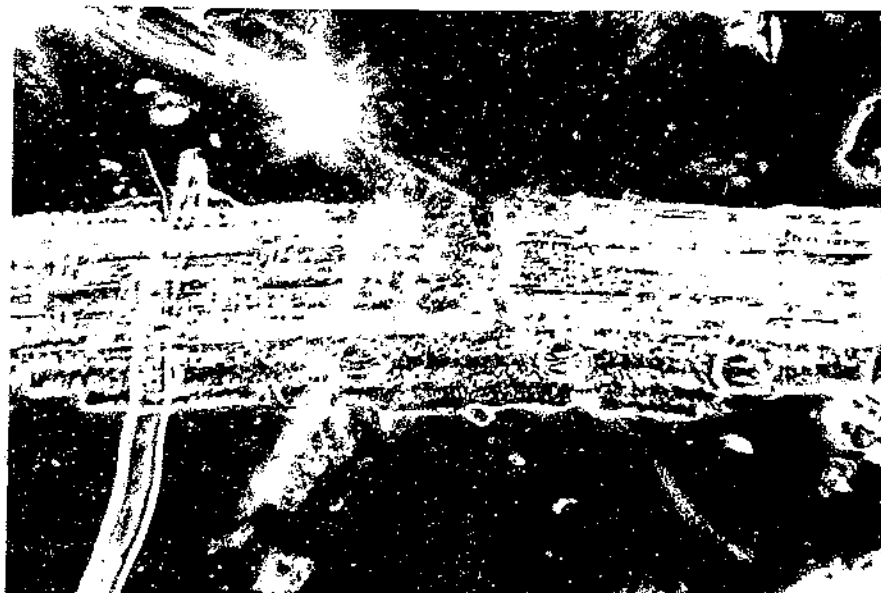
Black grama

Code

BOER

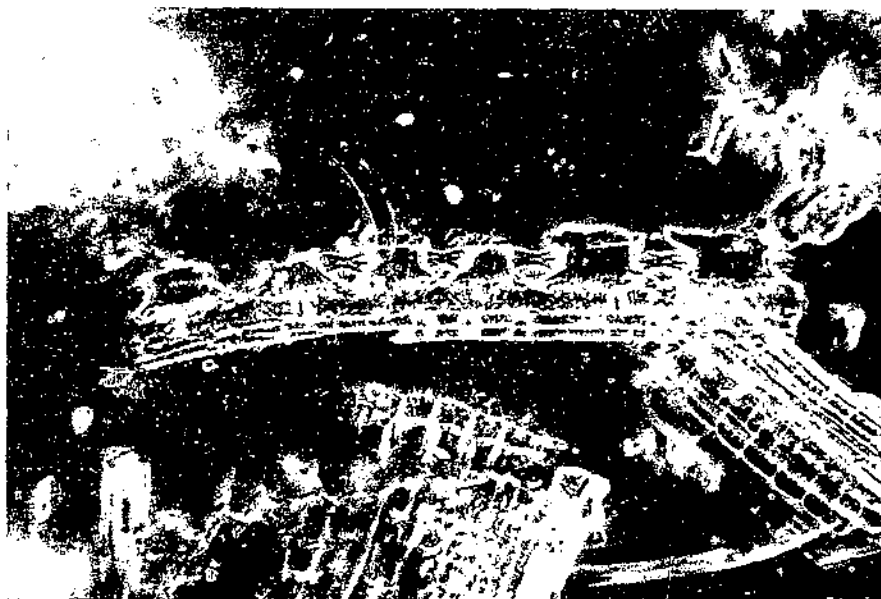


PN-5988

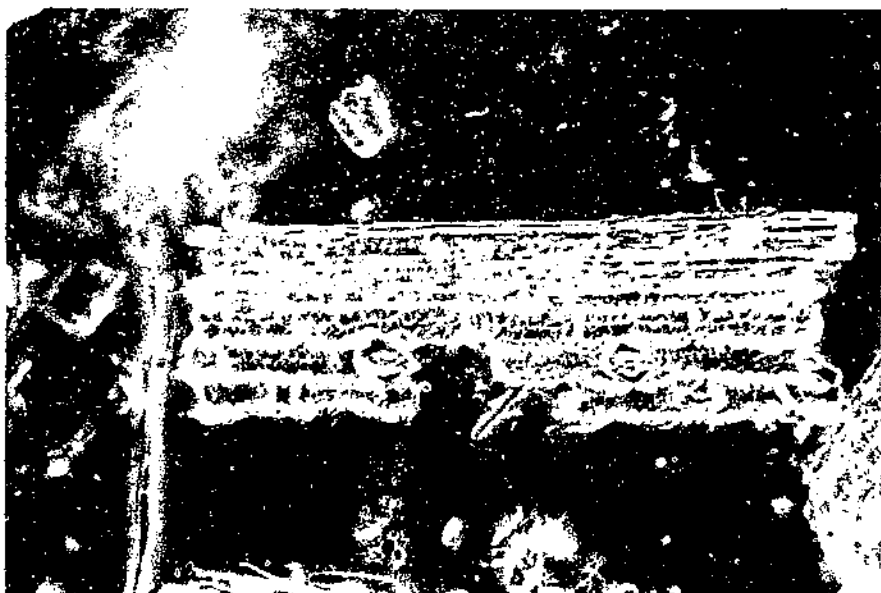


PN-5989

Resembles: Other *Bouteloua*



PN-5990



PN-5991

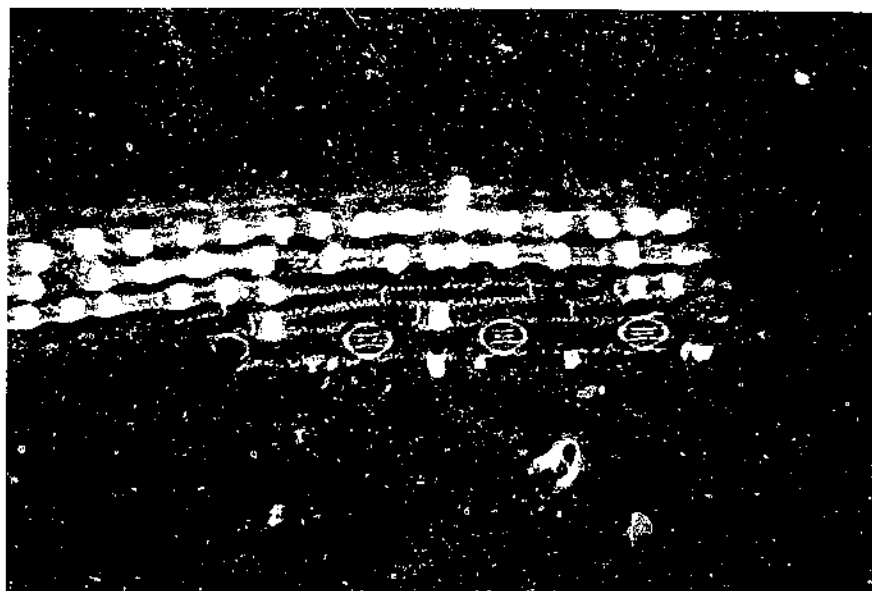
Characters: Diamond-shaped stomata appear attached to cell walls both top and bottom with stemlike appendage.

Botanical Name*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.**Common Name**

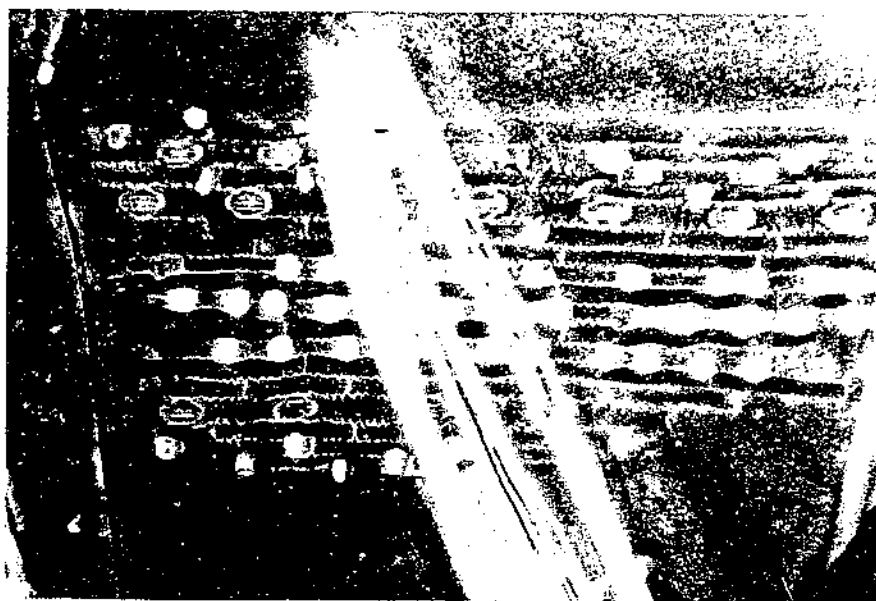
Blue grama

Code

BOGR

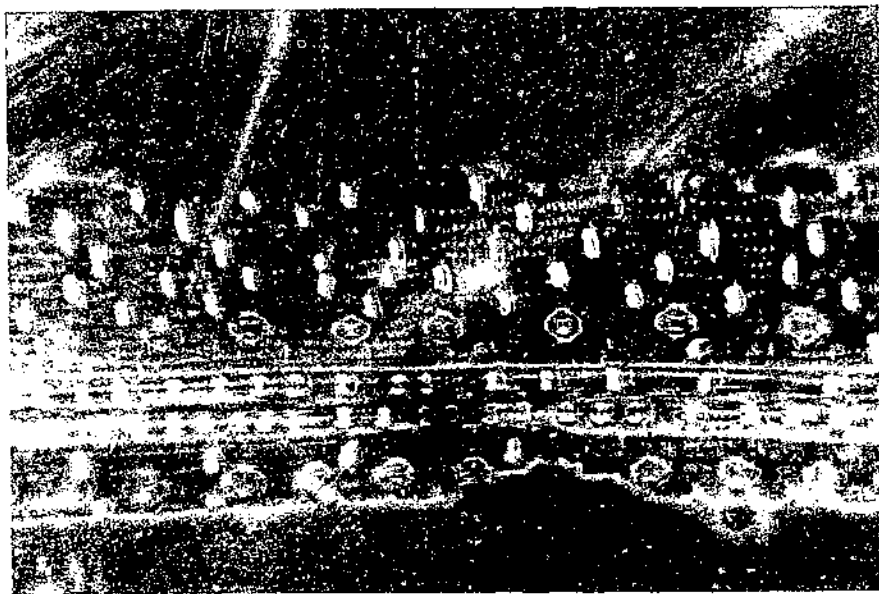


PN-5992

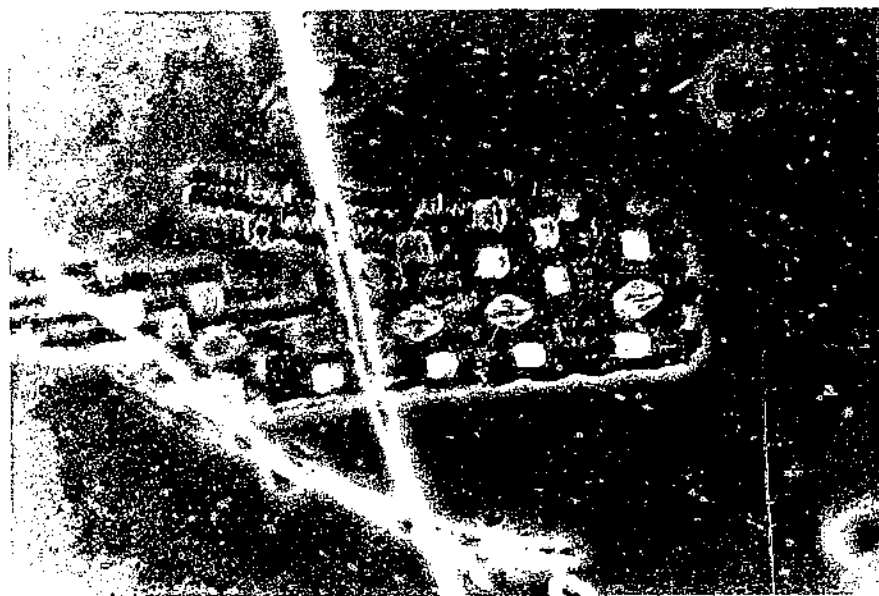


PN-5993

Resembles: *Buchloe dactyloides*, *Sporobolus cryptandrus*, *Stipa comata*



PN-5994



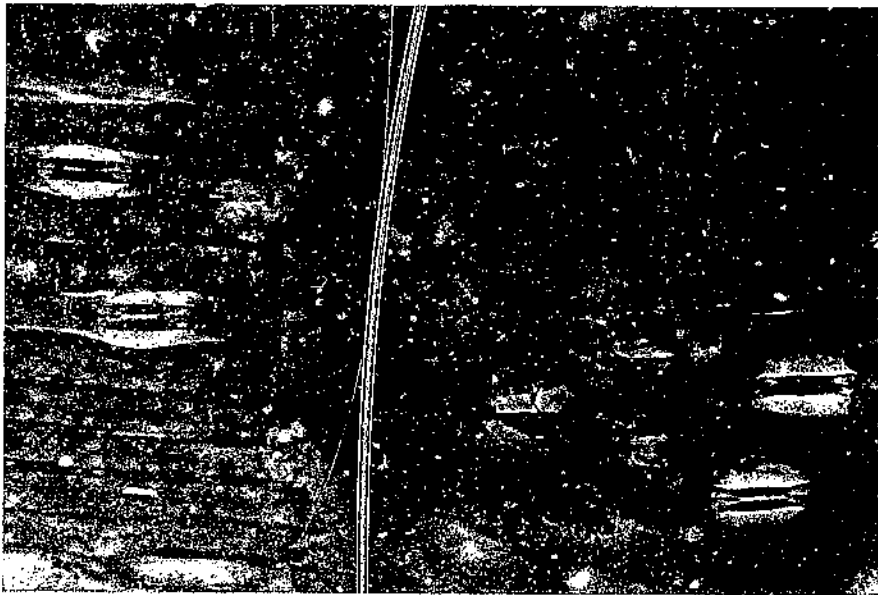
PN-5995

Characters: Silica cells oblong, close to cork cells; ends of cork cells extend into cell wall undulations; diamond-shaped stomata.

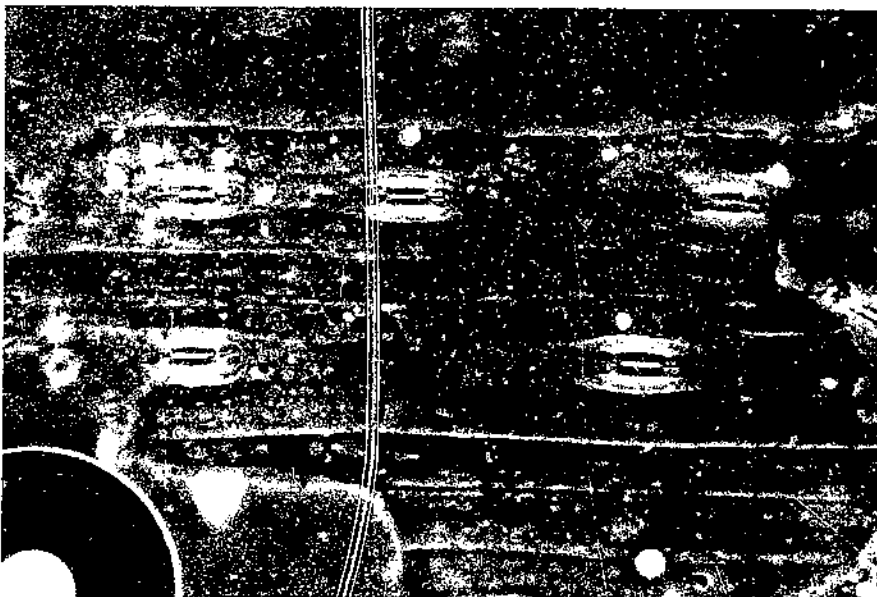
Botanical Name
Bromus inermis Leyss.

Common Name
Smooth brome

Code
BRIN



PN-5996

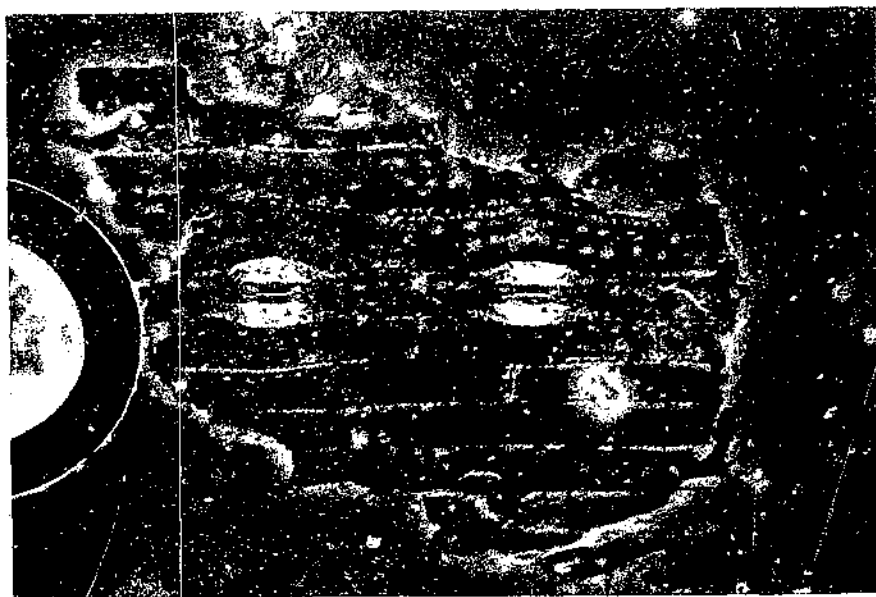


PN-5997

Resembles: Distinct



PN-5998



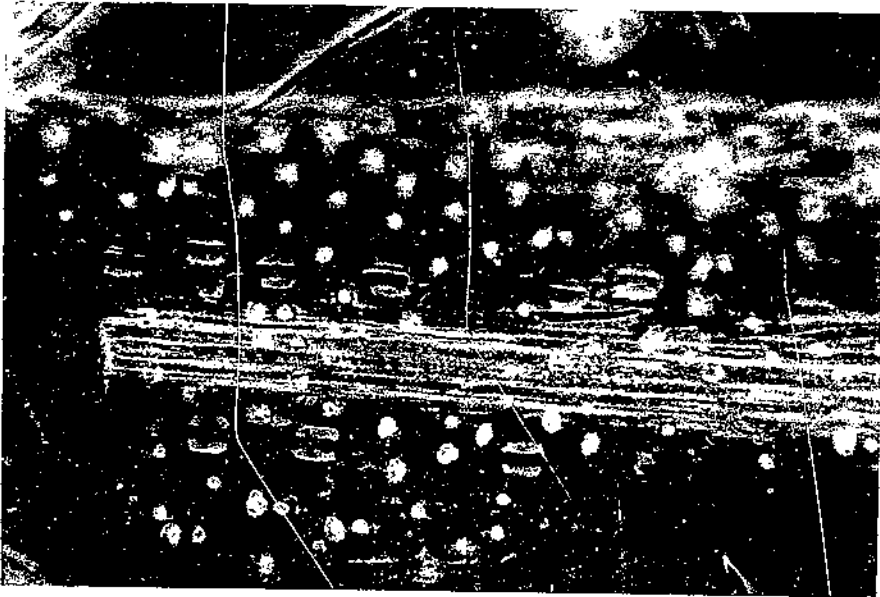
PN-5999

Characters: Very large cells and stomata; ends of stomata indistinct, blending into cell walls; few cell wall undulations.

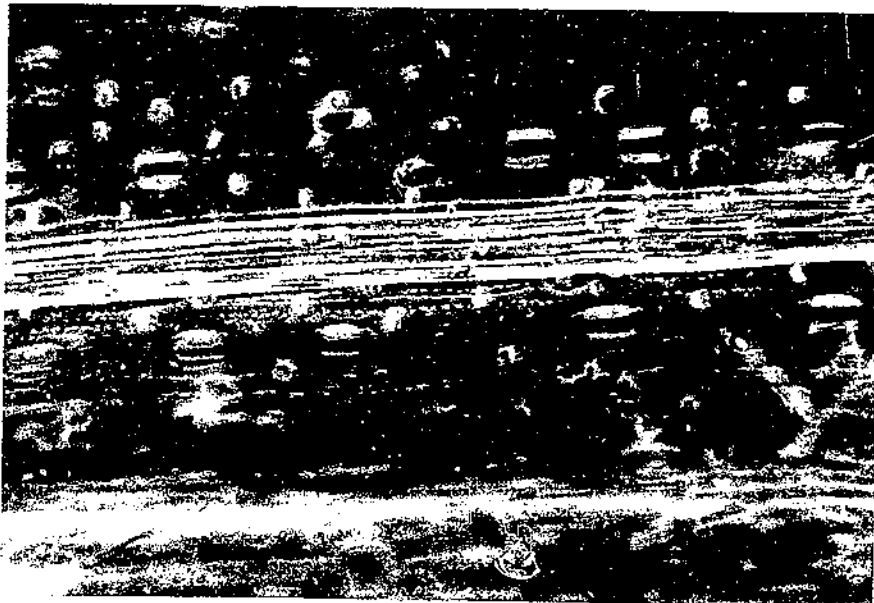
Botanical Name
Bromus tectorum L.

Common Name
Cheatgrass

Code
BRTE

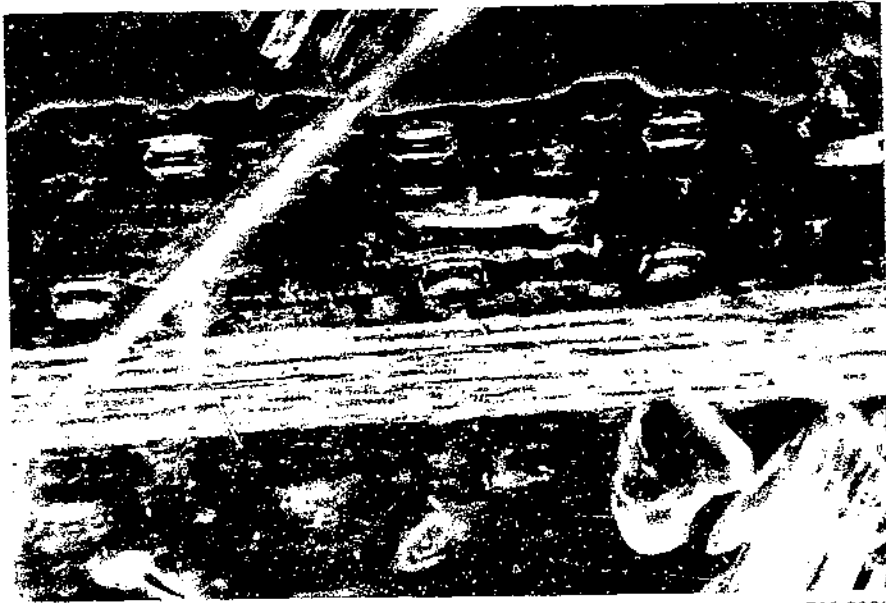


PN-6000



PN-6001

Resembles: Distinct



PN-6002



PN-6003

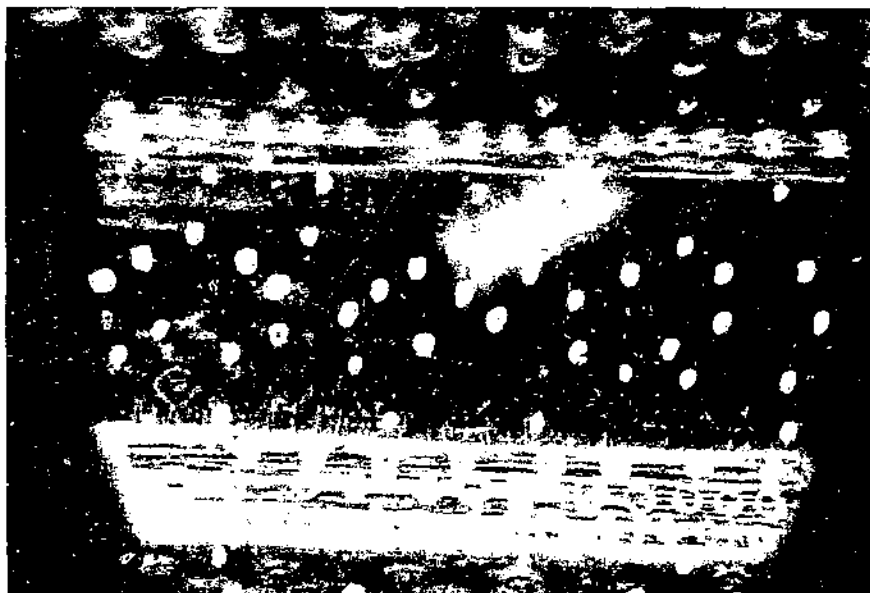
Characters: Many pitted cork cells without silica cells; midrib generally attached to epidermal fragment.

Botanical Name*Buchloe dactyloides* (Nutt.) Engelm.**Common Name**

Buffalograss

Code

BUDA



PN-6004

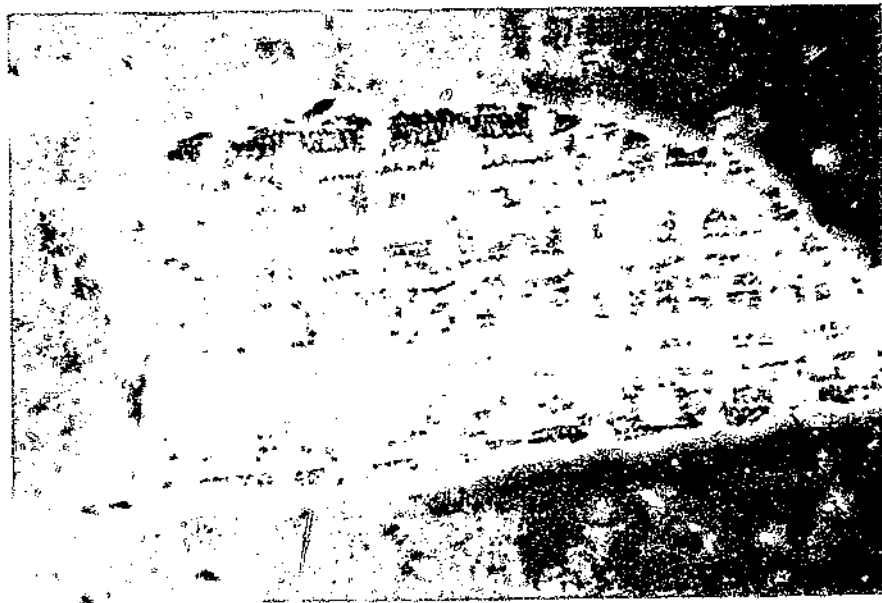


PJ-6005

Resembles: *Bouteloua gracilis*



PN-6006



PN-6007

Characters: Round to oblong stomata; refractive debris across epidermal fragments; indistinct cork cells.

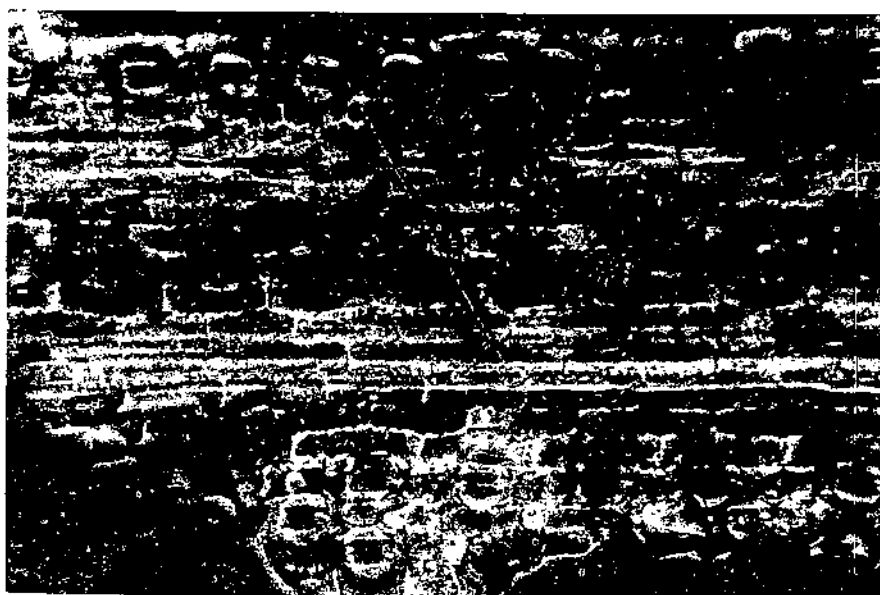
Botanical Name
Carex eleocharis Bailey

Common Name
Needleleaf sedge

Code
CAEL

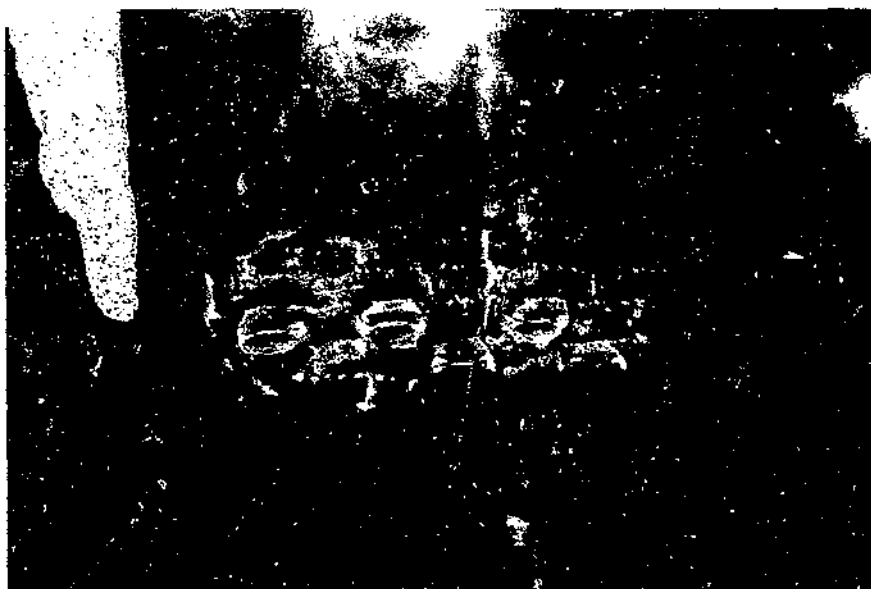


PN-6008



PN-6009

Resembles: Other Carex



PN-6010



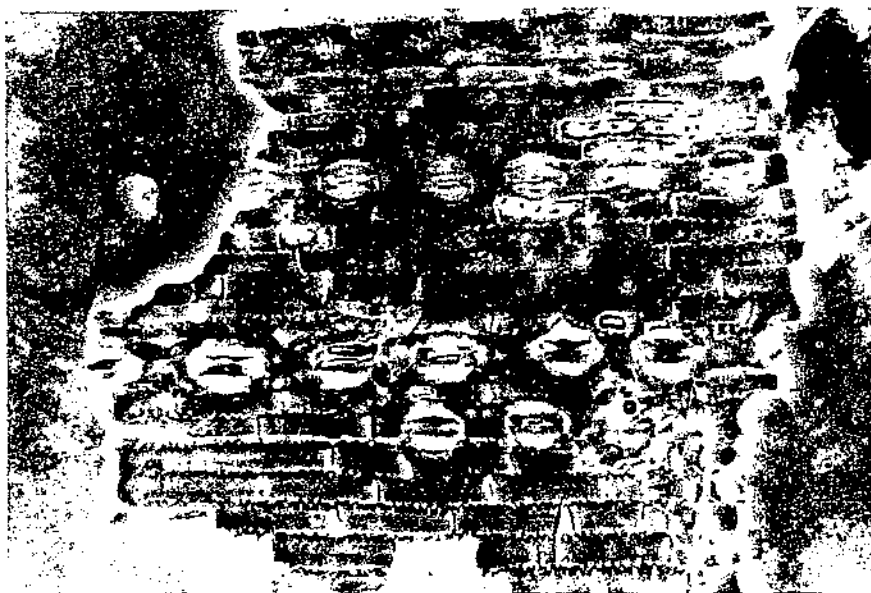
PN-6011

Characters: Closely spaced, dark-guard cells on stomata with refractive material on epidermal fragments; slender cells, no silica or cork cells.

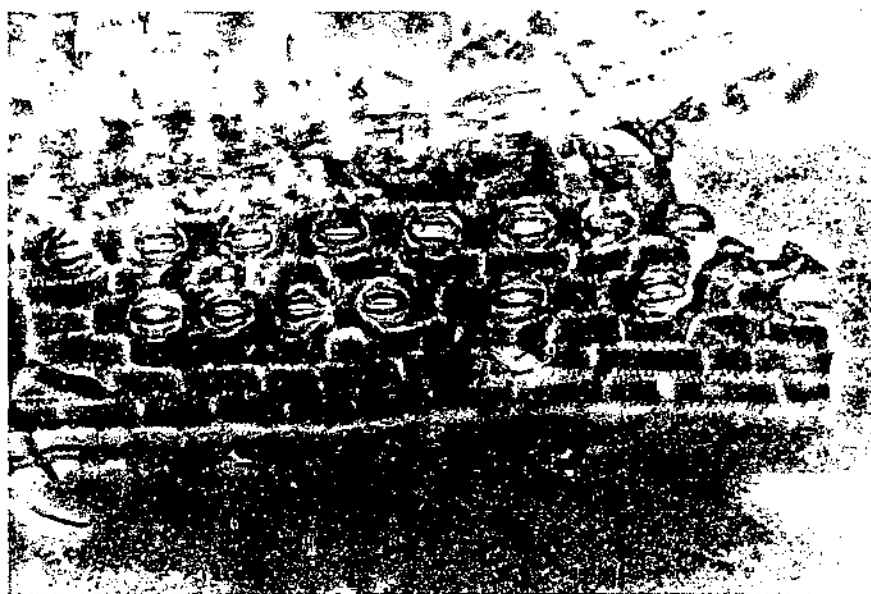
Botanical Name
Carex filifolia Nutt.

Common Name
Threadleaf sedge

Code
CAFI

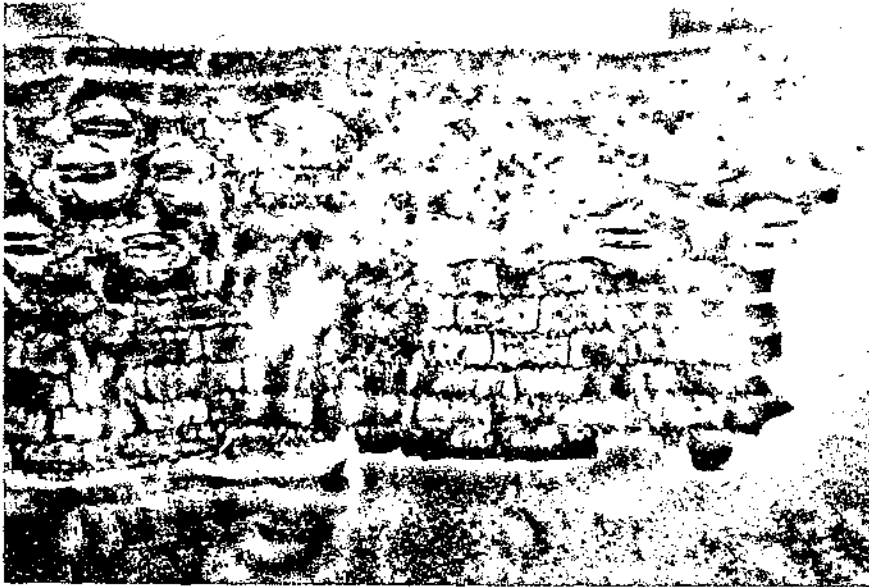


PN-6012

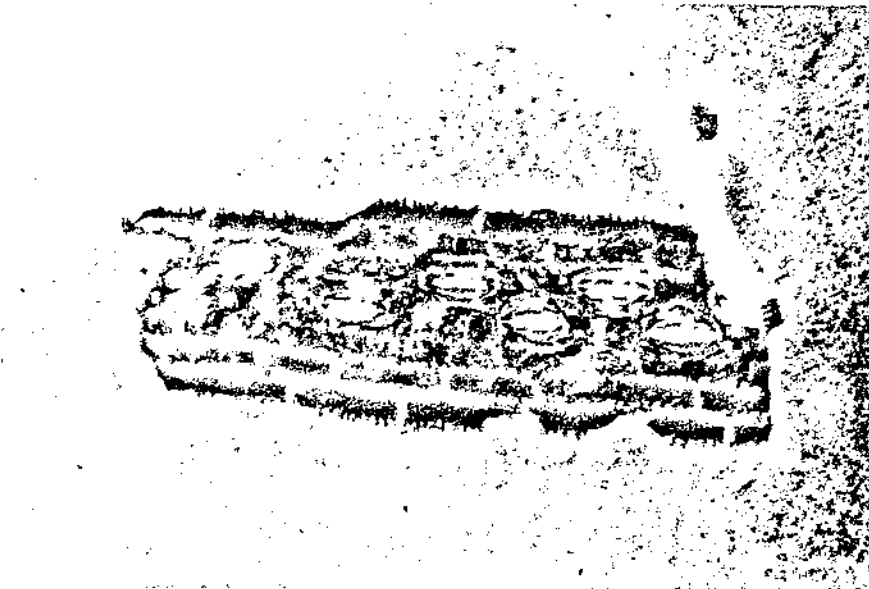


PN-6013

Resembles: Other Carex



PN-6014



PN-6015

Characters: Large, closely spaced stomata; cells distinctly like brick wall; no silica cells.

Botanical Name*Elymus canadensis* L.**Common Name**

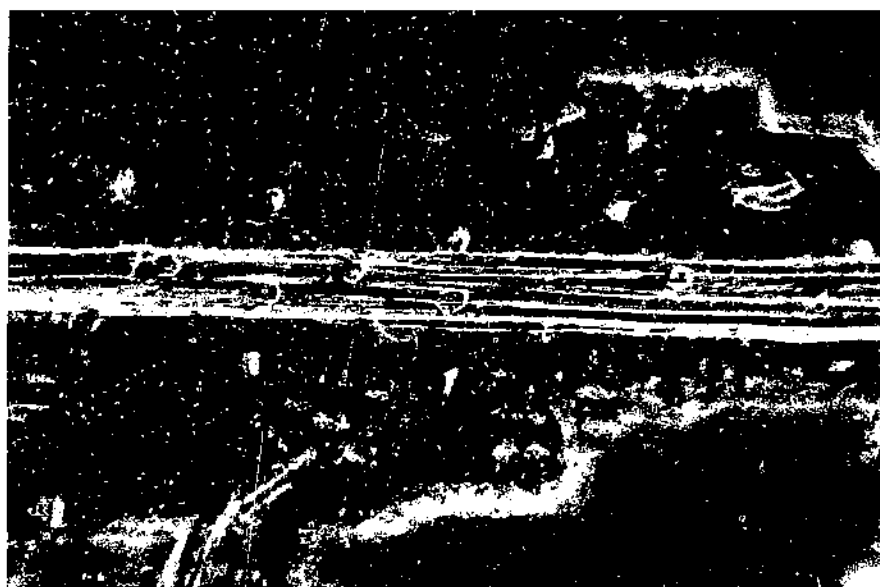
Canada wildrye

Code

ELCA



PN-6016



PN-6017

Resembles: *Agropyron cristatum*



PN-6018



PN-6019

Characters: Most cork cells with silica cell attached; dark cell structures.

Botanical Name
Elymus junceus Fisch.

Common Name
Russian wildrye

Code
ELJU

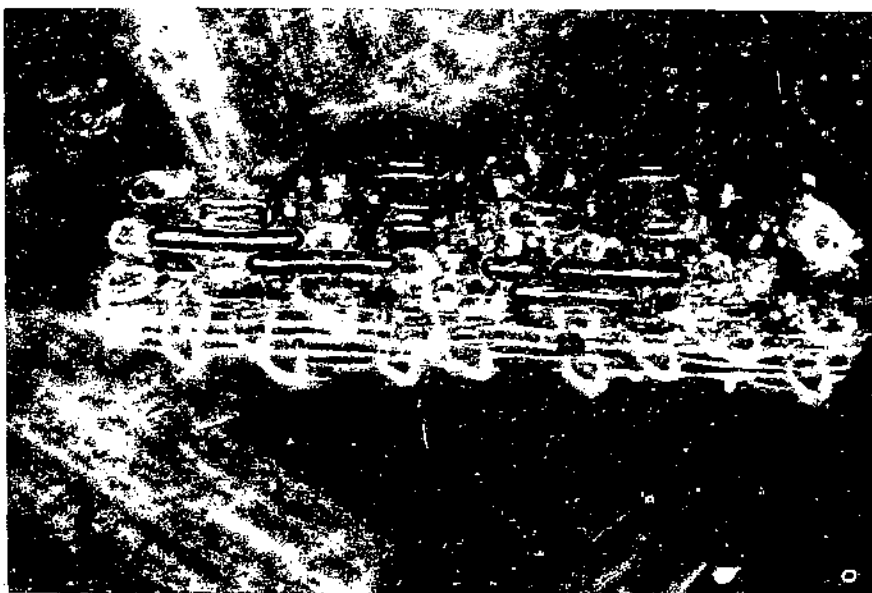


PN-6020



PN-6021

Resembles: Distinct



PN-6022



PN-6023

Characters: Debris or other cell layer portions almost obscuring large stomata.

Botanical Name*Eragrostis curvula* (Schrad.) Nees**Common Name**

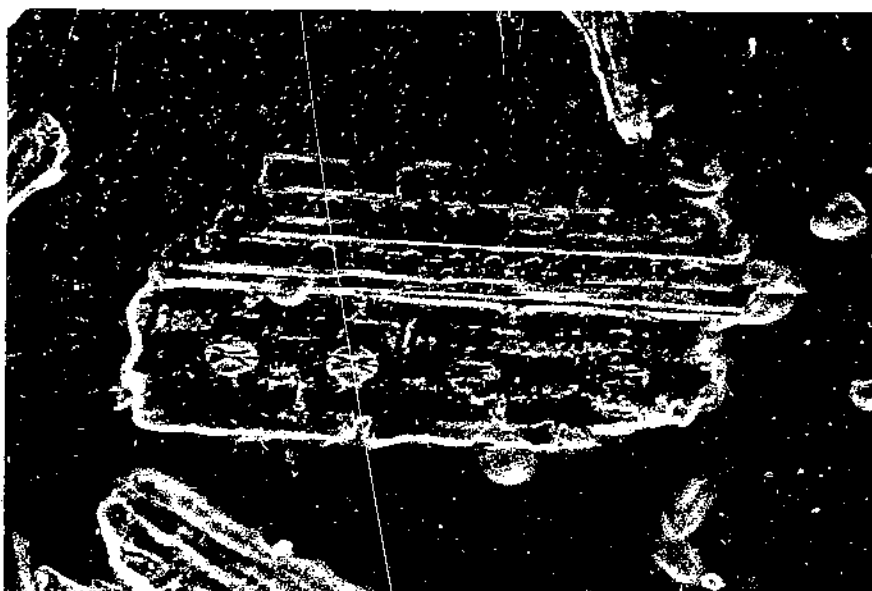
Weeping lovegrass

Code

ERCU

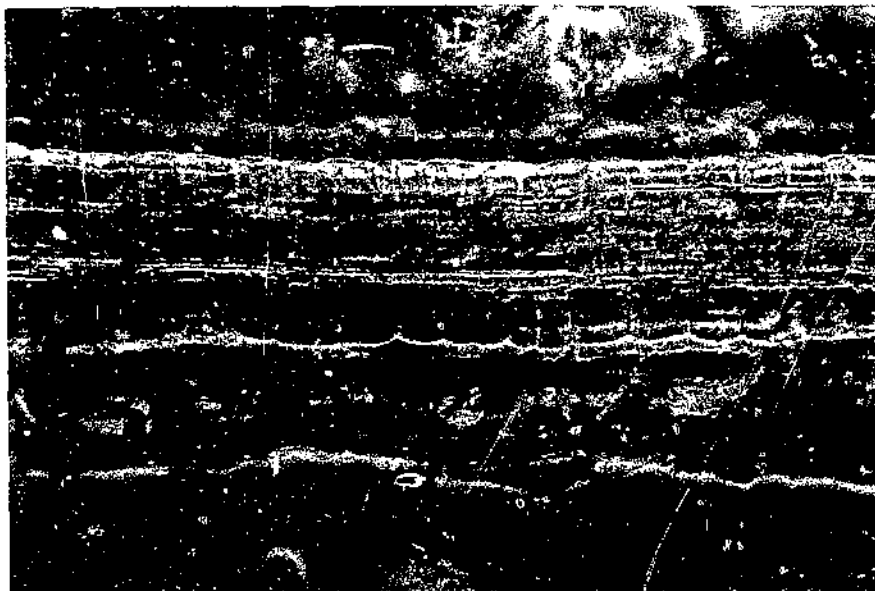


PN-6024



PN-6025

Resembles: Distinct



PN-6026



PN-6027

Characters: Undulating cell walls not prominent; round to round-oblong stomata.

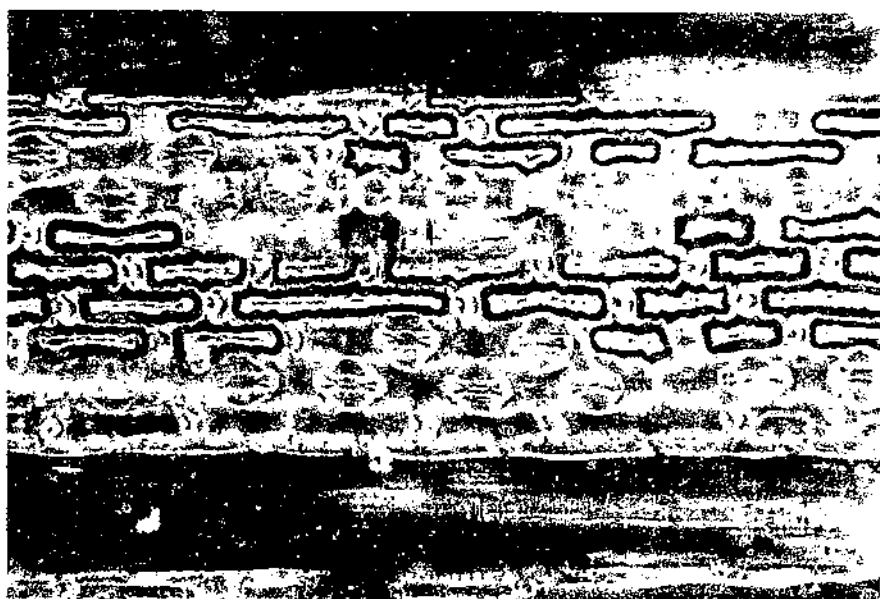
Botanical Name
Hordeum jubatum L.

Common Name
Foxtail barley

Code
HOJU



PN-6028



PN-6029

Resembles: Distinct



PN-6030



PN-6031

Characters: Very large, closely spaced stomata, indistinct because of refractive material.

Botanical Name*Koeleria cristata* (L.) Pers.**Common Name**

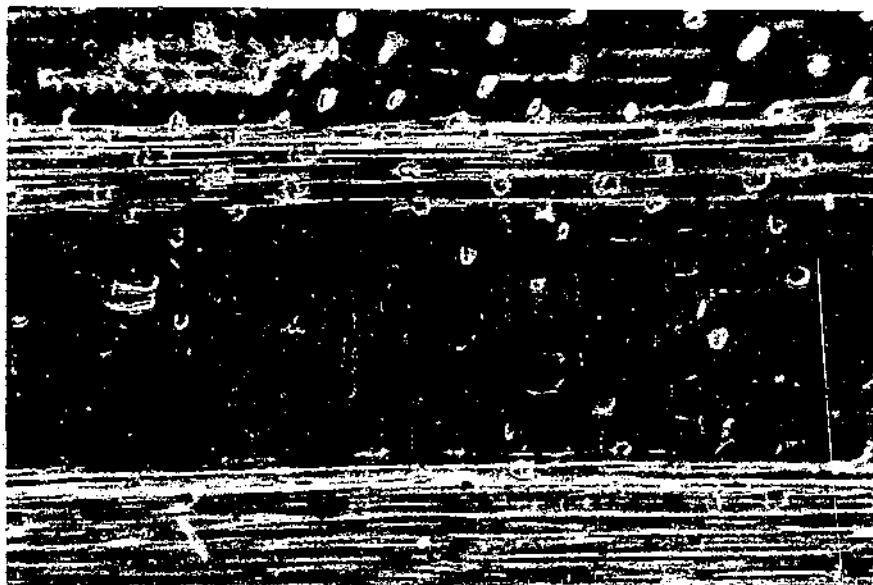
Prairie junegrass

Code

KOCR

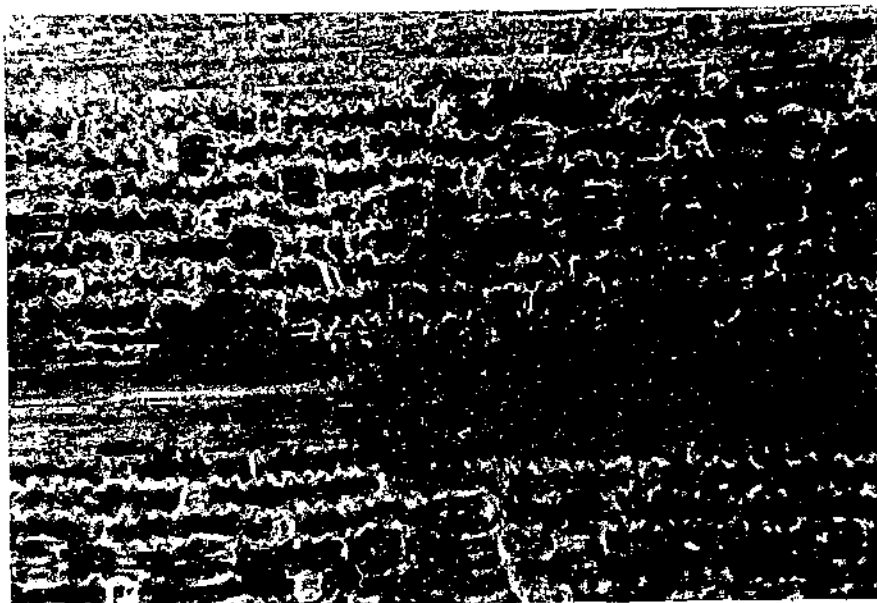


PN-6032

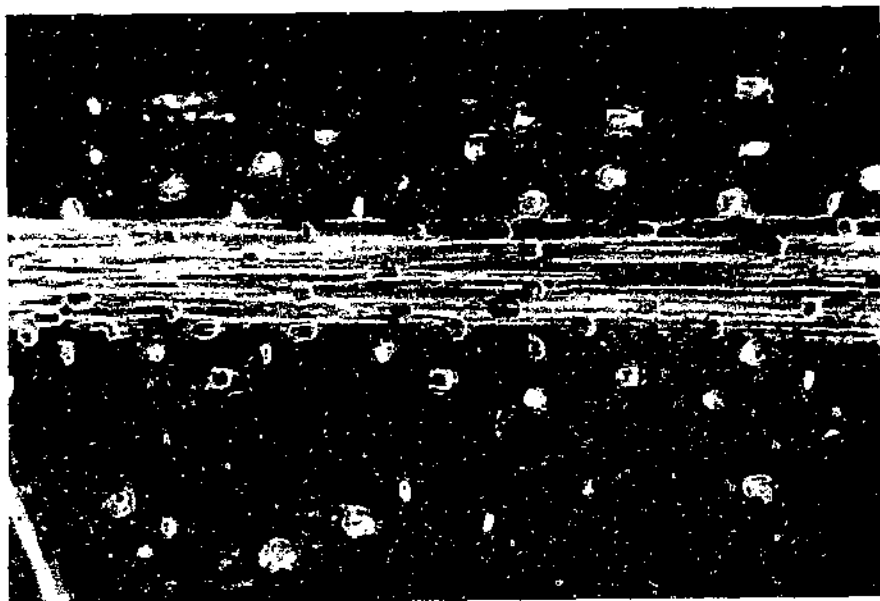


PN-6033

Resembles: Distinct



PN-6034



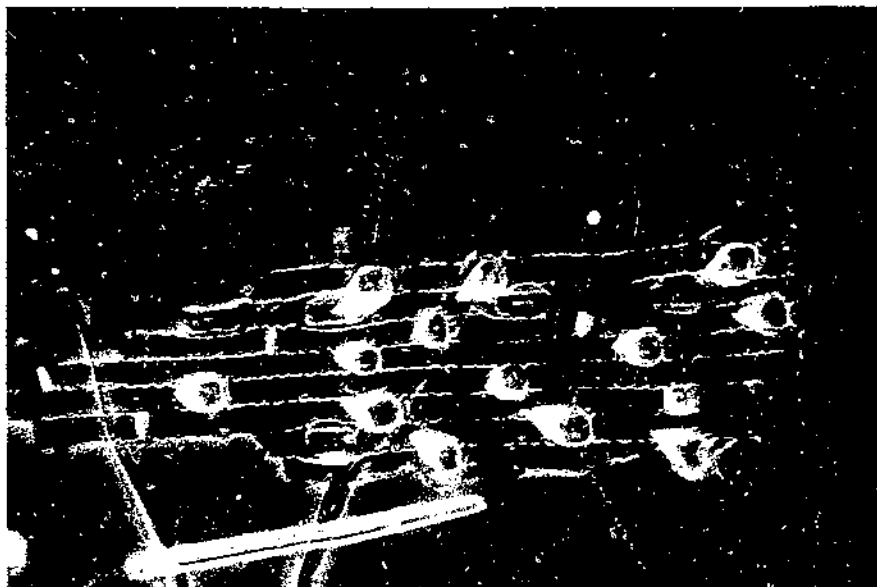
PN-6035

Characters: Hexagonal stomata flat on top and bottom, often taller than wide.

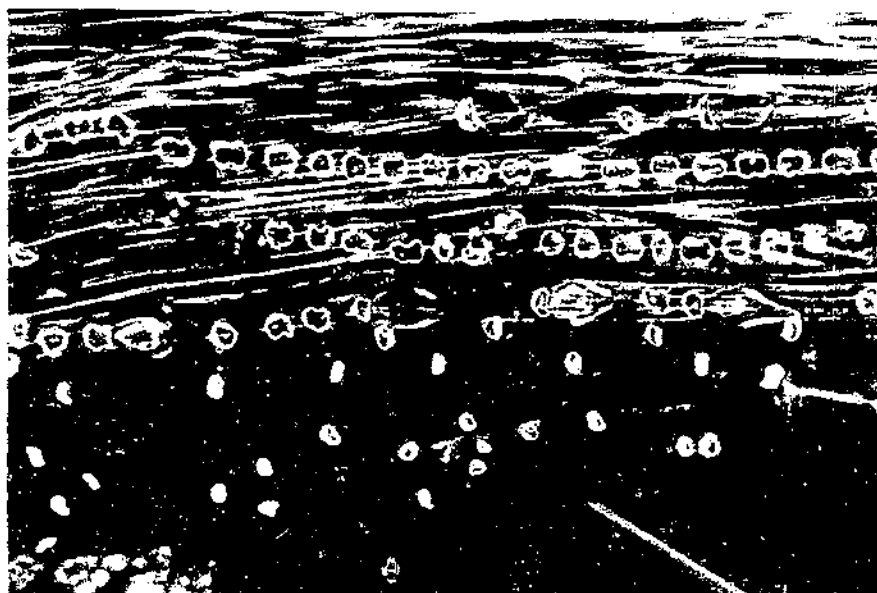
Botanical Name
Oryzopsis hymenoides
(Roem. & Schult.) Ricker

Common Name
Indian ricegrass

Code
ORHY



PN-6036



PN-6037

Resembles: Distinct



PN-6038



PN-6039

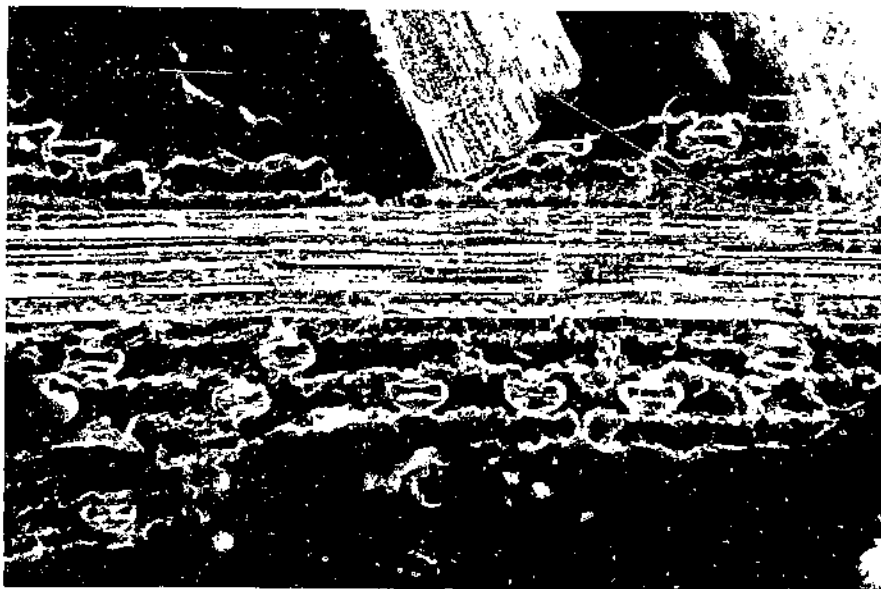
Characters: Many hourglass-shaped silica cells on midrib sections of epidermal fragments; some cork cells with wide, pointed hair; silica cells at cork cells distinct and round-oblong.

Botanical Name*Panicum obtusum* H.B.K.**Common Name**

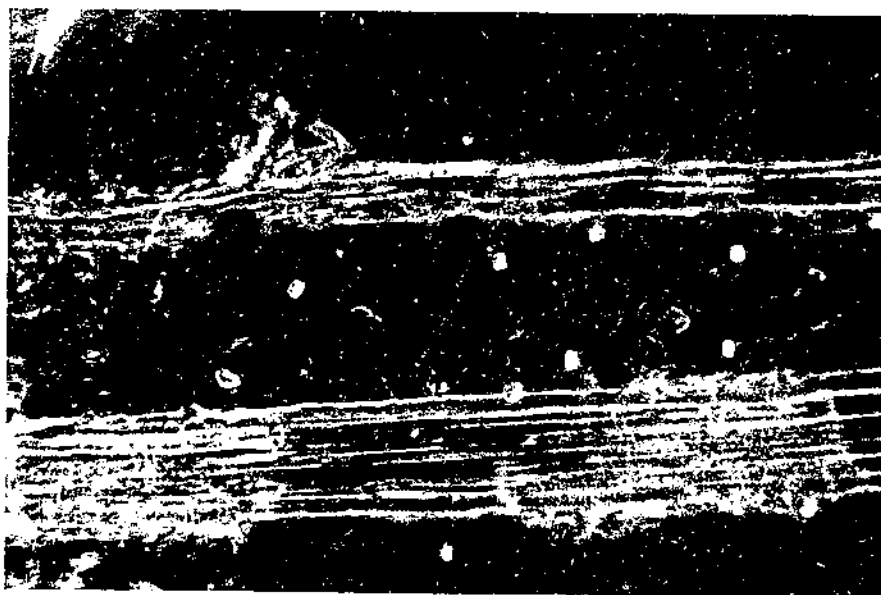
Vine-mesquite panic

Code

PAOB

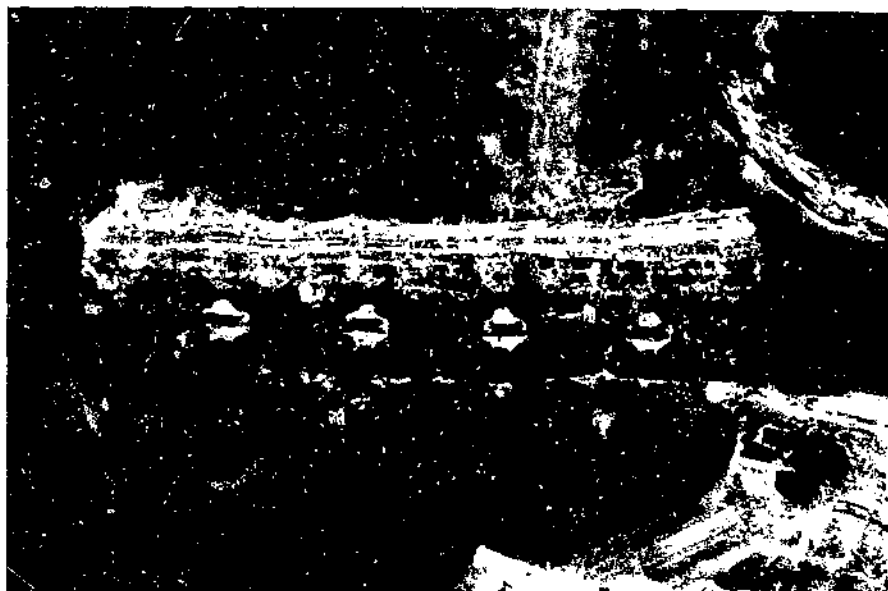


PN-6040



PN-6041

Resembles: Distinct



PN-6042



PN-6043

Characters: Medium to large stomata with modified diamond shape, flattened at top and bottom.

Botanical Name
Panicum virgatum L.

Common Name
Switchgrass

Code
PAVI

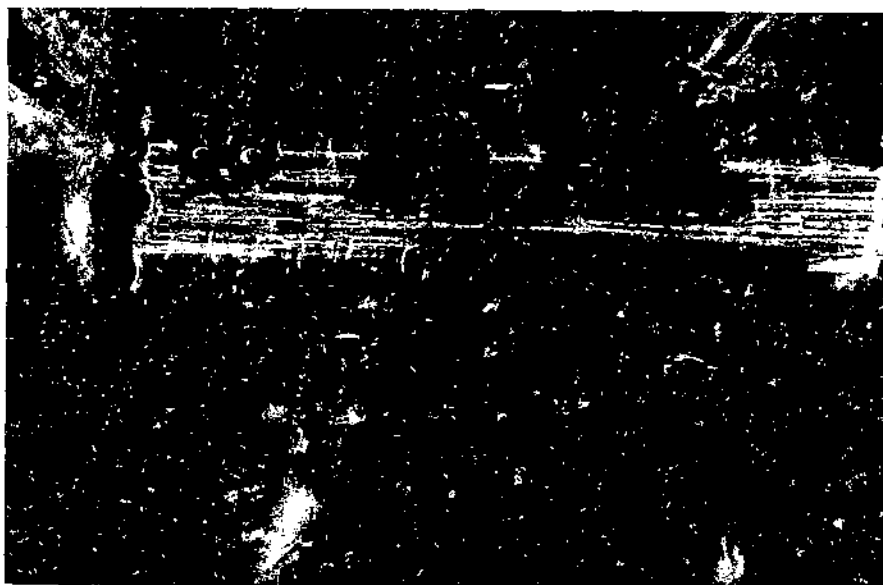


PN-6044



PN-6045

Resembles: Distinct



PN-6046



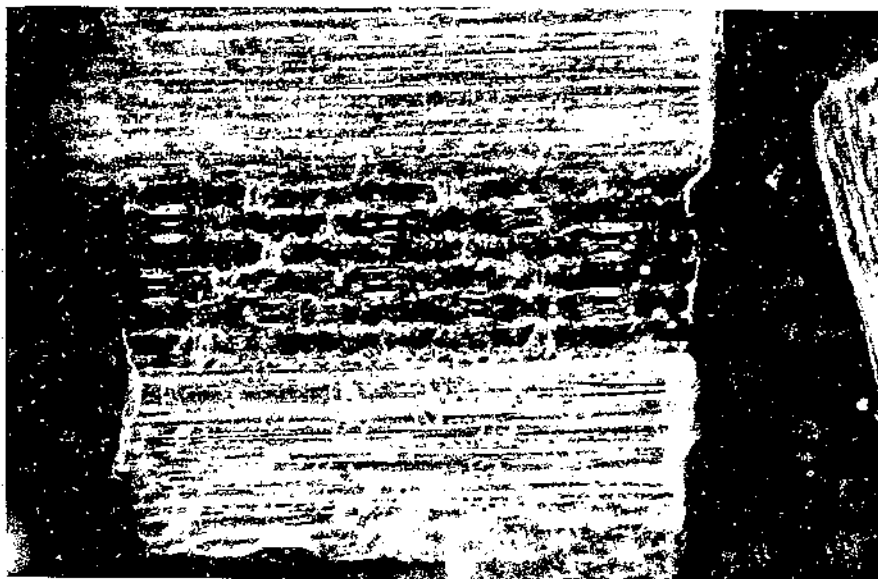
PN-6047

Characters: Cell ends mostly a line, some refractive, or slender oblong cork cells with refractive cell walls.

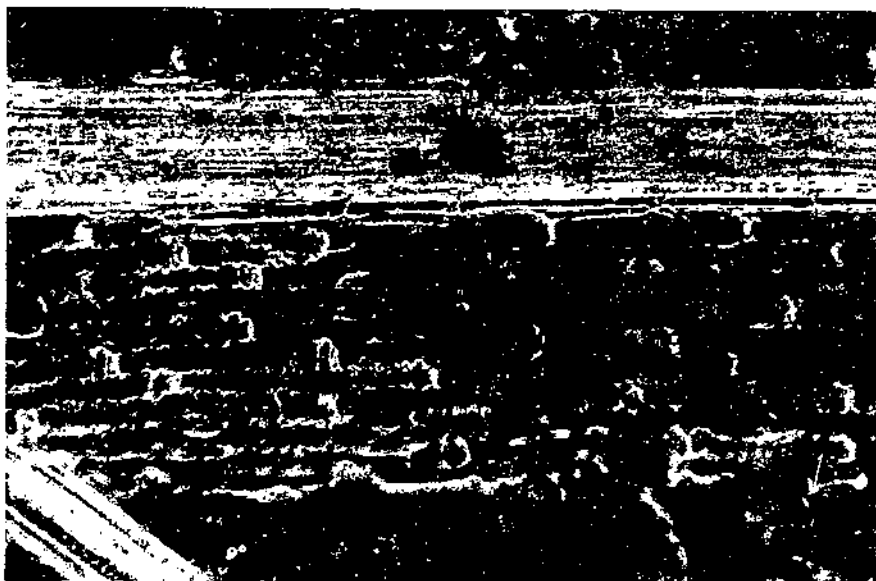
Botanical Name
Poa pratensis L.

Common Name
Kentucky bluegrass

Code
POPR

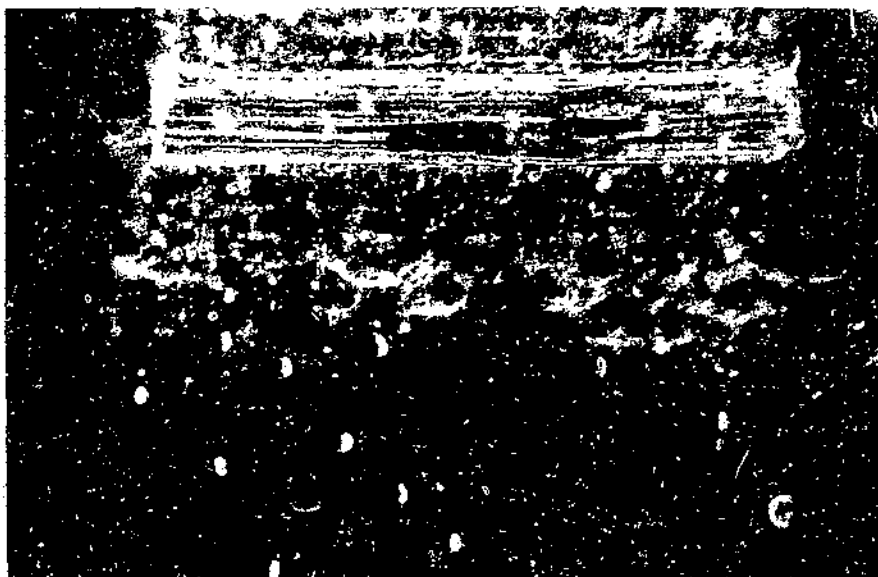


PN-6048

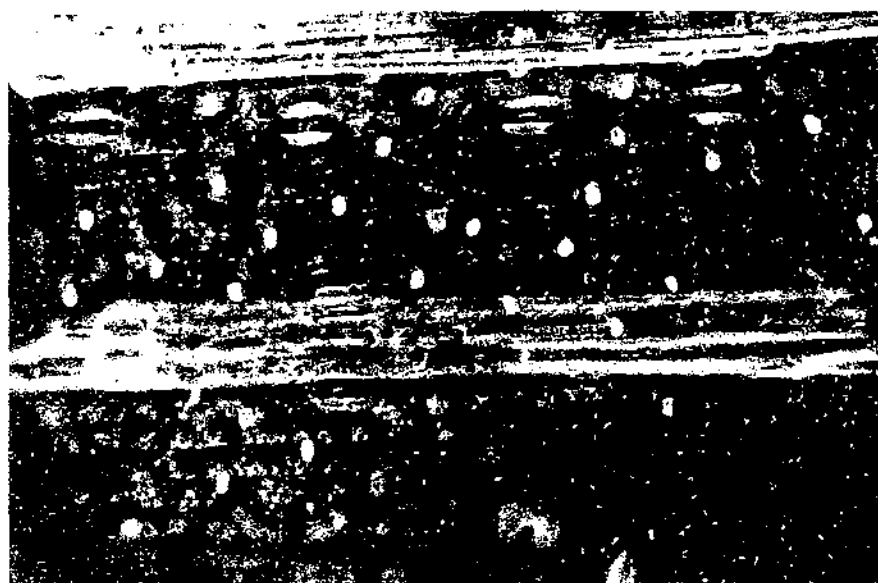


PN-6049

Resembles: Other Poas



PN-6050



PN-6051

Characters: Vertical, distinct, cork and silica cells; less debris on epidermal fragments.

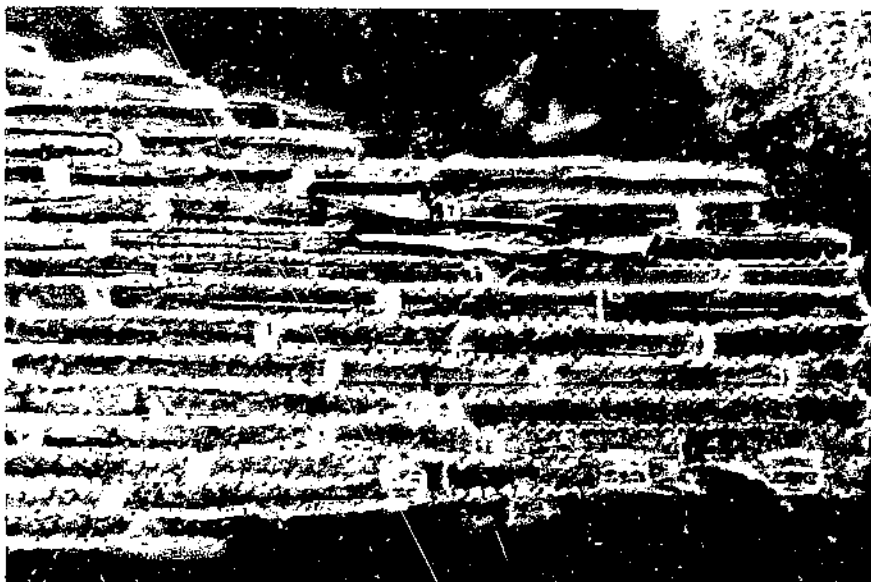
Botanical Name
Poa secunda Presl.

Common Name
Sandberg bluegrass

Code
POSE



PN-6052



PN-6053

Resembles: Other Poas, *Koeleria cristata*



PN-6054



PN-6055

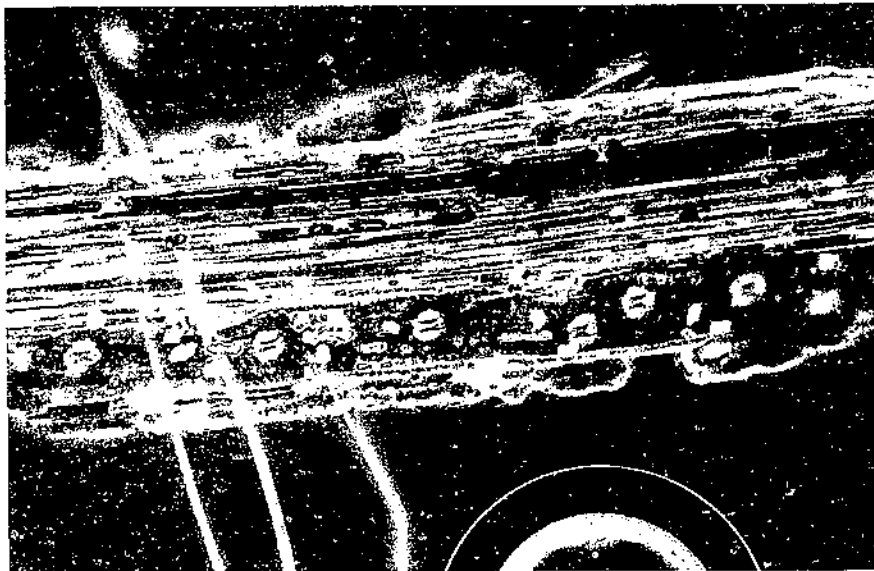
Characters: Vertical or slightly oblique cork and silica cells with deep cell wall undulations; sparse, sometimes oblique stomata.

Botanical Name*Schedonnardus paniculatus* (Nutt.) Trel.**Common Name**

Common tumblegrass

Code

SCPA



PN-6056

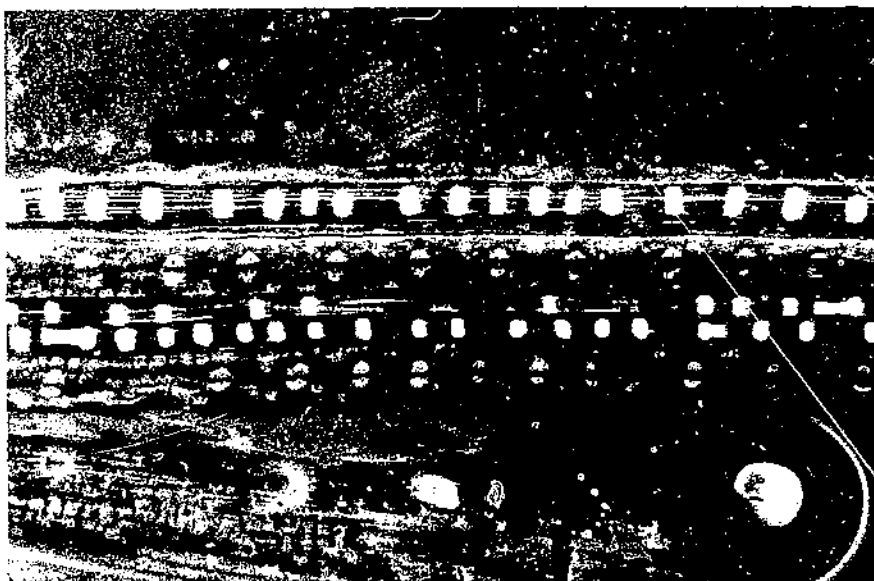


PN-6057

Resembles: Distinct



PN-6058



PN-6059

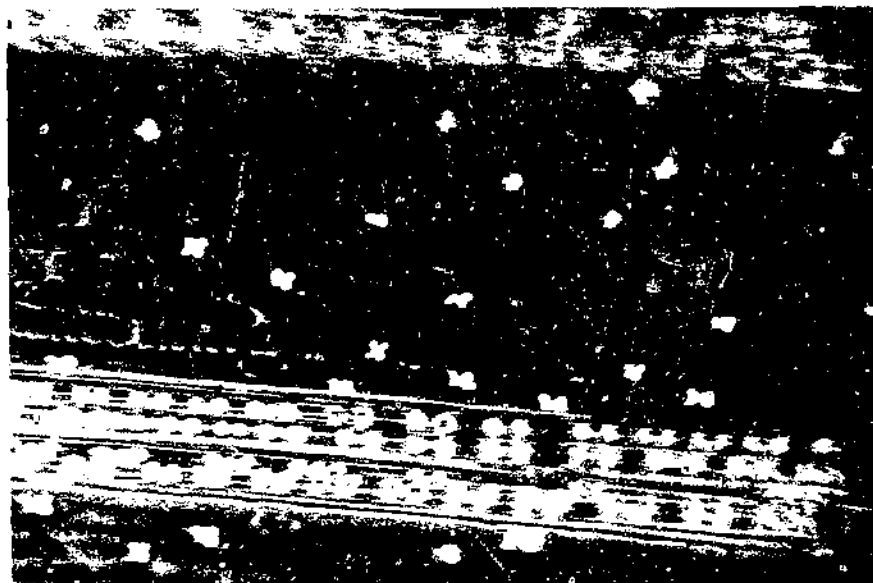
Characters: Numerous, prominent, round-oblong silica cells on midribs; very small, closely spaced stomata.

Botanical Name*Setaria viridis* (L.) Beauv.**Common Name**

Green bristlegrass

Code

SEVI



PN-6060

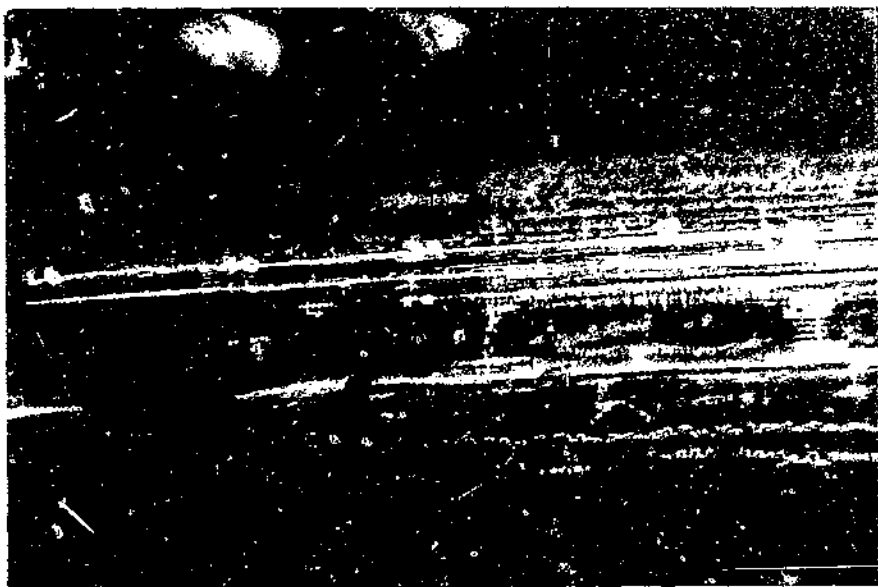


PN-6061

Resembles: Distinct



PN-6062



PN-6063

Characters: Many silica cells in shape of plus sign (+); dark, round, pitted cork cells; double, round silica cells on midribs.

Botanical Name*Sorghastrum nutans* (L.) Nash**Common Name**

Yellow indiagrass

Code

SONU



PN-6064



PN-6065

Resembles: *Andropogon halli*



PN-6066



PN-6067

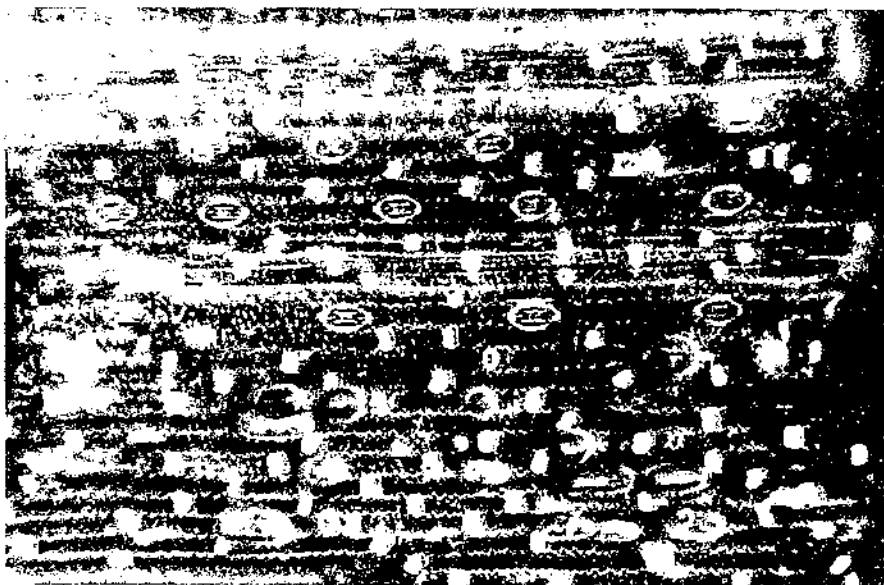
Characters: Most epidermal fragments light refractive; short, diamond-shaped stomata.

Botanical Name*Sporobolus cryptandrus* (Torr.) A. Gray**Common Name**

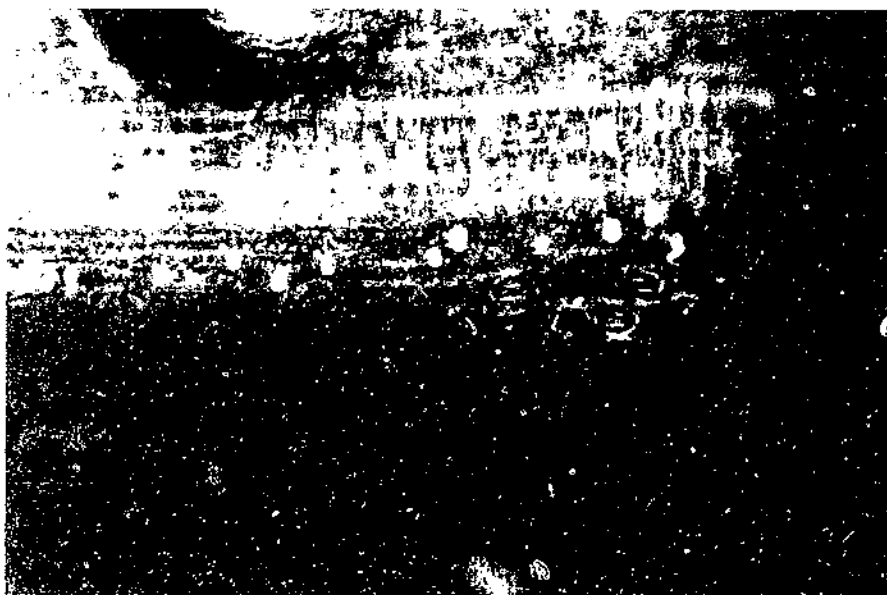
Sand dropseed

Code

SPCR

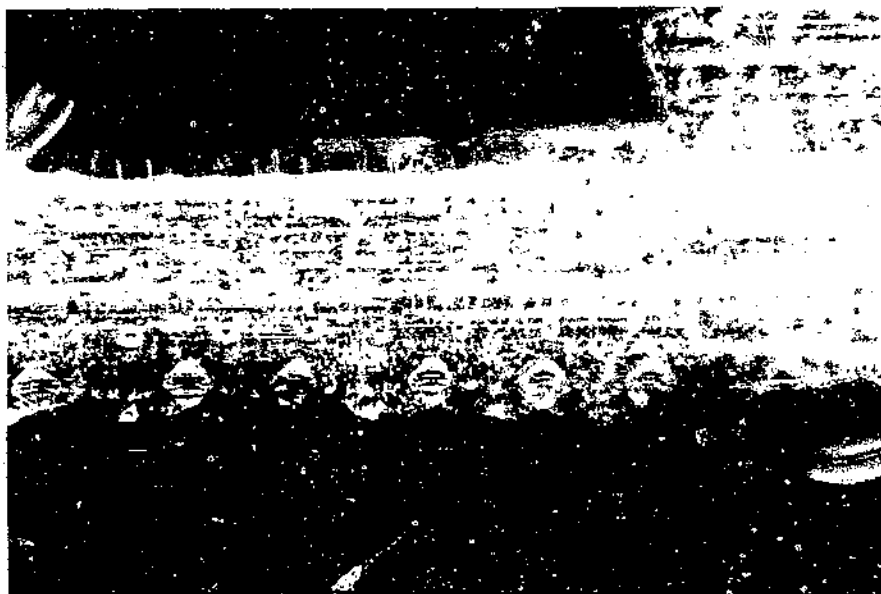


PN-6068



PN-6069

Resembles: *Buchloe dactyloides*, *Bouteloua gracilis*



PN-6070



PN-6071

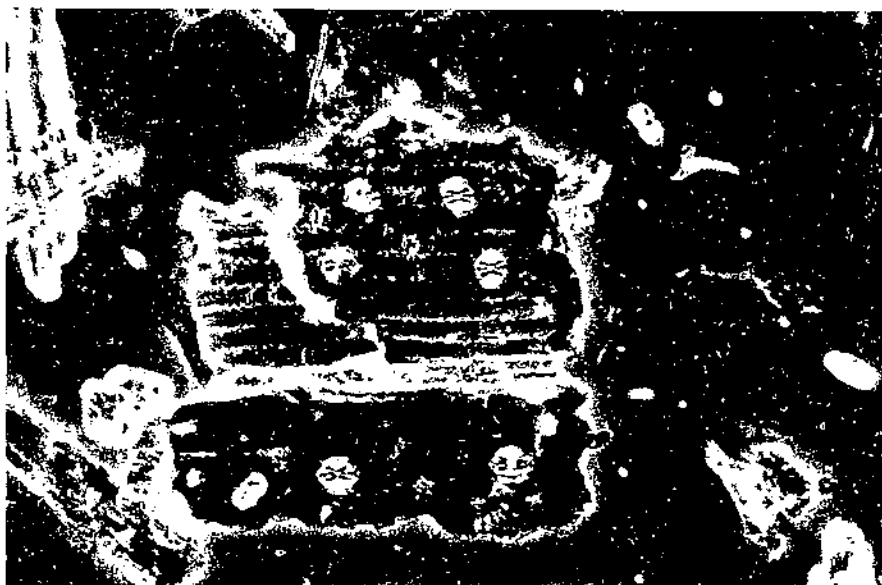
Characters: Gray dots within cells of most epidermal fragments.

Botanical Name*Sporobolus flexuosus* (Thurb.) Rydb.**Common Name**

Mesa dropseed

Code

SPFL

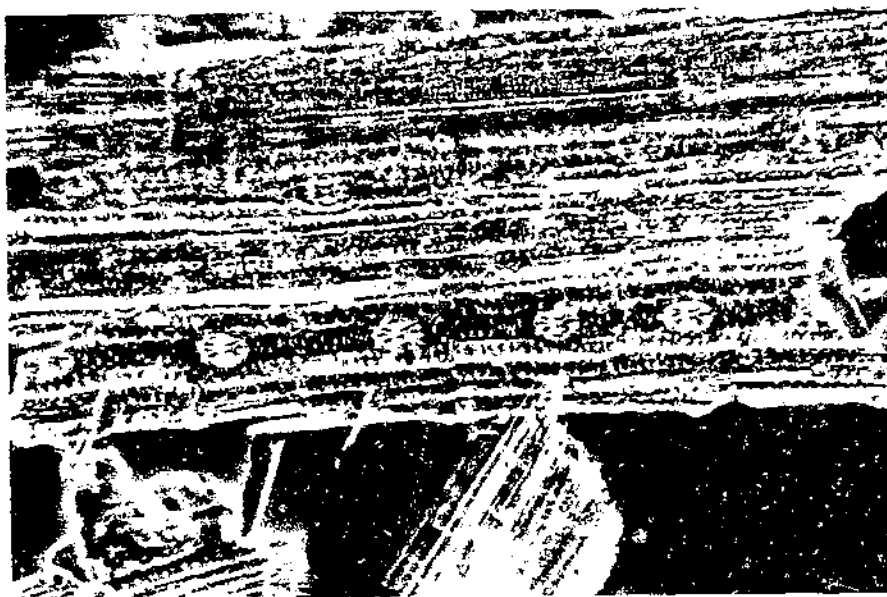


PN-6072

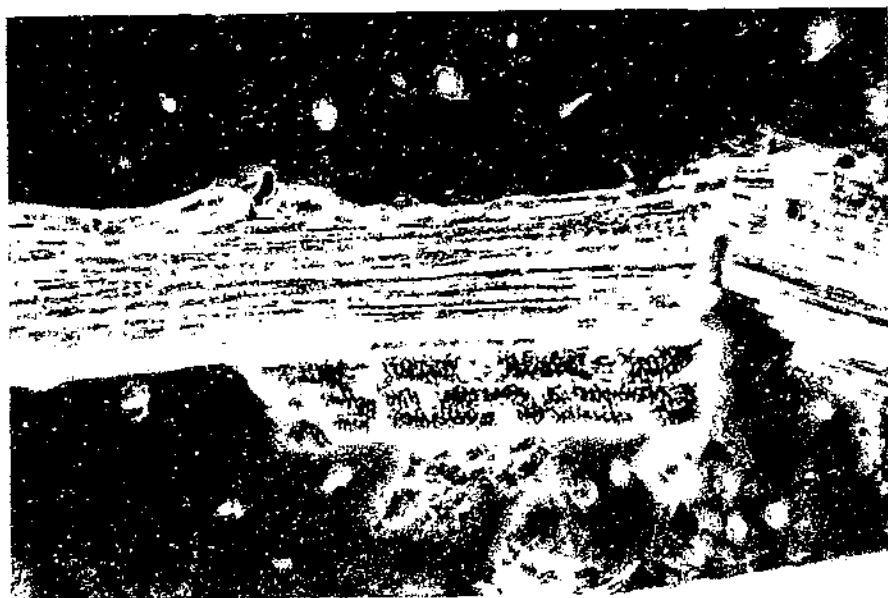


PN-6073

Resembles: *Sporobolus cryptandrus*



PN-6074



PN-6075

Characters: Many small, gray dots within cells; a considerable amount of midrib attachment.

Botanical Name*Stipa comata* Trin. & Rupr.**Common Name**

Needleandthread grass

Code

STCO

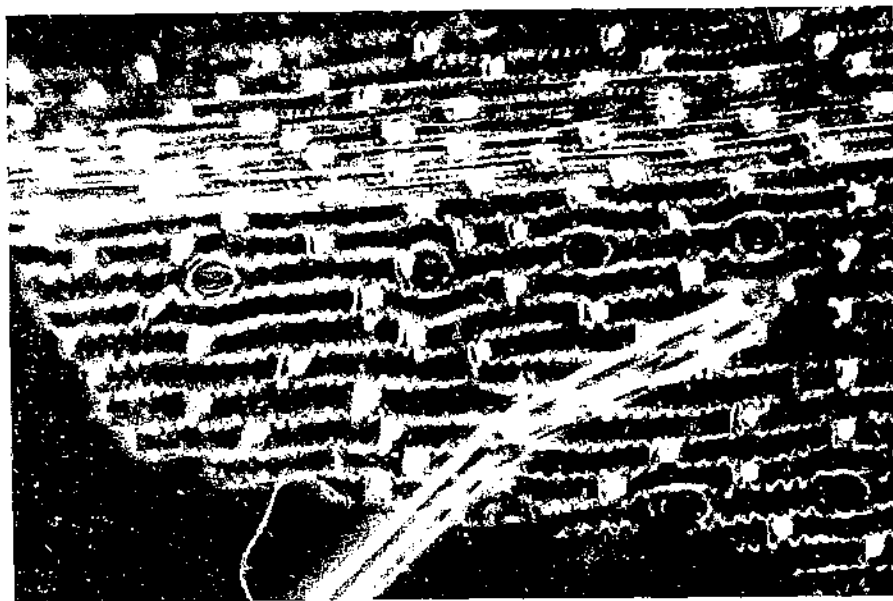


PN-6076

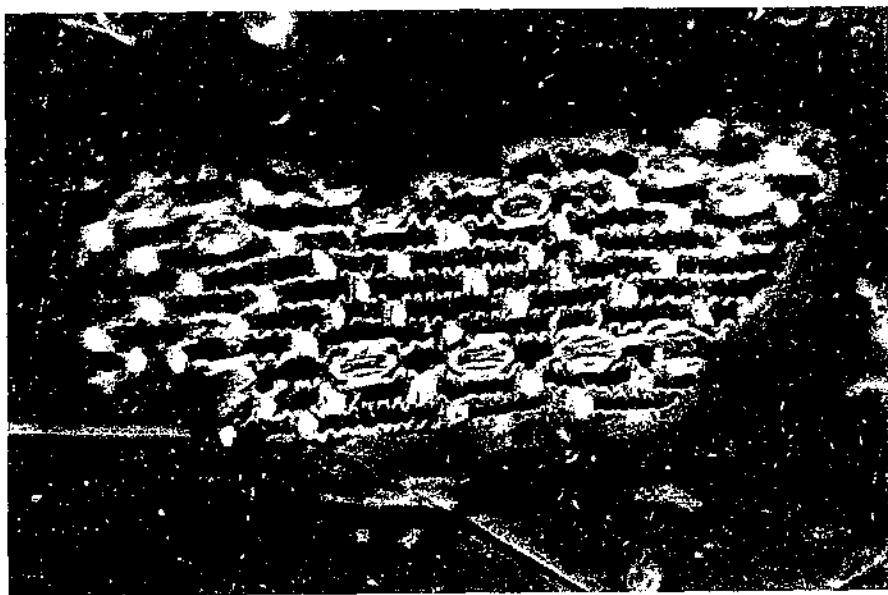


PN-6077

Resembles: *Bouteloua gracilis*



PN-6078



PN-6079

Characters: Large, spherical silica cells barely touching long, narrow cork cells; moderate to deep cell undulations.

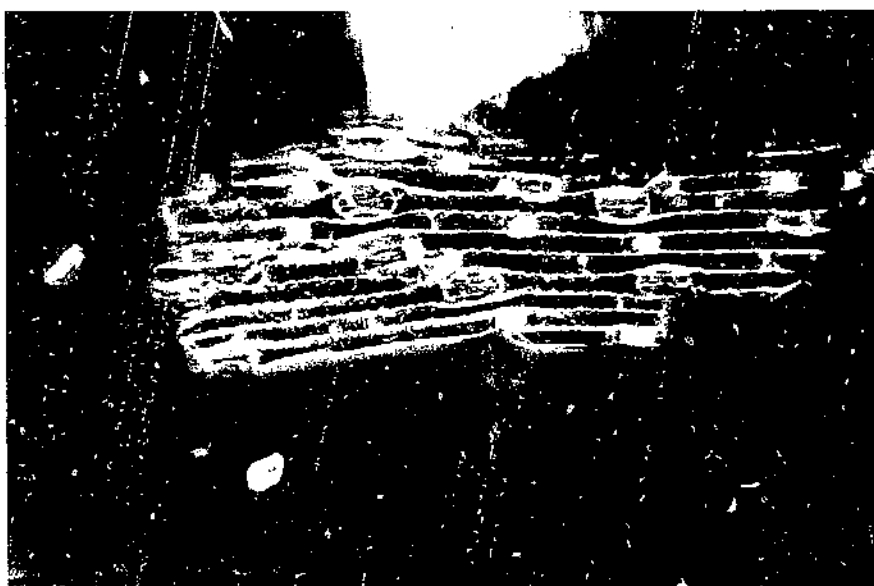
Botanical Name
Stipa viridula Trin.

Common Name
Green needlegrass

Code
STVI

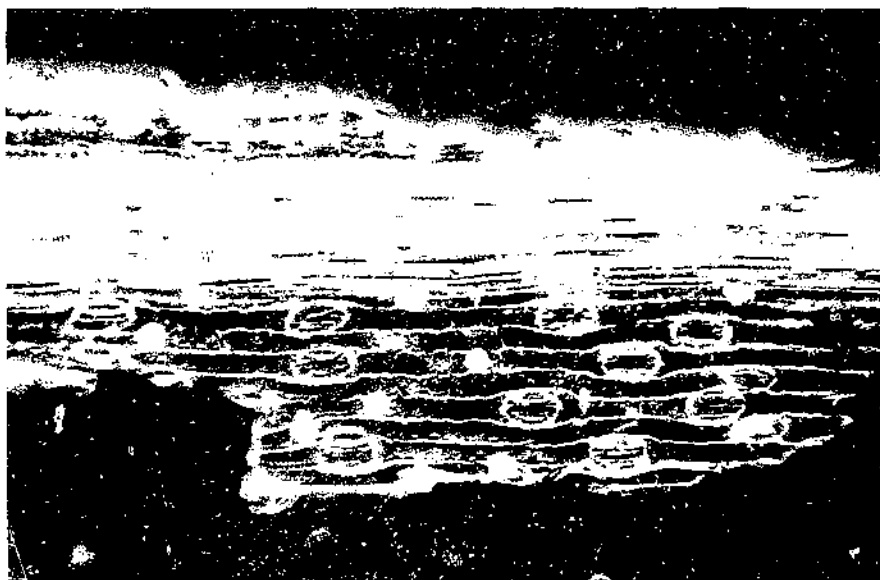


PN-6080

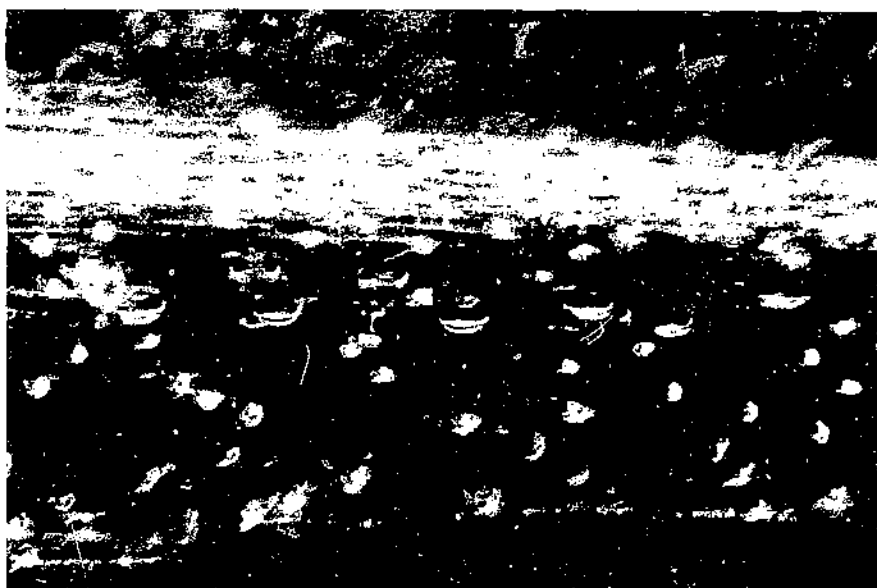


PN-6081

Resembles: *Aristida longiseta*



PN-6082



PN-6083

Characters: Large stomata; less debris with few midribs.

Botanical Name*Vulpia octoflora* (Walt.) Rydb.**Common Name**

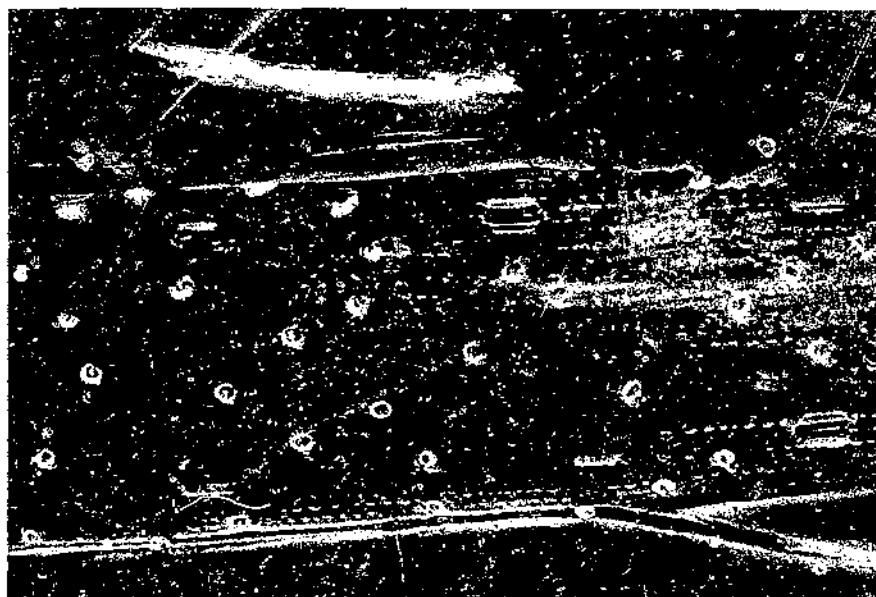
Common sixweeksgrass

Code

VUOC

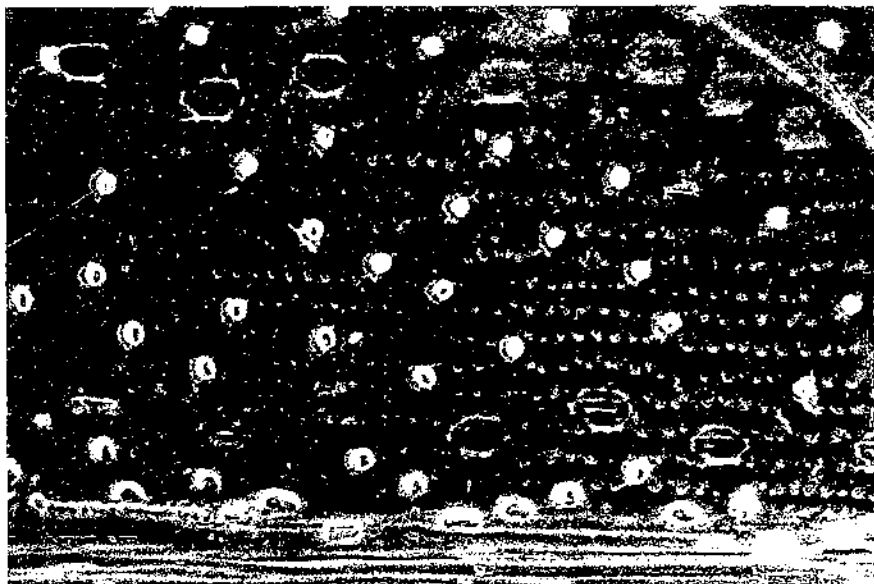


PN-6084

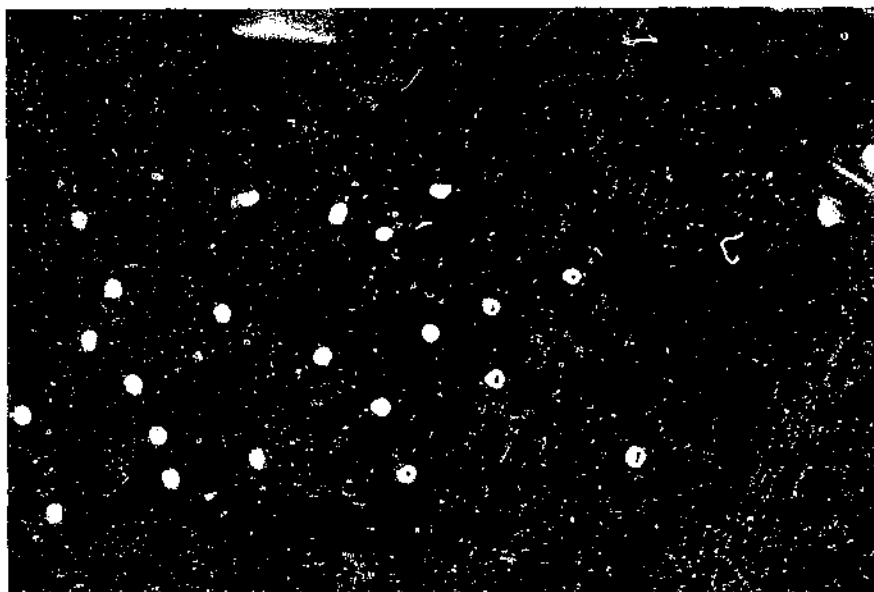


PN-6085

Resembles: Distinct



PN-6086



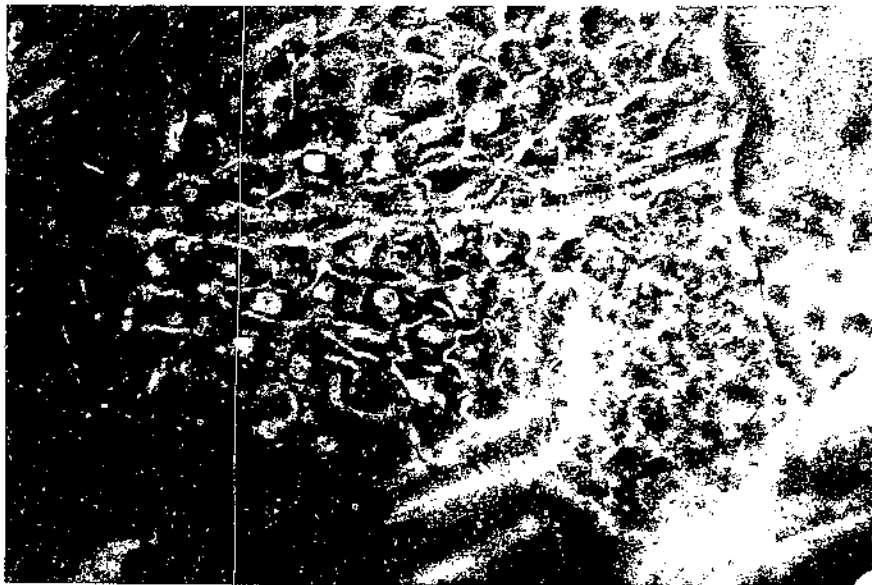
PN-6087

Characters: Very deep cell wall undulations; C-shaped cork cells around spherical silica cells, which often have black dot in center.

Botanical Name
Achillea millefolium L.

Common Name
Common yarrow

Code
ACMI

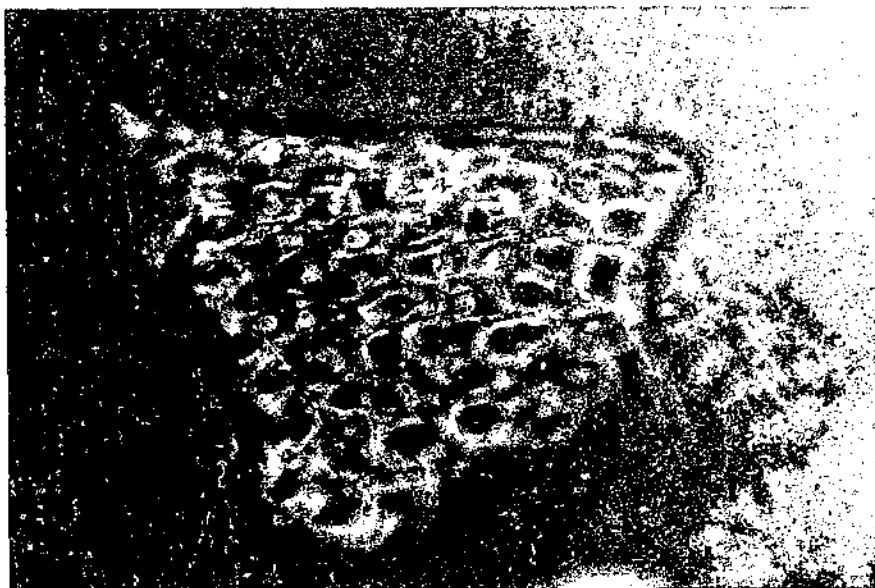


PN-6088



PN-6089

Resembles: *Lithospermum incisum*



PN-6090



PN-6091

Characters: Round bodies within cell walls; few, small, slender, light-refractive hairs; no clearly defined silica cells; stomata not visible.

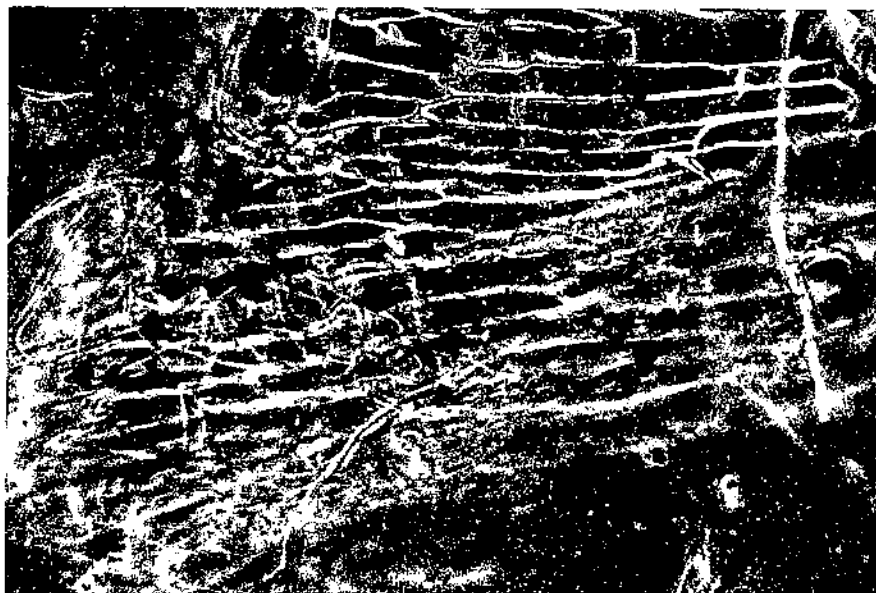
Botanical Name
Artemisia bigelovi A. Gray

Common Name
Bigelow sagebrush

Code
ARBI

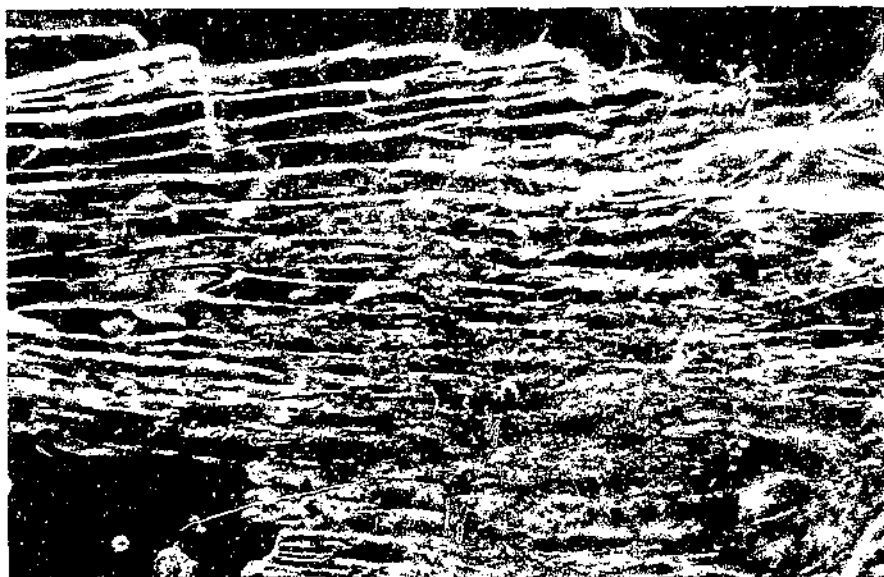


PN-6092



PN-6093

Resembles: Distinct



PN-6094



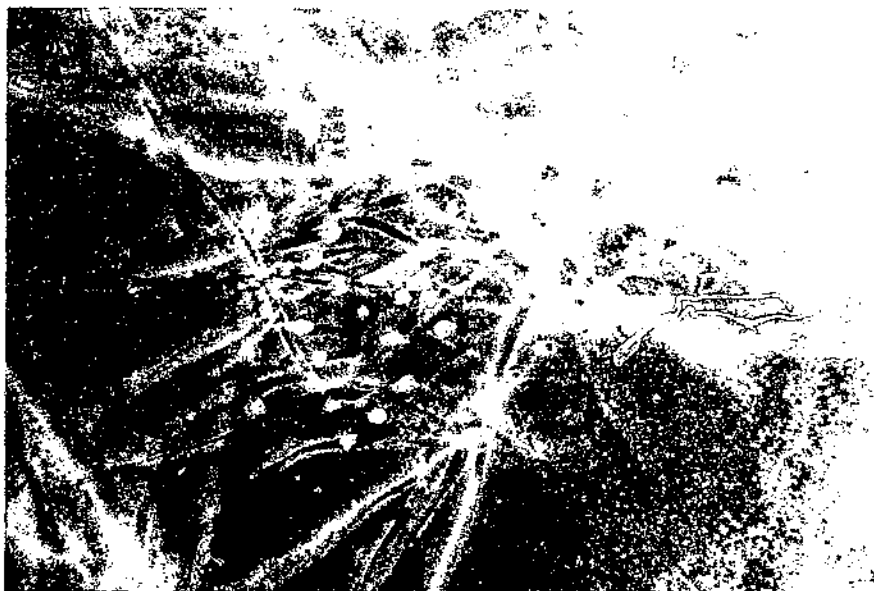
PN-6095

Characters: Mostly linear, smooth-walled cells; very small (hardly visible), sparse stomata.

Botanical Name
Artemisia frigida Willd.

Common Name
Fringed sagebrush

Code
ARFR

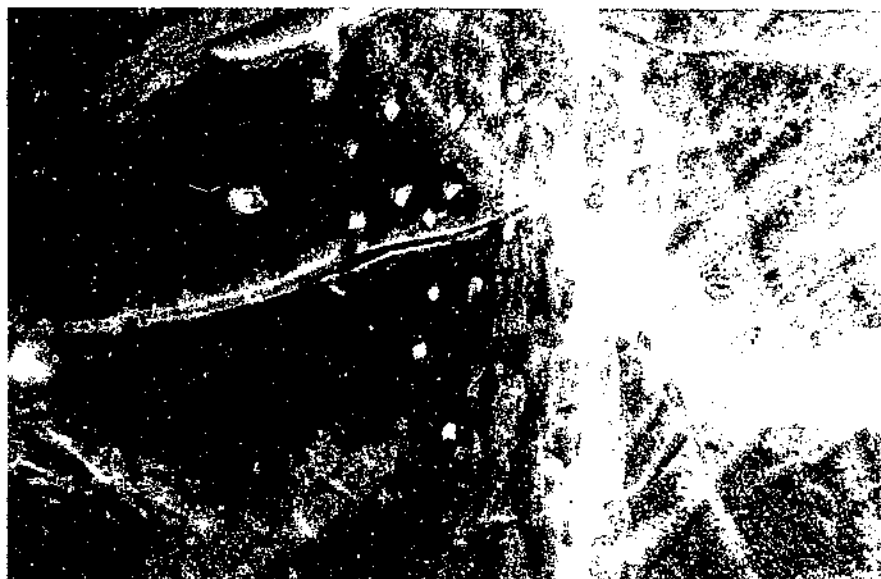


PN-6096

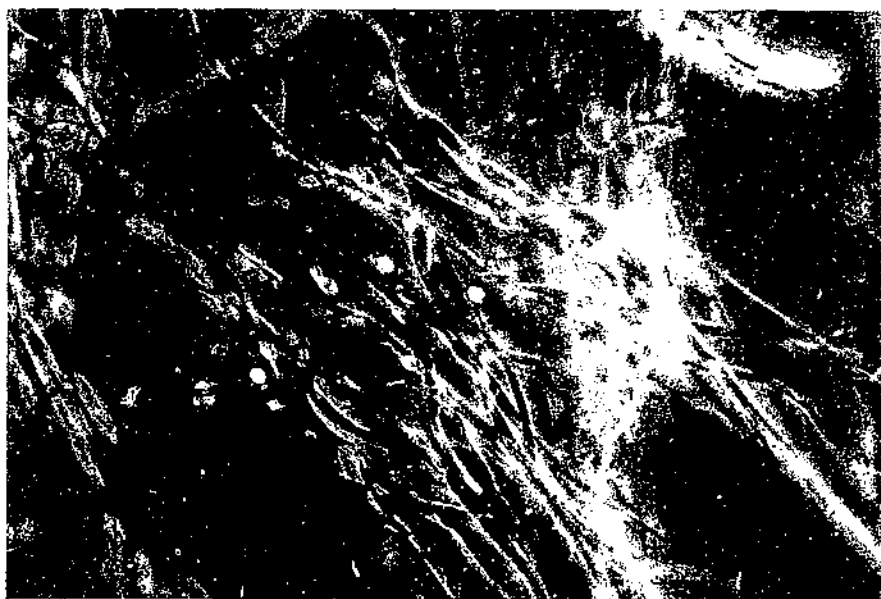


PN-6097

Resembles: *Ceratoides lanata*, *Sphaeralcea coccinea*



PN-6098



PN-6099

Characters: Many overlapping flattened hairs with white bases and round to elliptical dots; submerged stomata often difficult to see.

Botanical Name*Astragalus adsurgens* Pall.**Common Name**

Standing milkvetch

Code

ASAD



PN-6100

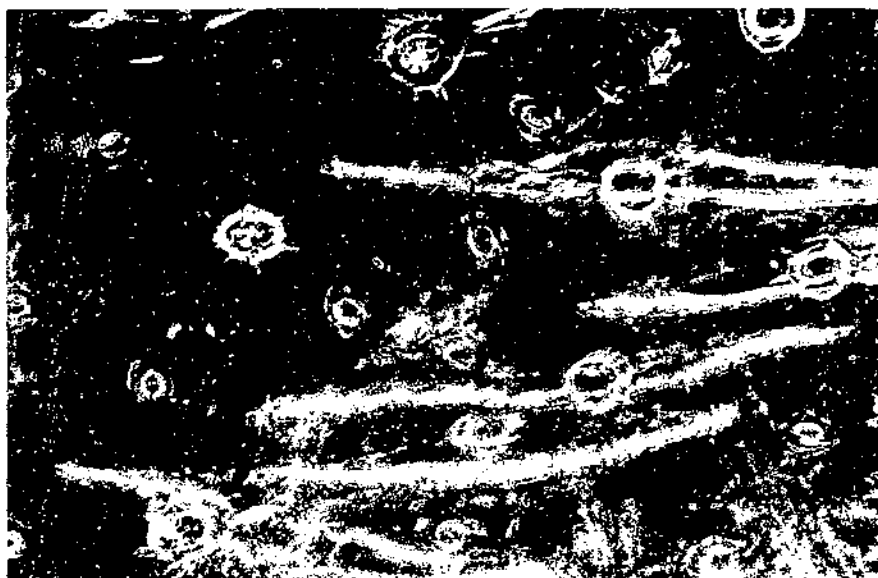


PN-6101

Resembles: *Lupinus plattensis*



PN-6102



PN-6103

Characters: Prominent, almond-shaped stomata; round, refractive trichome bases with versatile hairs attached.

Botanical Name*Astragalus drummondi* Dougl.**Common Name**

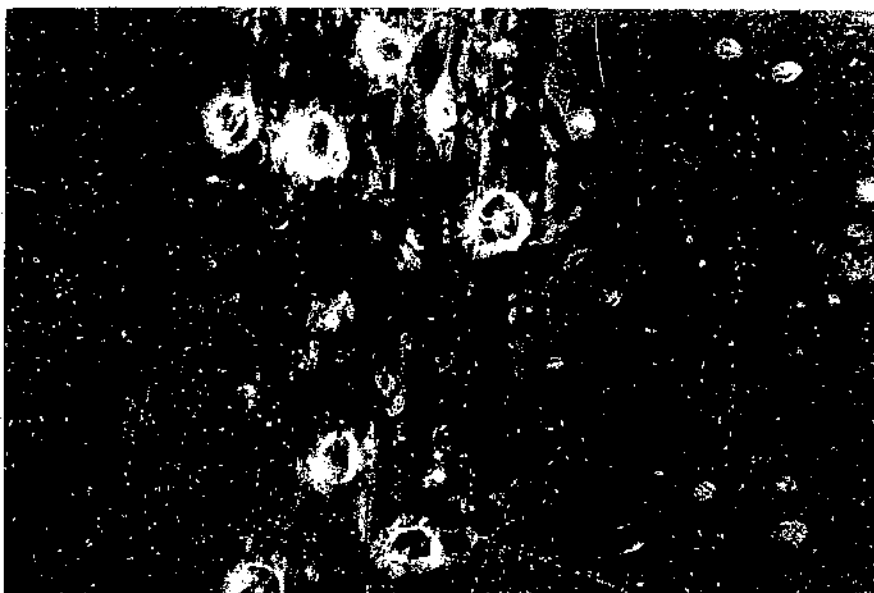
Drummond milkvetch

Code

ASDR



PN-6104

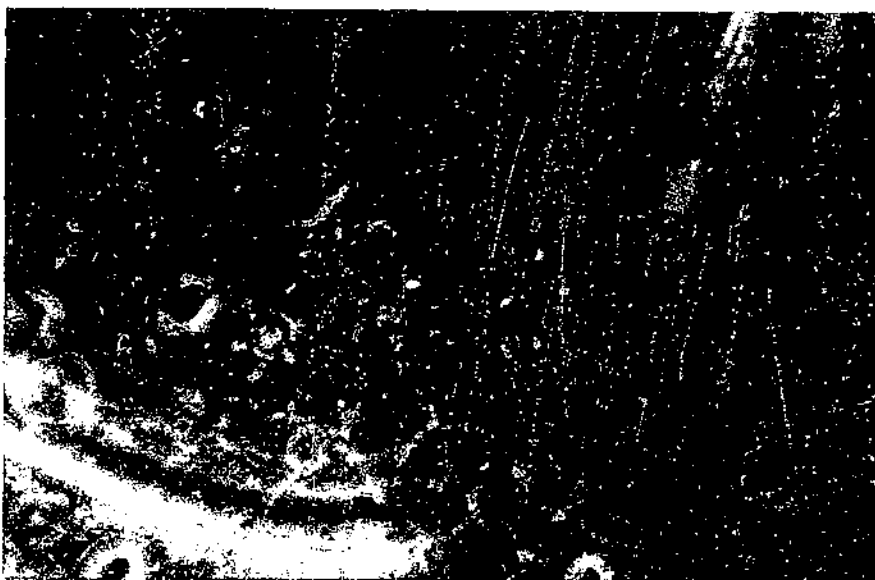


PN-6105

Resembles: Distinct



PN-6106



PN-6107

Characters: Some refractive, round hair bases; many stomata open.

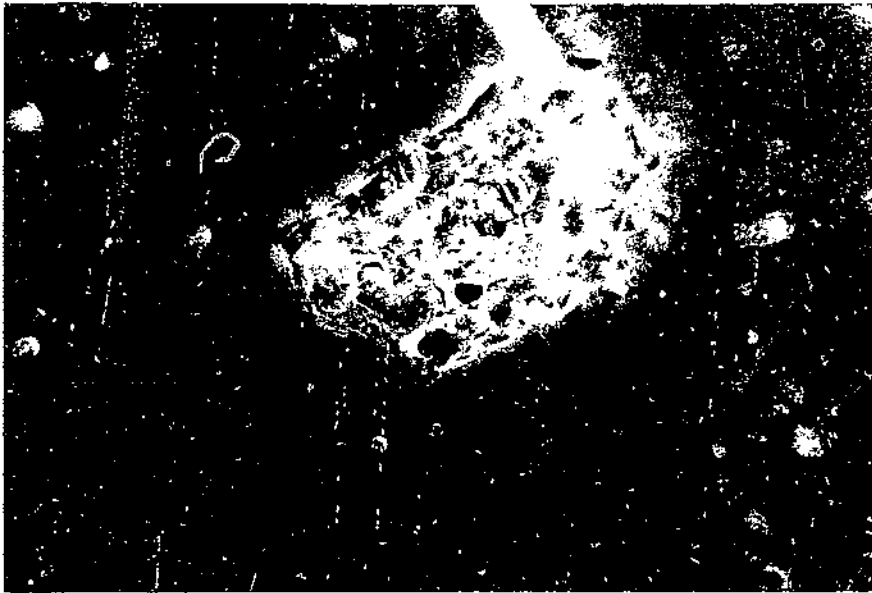
Botanical Name
Aster falcatus Lindl.

Common Name
Whiteprairie aster

Code
ASFA

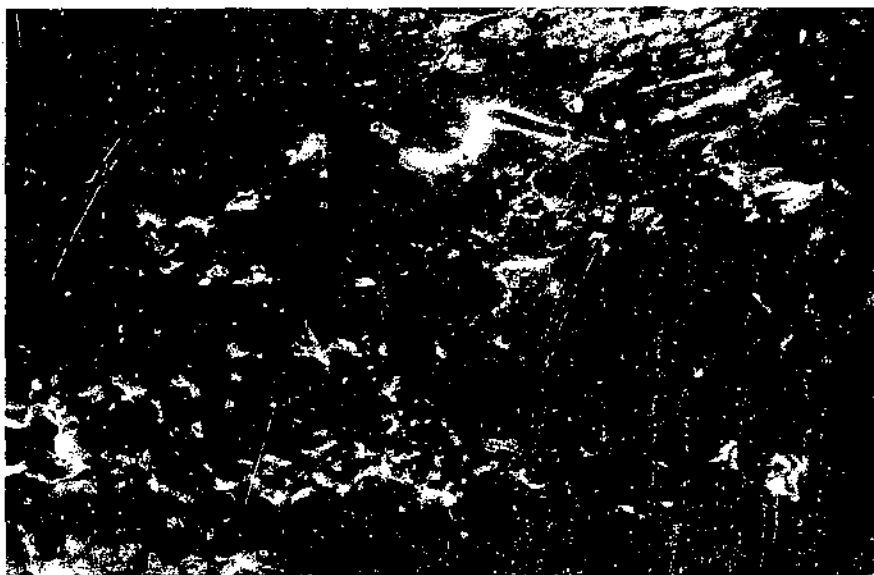


PN-6108

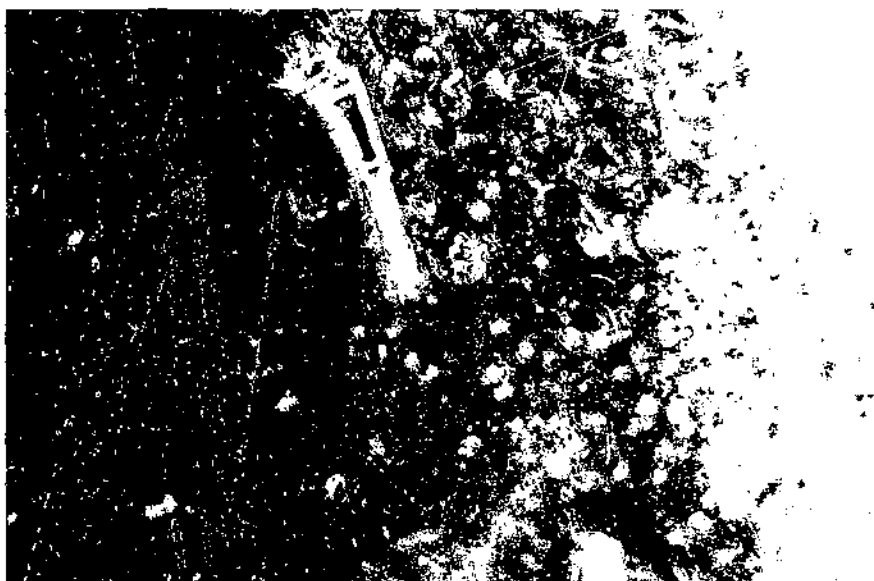


PN-6109

Resembles: Distinct



PN-6110



PN-6111

Characters: Wavy, generally indistinct cell walls; generally open stomata; some medium-length hairs attached.

Botanical Name*Ceratoides lanata* (Pursh.) Howell**Common Name**

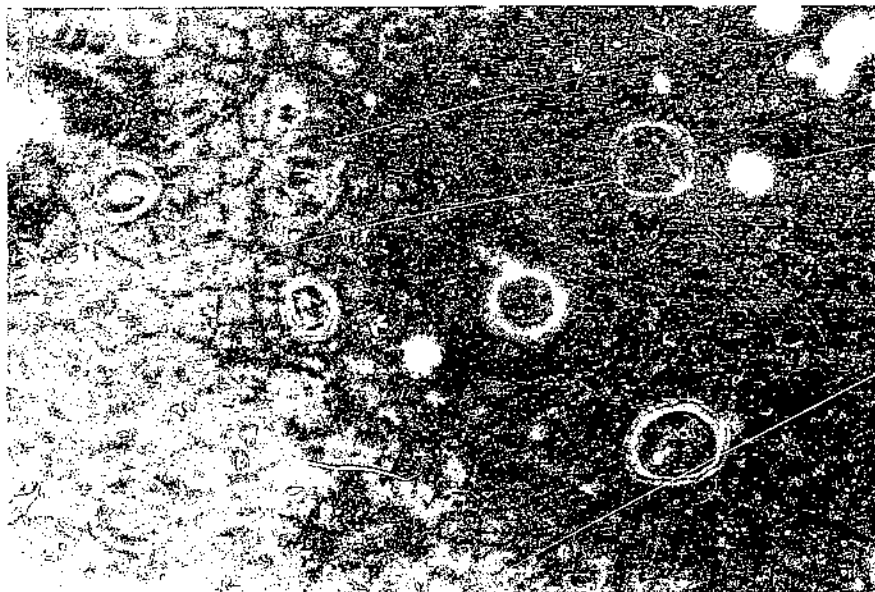
Common winterfat

Code

CELA

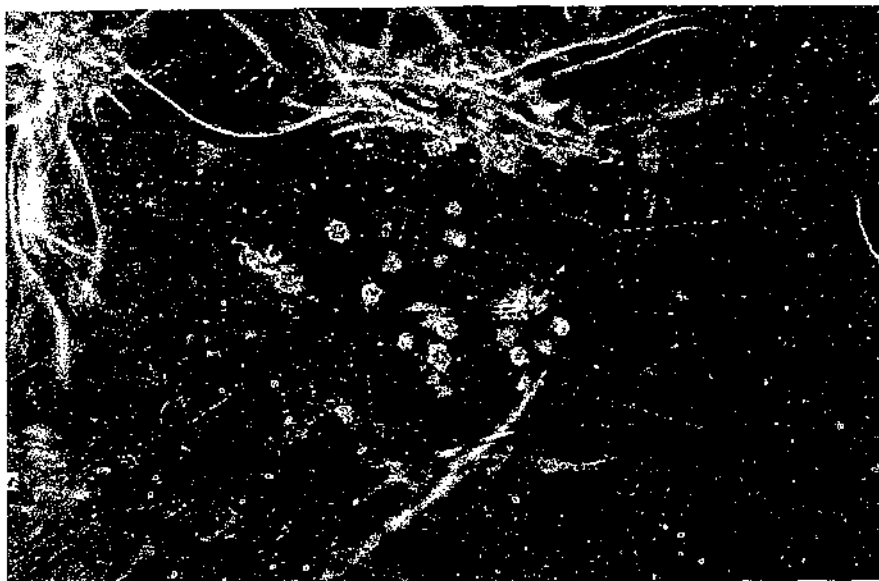


PN-6112

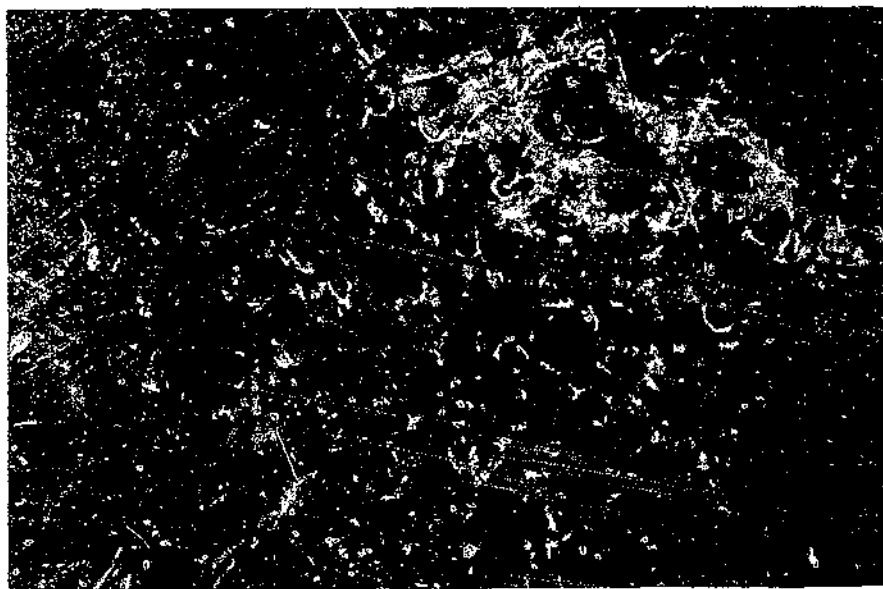


PN-6113

Resembles: *Artemisia frigida*, *Sphaeralcea coccinea*



PN-6114



PN-6115

Characters: Eight-armed stellate hairs, appressed; indistinct stomata; circular, slightly refractive bases for unattached hairs.

Botanical Name*Chrysothamnus nauseosus* (Pall.) Britton**Common Name**

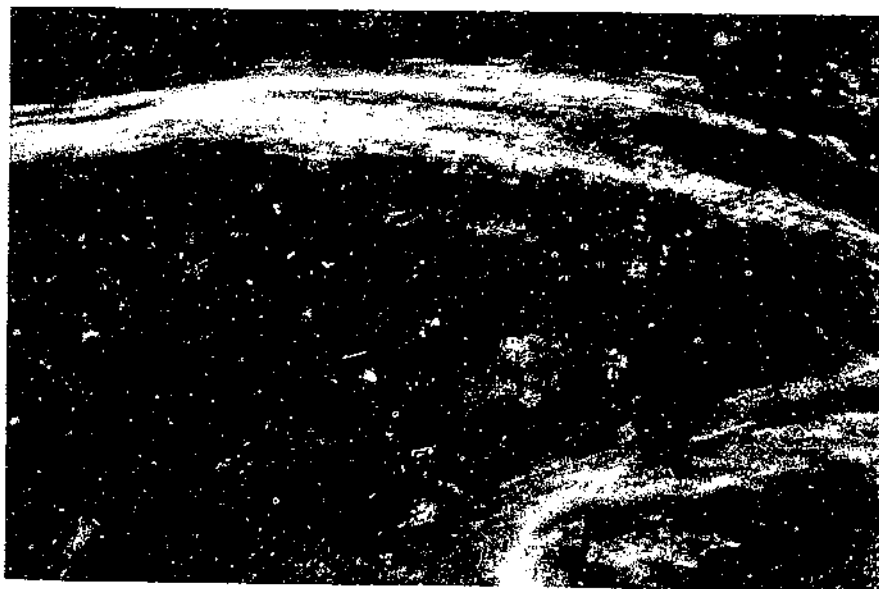
Rubber rabbitbrush

Code

CHNA



PN-6116

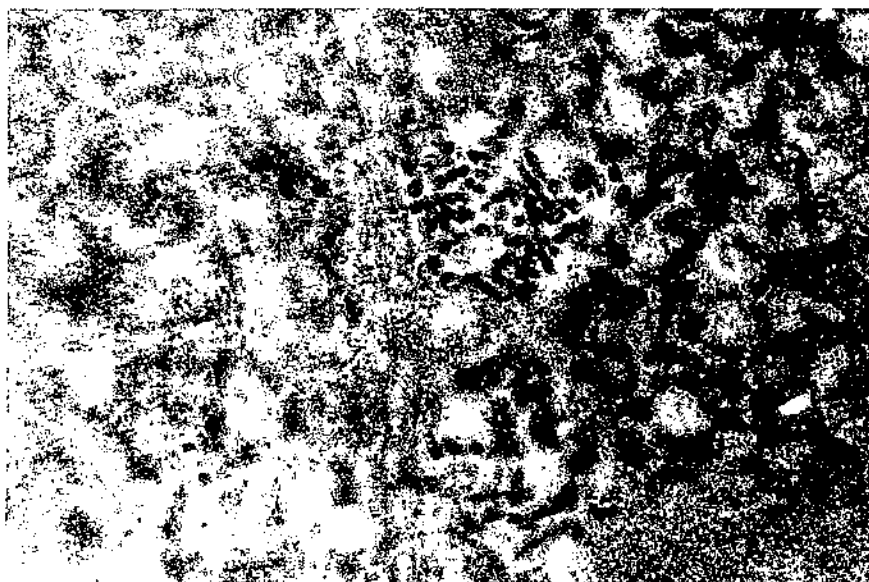


PN-6117

Resembles: Distinct



PN-6118



PN-6119

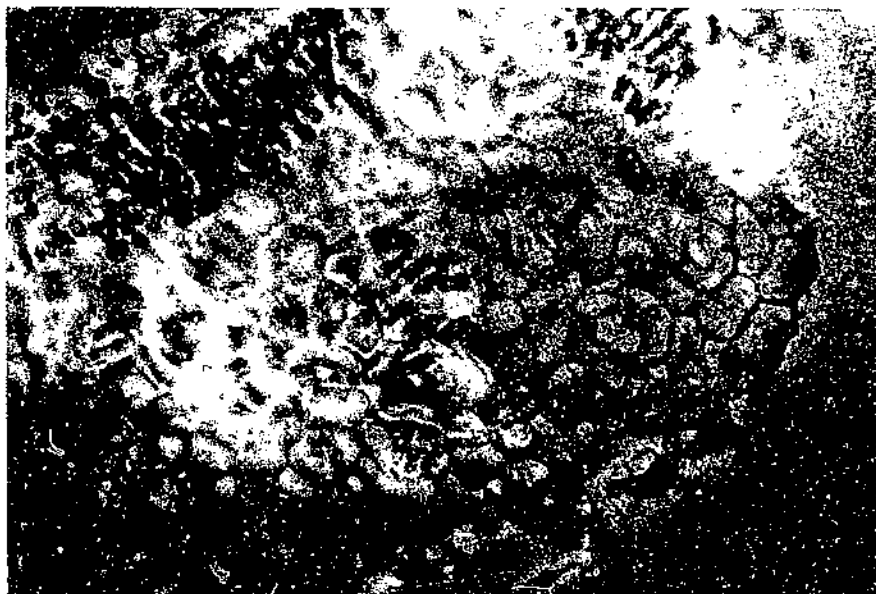
Characters: Stomata having 2 or 3 subsidiary cells as large or larger than epidermal cells; random stomata arrangement, often with dark starch grains attached.

Botanical Name*Chrysopsis villosa* (Pursh.) Nutt.**Common Name**

Hairy goldaster

Code

CHVI



PN-6120

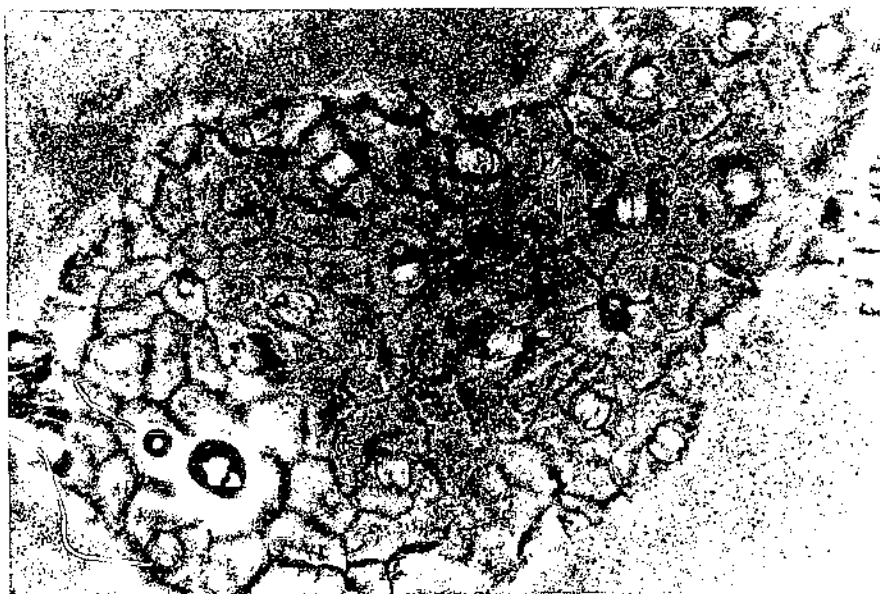


PN-6121

Resembles: Distinct



PN-6122



PN-6123

Characters: Stomata having 2 or 3 subsidiary cells with guard cells separated into 2 distinct halves; large refractive bases for hairs not attached.

Botanical Name*Cirsium arvense* (L.) Scop.**Common Name**

Canadian thistle

Code

CIAR

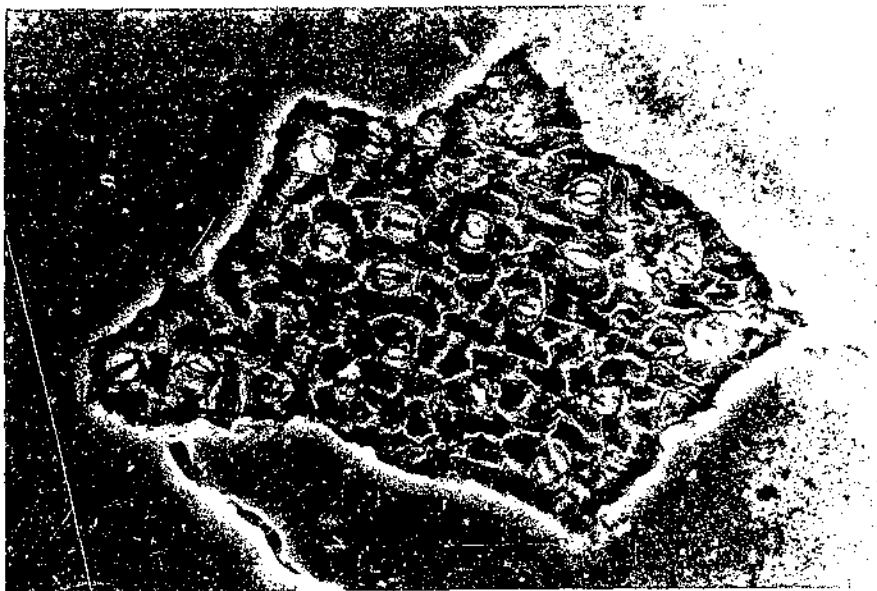


PN-6124



PN-6125

Resembles: Distinct



PN-6126



PN-6127

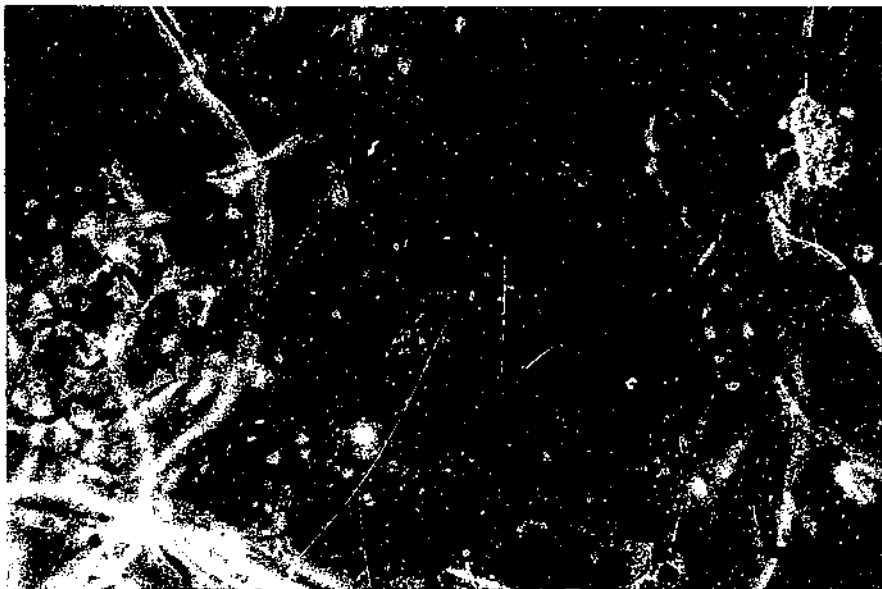
Characters: Moderate to indistinct stomata blending with cells; partially open guard cells.

Botanical Name*Cirsium undulatum* (Nutt.) Spreng.**Common Name**

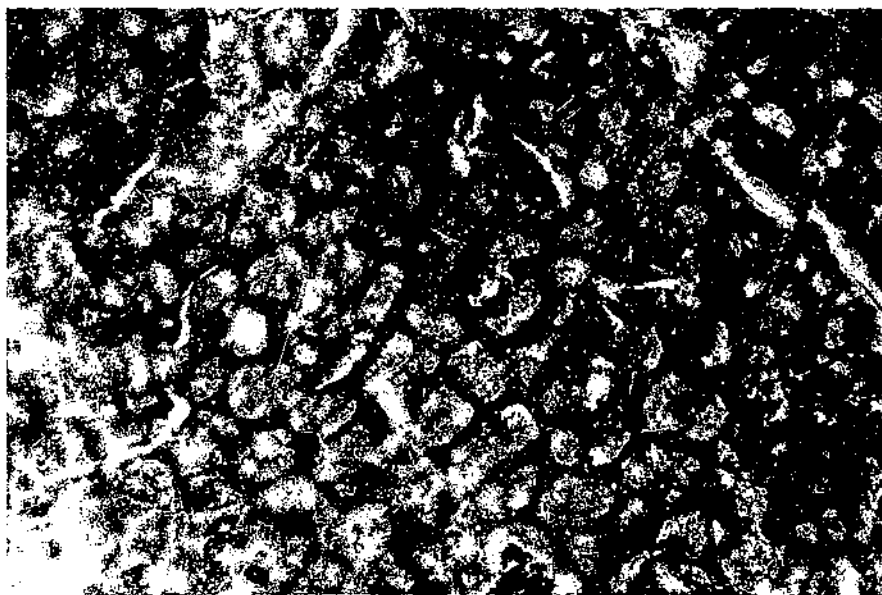
Wavyleaf thistle

Code

CIUN

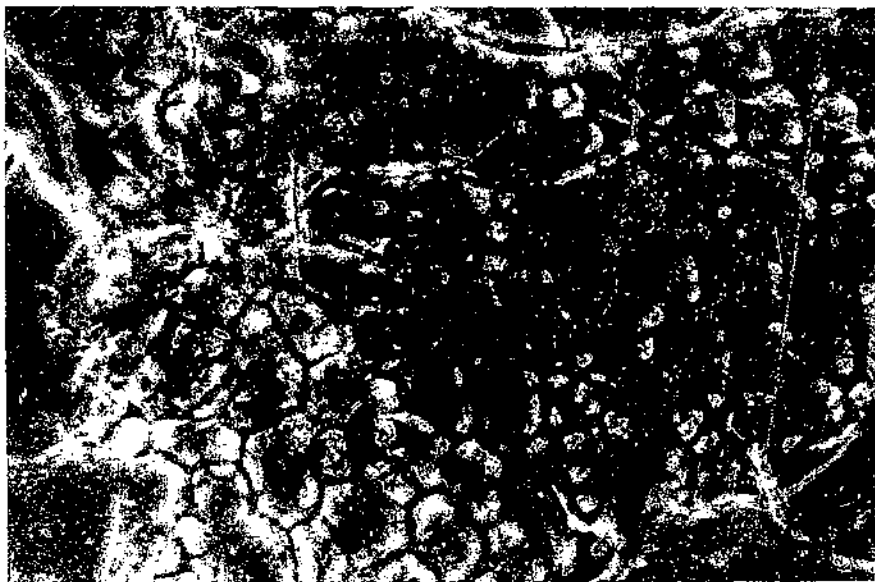


PN-6128

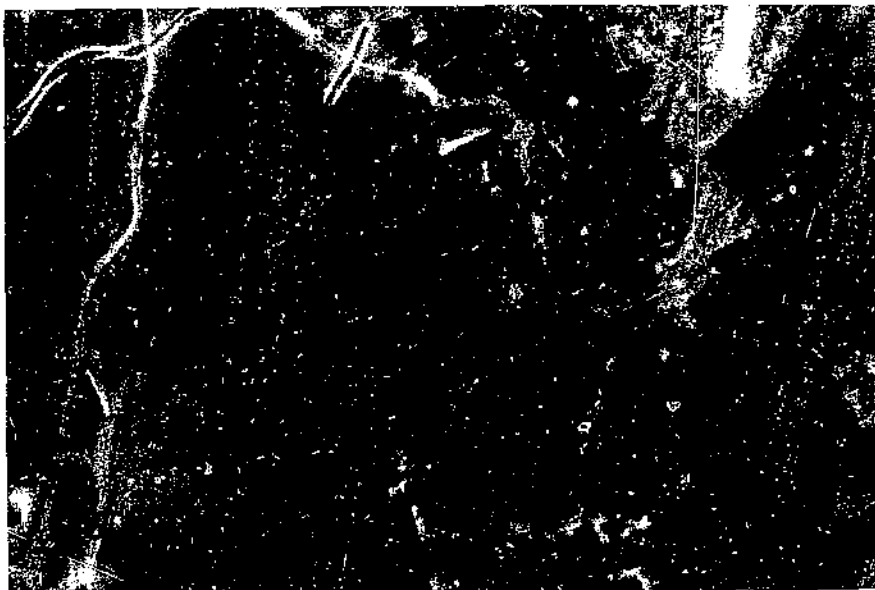


PN-6129

Resembles: Distinct



PN-6130



PN-6131

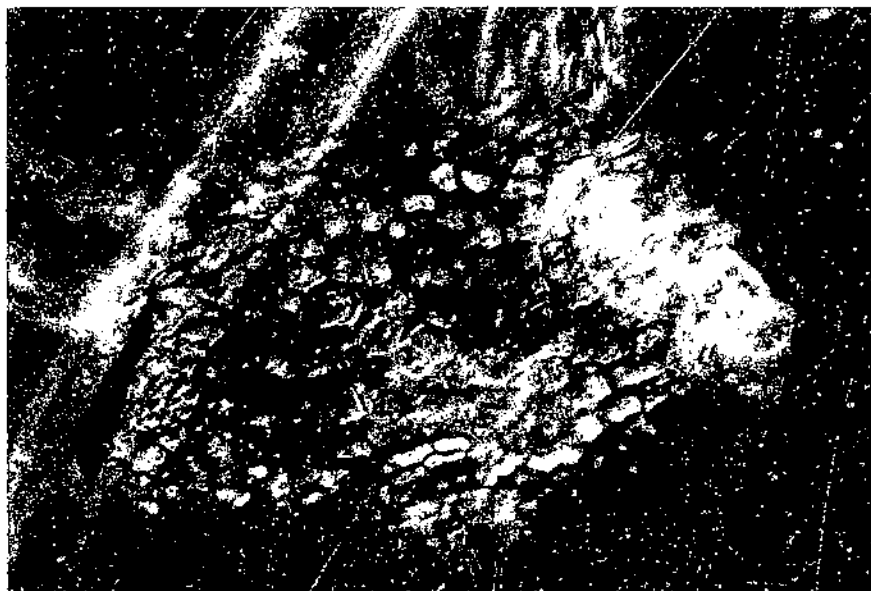
Characters: Sunken, indistinct stomata; some attached hairs.

Botanical Name*Cowania stansburiana* Torr.**Common Name**

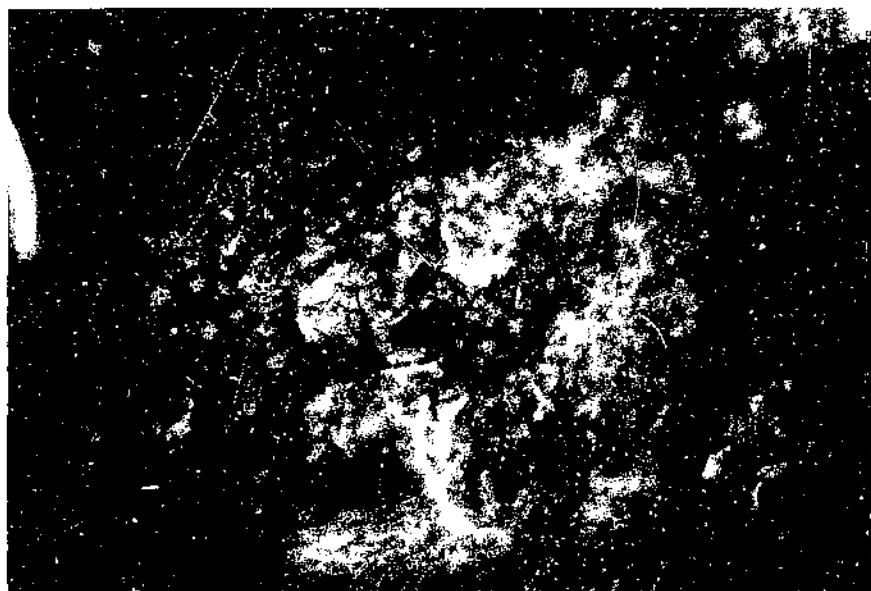
Stansbury cliffrose

Code

COST

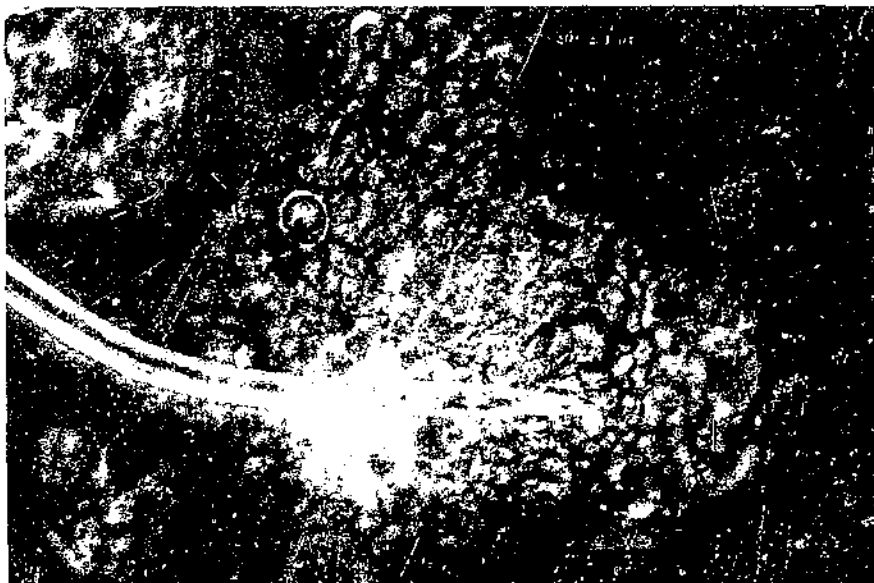


PN-6132



PN-6133

Resembles: Distinct



PN-6134



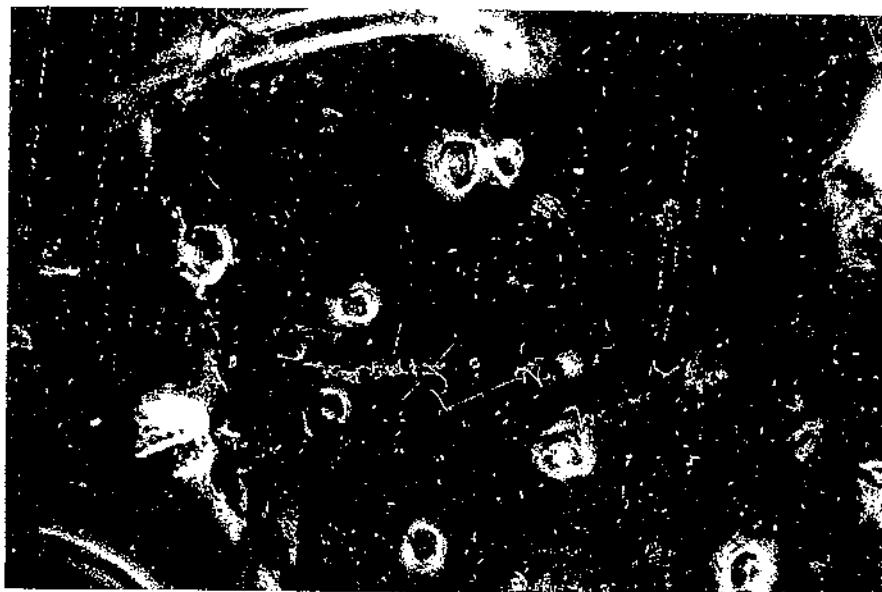
PN-6135

Characters: Small, submerged stomata, scarcely visible as guard cell openings between small epidermal cells.

Botanical Name
Delphinium geyeri Greene

Common Name
Geyer larkspur

Code
DEGE



PN-6136

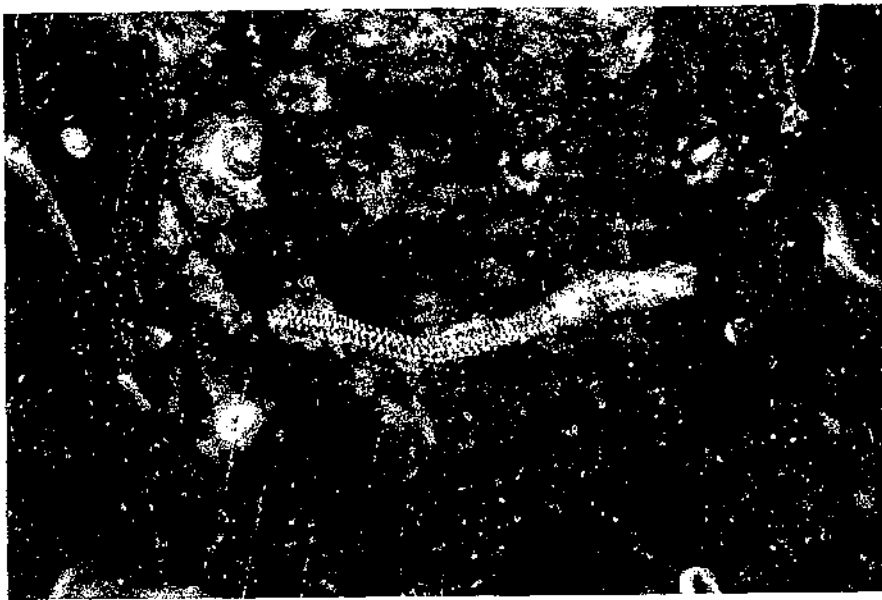


PN-6137

Resembles: Distinct



PN-6138



PN-6139

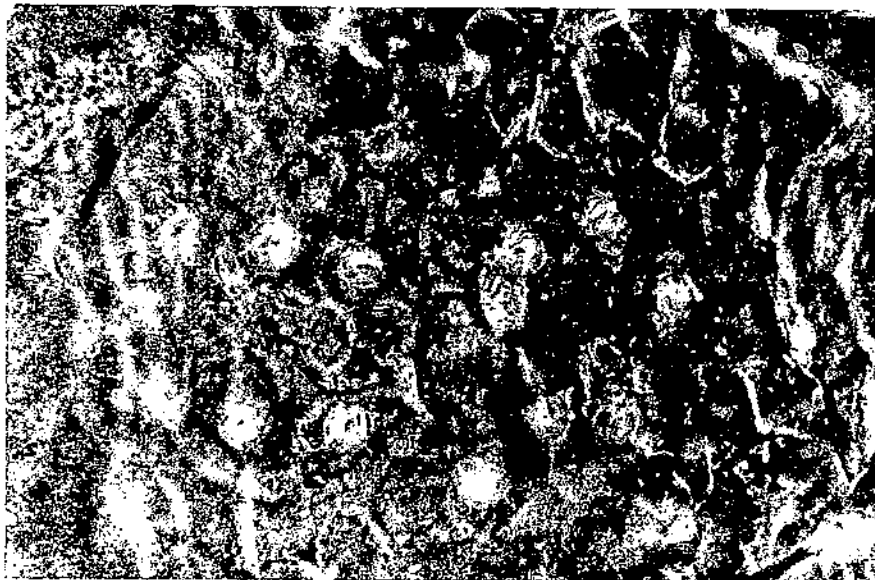
Characters: Very large, partially open stomata; indistinct subsidiary cell walls blending with epidermal cells.

TB 1582 (1979) - USDA TECHNICAL BULLETINS - UPDATA
ATLAS OF EPIDERMAL PLANT FRAGMENTS INGESTED BY GRAZING ANIMALS
HOWARD, G. S. ; SAMUEL, M. J. - 2 OF 2

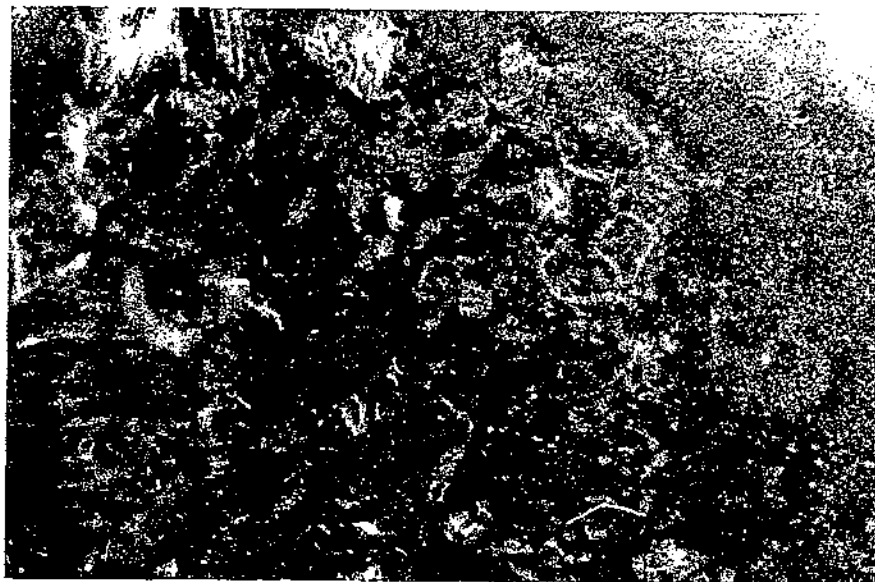
Botanical Name
Eriogonum effusum Nutt.

Common Name
Spreading wildbuckwheat

Code
EREF

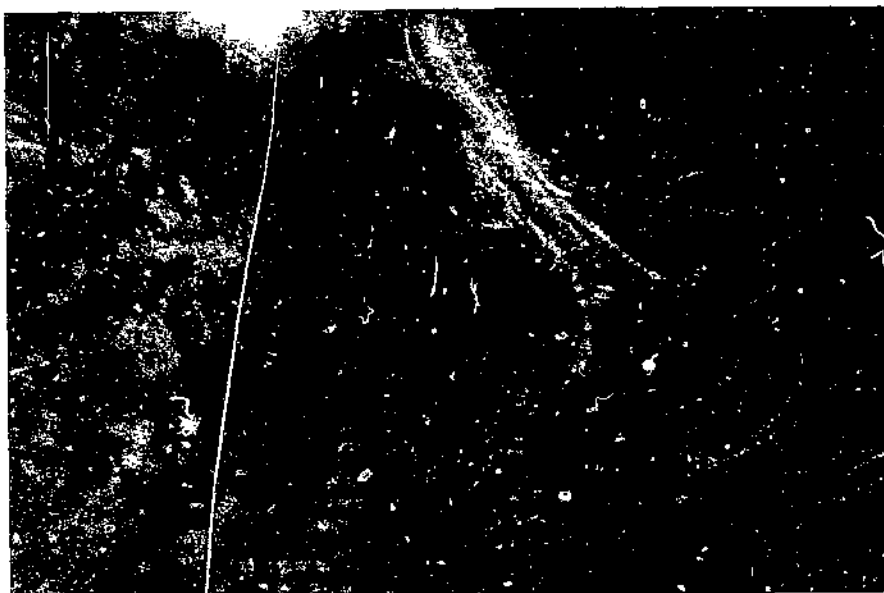


PN-6140



PN-6141

Resembles: Distinct



PN-6142



PN-3143

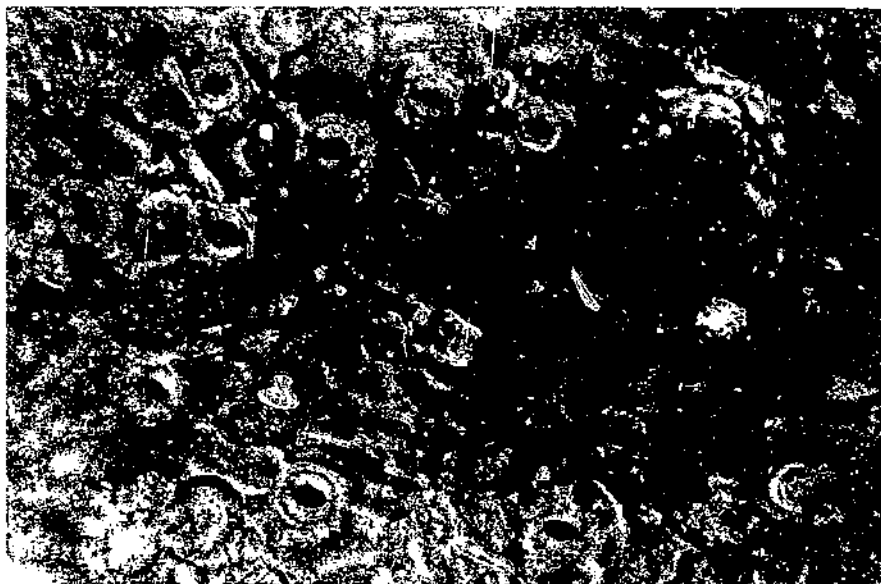
Characters: Generally indistinct cell walls with moderate to prominent stomata; dark guard cell openings.

Botanical Name*Gutierrezia sarothrae* (Pursh) Britt. & Rusby**Common Name**

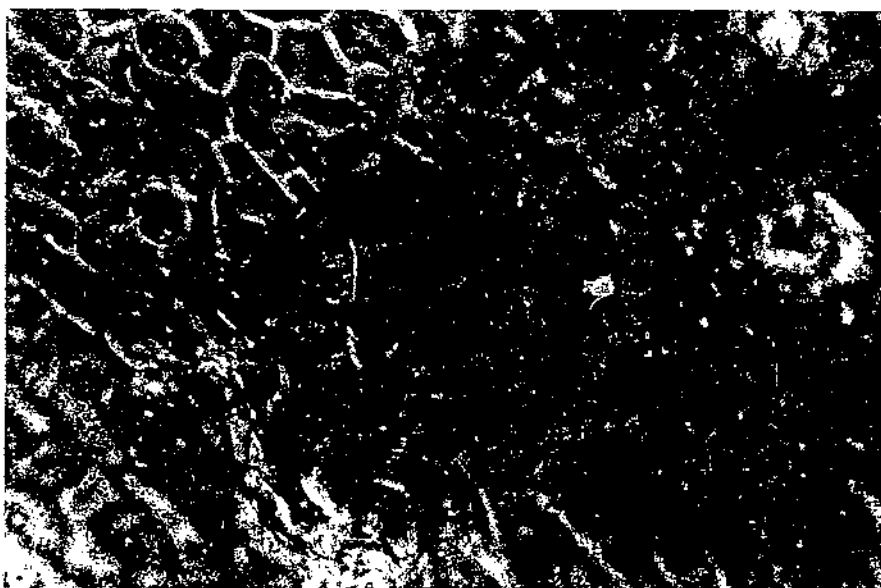
Broom snakeweed

Code

GUSA

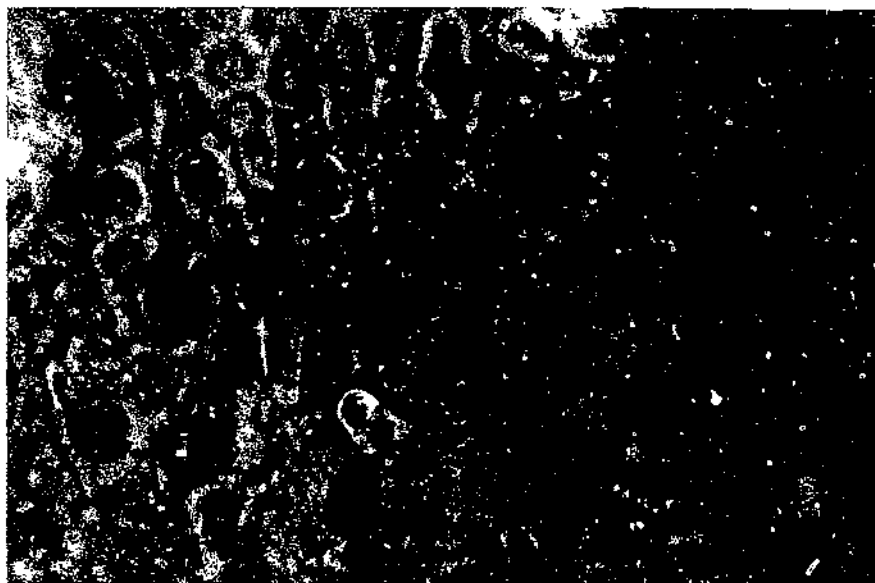


PN-6144

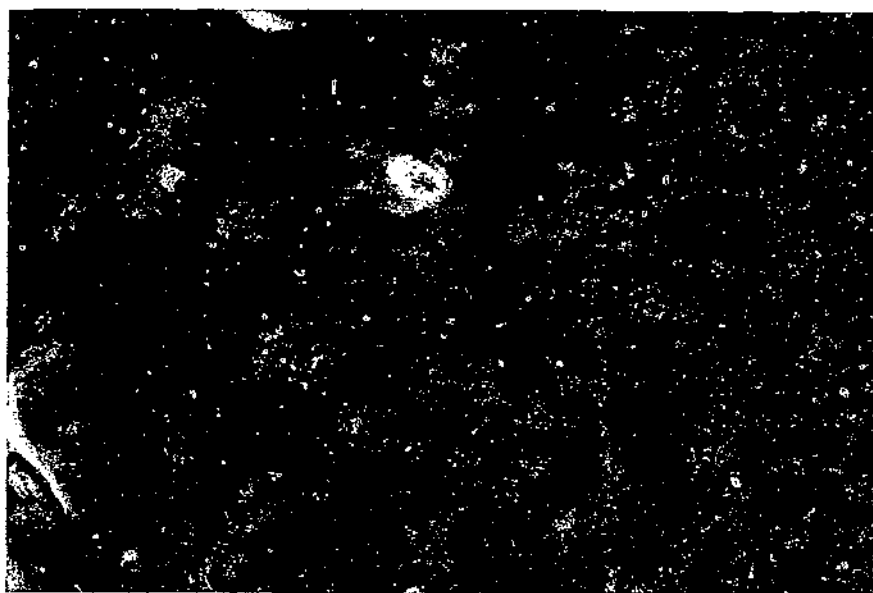


PN-6145

Resembles: Distinct



PN-6146



PN-6147

Characters: Moderate to distinct stomata; little or no debris or refractive bodies.

Botanical Name*Haplopappus spinulosus* (Pursh) DC.**Common Name**

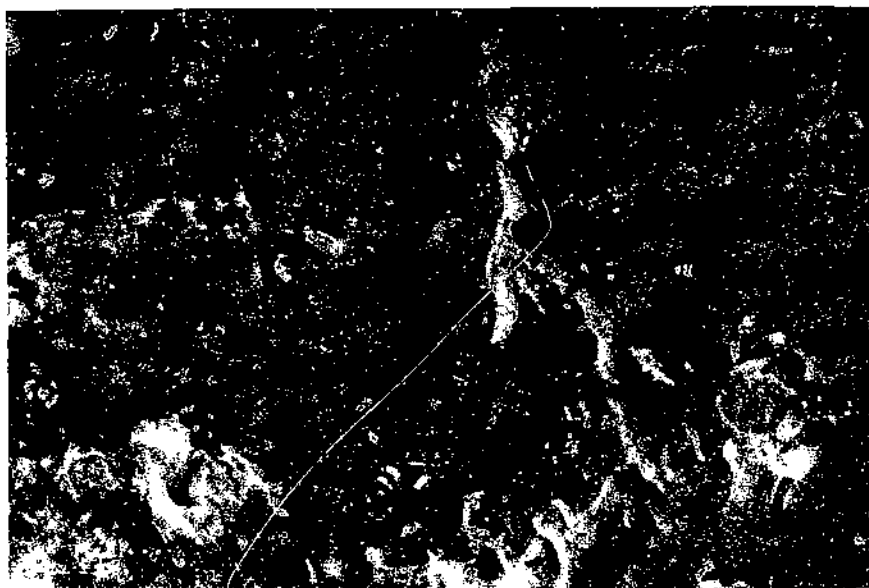
Ironplant goldenweed

Code

HASP

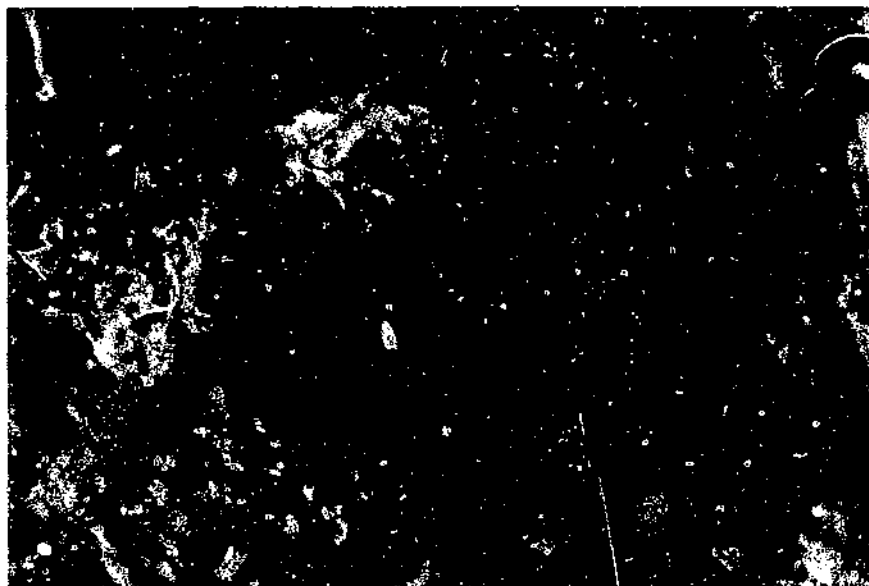


PN-6148

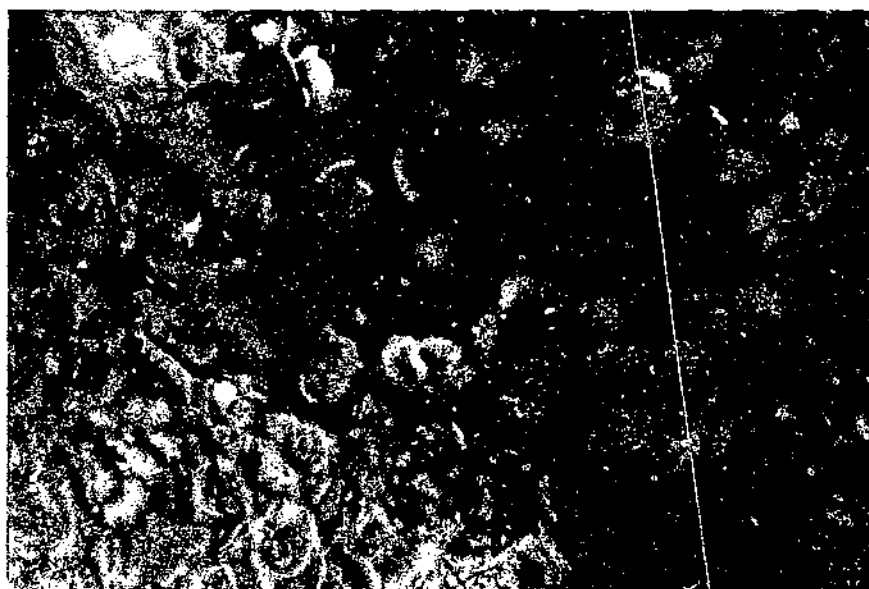


PN-6149

Resembles: Distinct



PN-6150



PN-6151

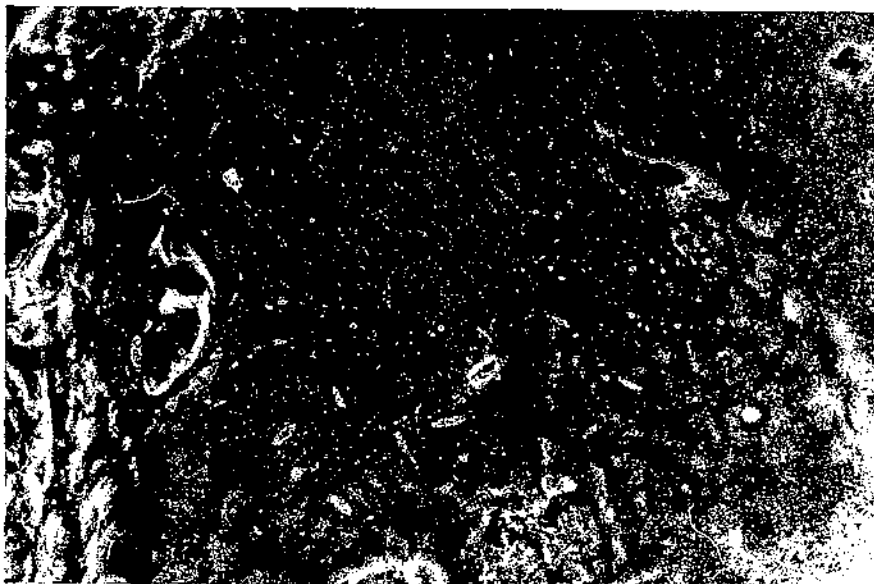
Characters: Indistinct subsidiary cells; debris over and between stomata; some slightly refractive bodies and hairs.

Botanical Name*Helianthus pumilus* Nutt.**Common Name**

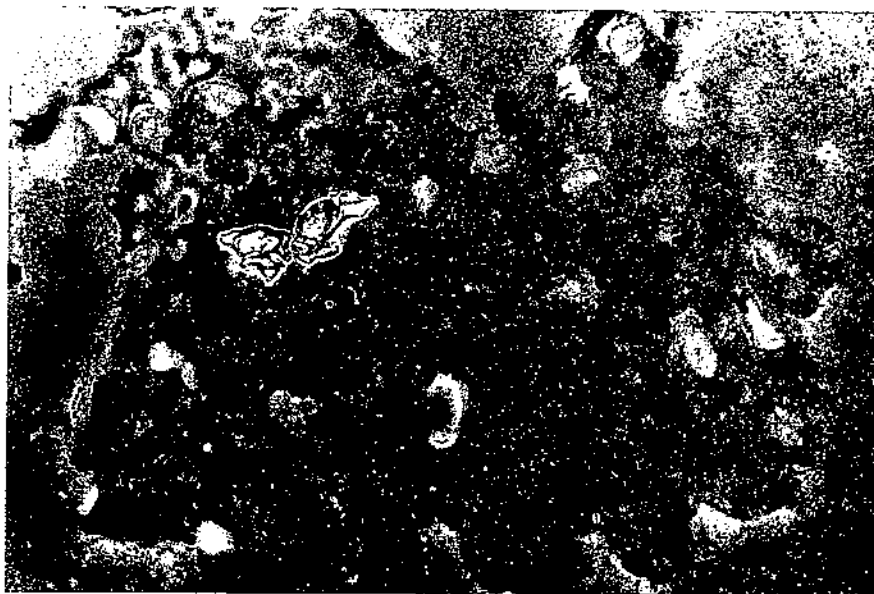
Sunflower

Code

HEPU

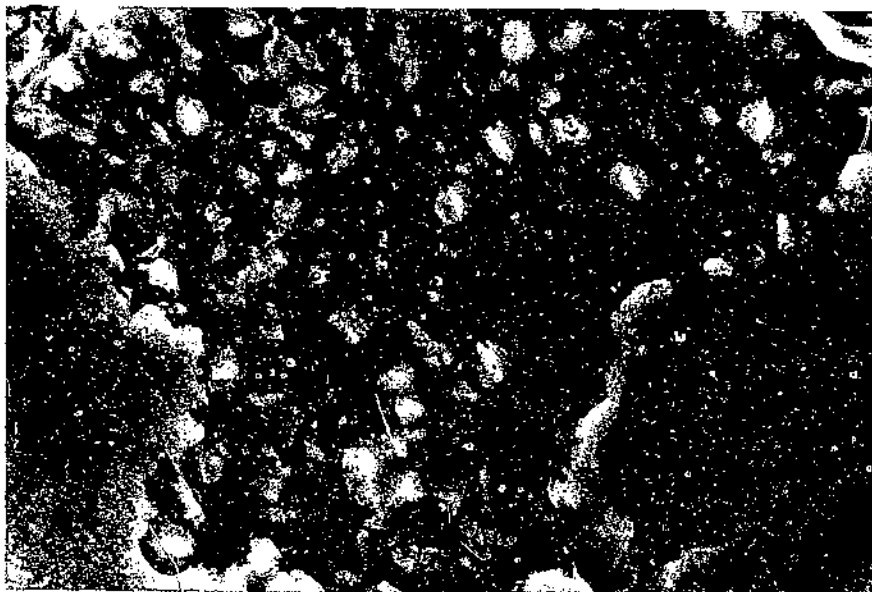


PN-6152

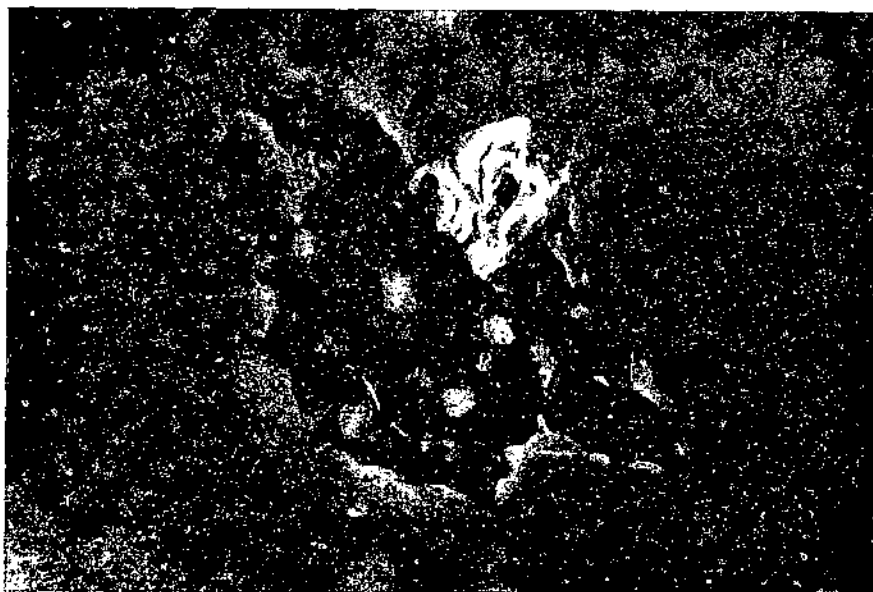


PN-6153

Resembles: Distinct



PN-6154



PN-6155

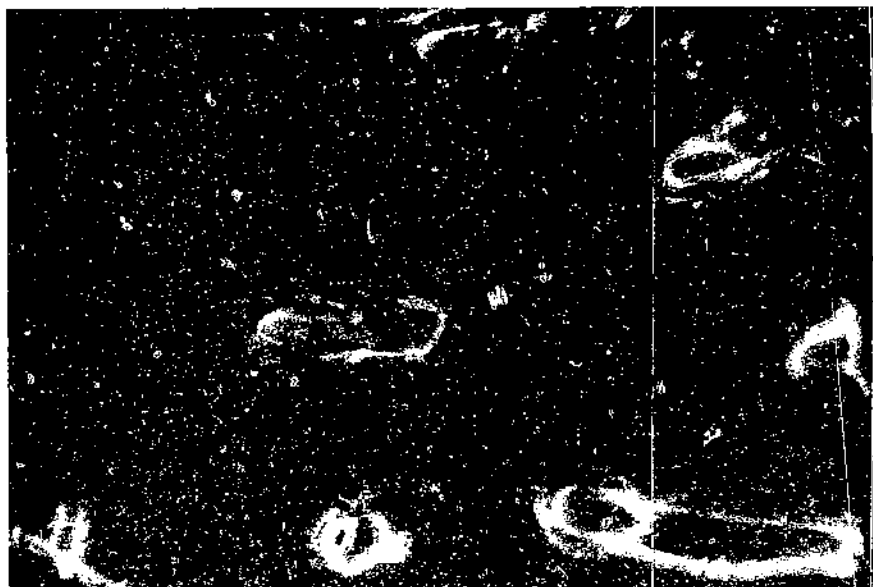
Characters: Indistinct, wavy cell walls; prominent, separated companion cells in stomata; indistinct, open guard cells.

Botanical Name*Hymenoxys acaulis* (Pursh) Parker**Common Name**

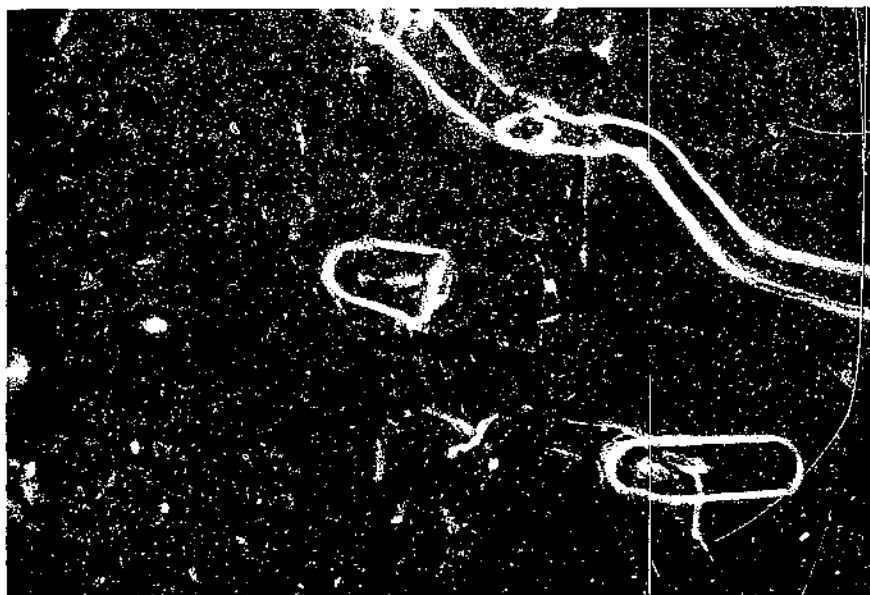
Stemless actinea

Code

HYAC

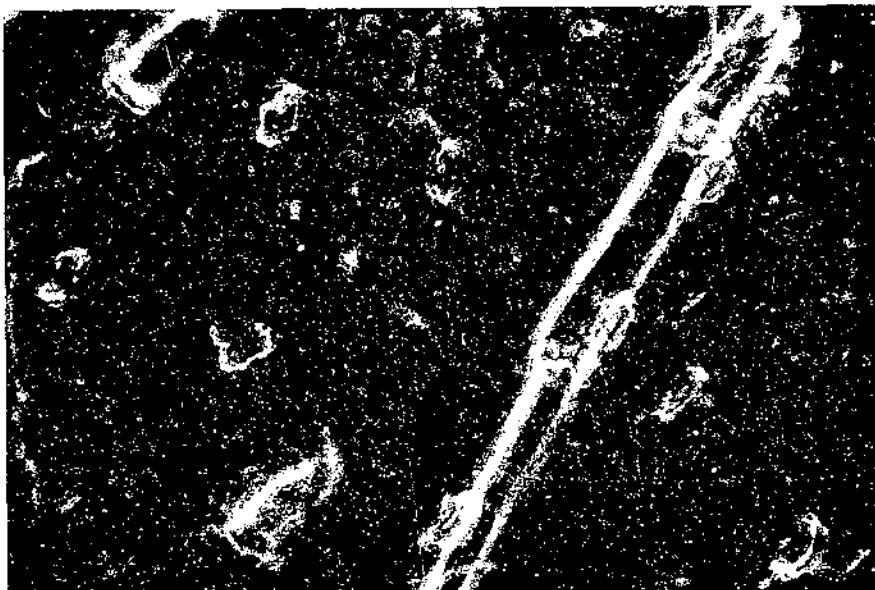


PN-6156

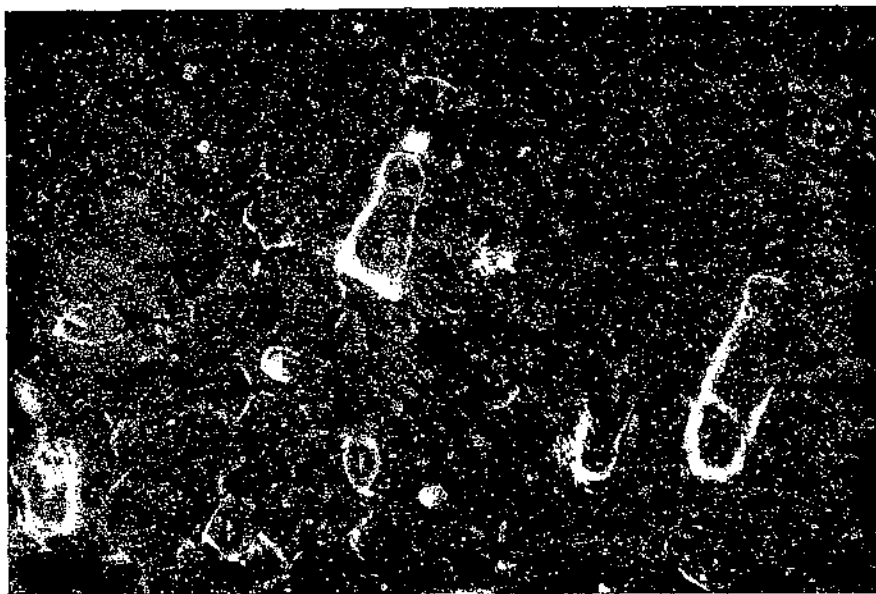


PN-6157

Resembles: Distinct



PN-6158



PN-6159

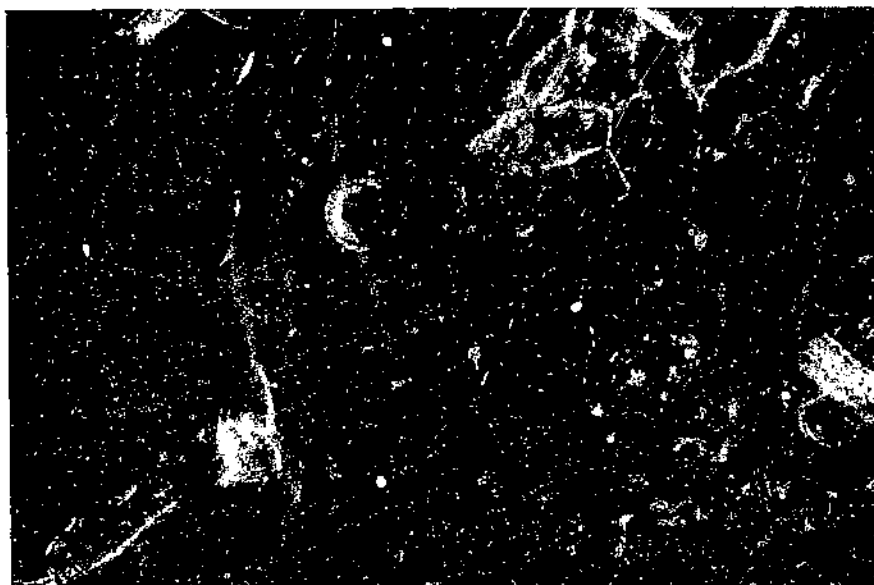
Characters: Very distinct cells, stomata, hairs; some hairs broken but attached and refractive.

Botanical Name*Kochia scoparius* (L.) Schrad.**Common Name**

Belvedere summercypress

Code

KOSC

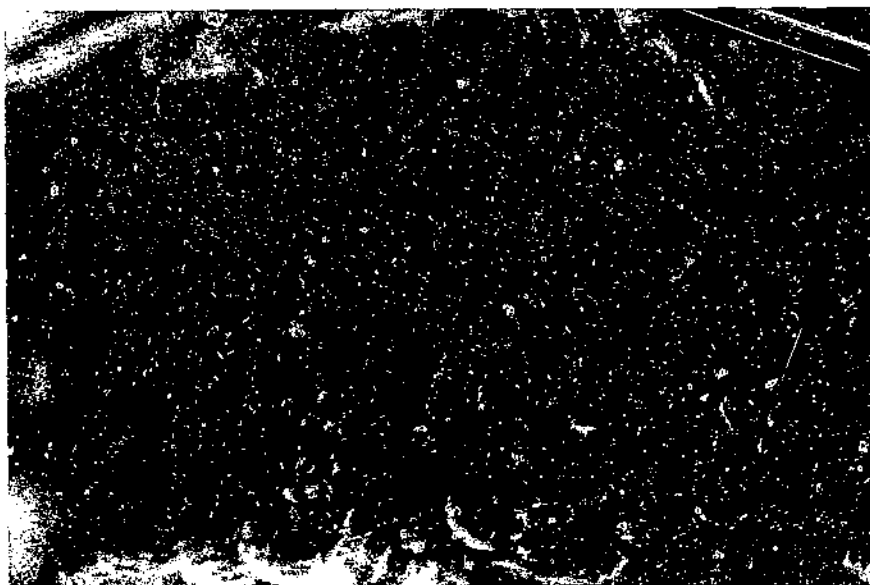


PN-6160



PN-6161

Resembles: Distinct



PN-6162



PN-6163

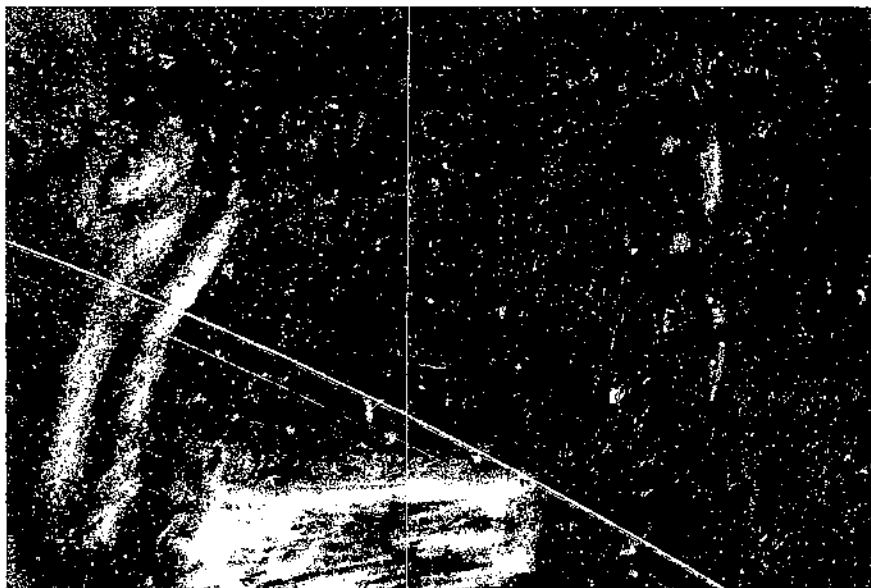
Characters: Clear, thin cell walls with small, dark stomata; some refractive bodies.

Botanical Name*Lepidium densiflorum* Schrad.**Common Name**

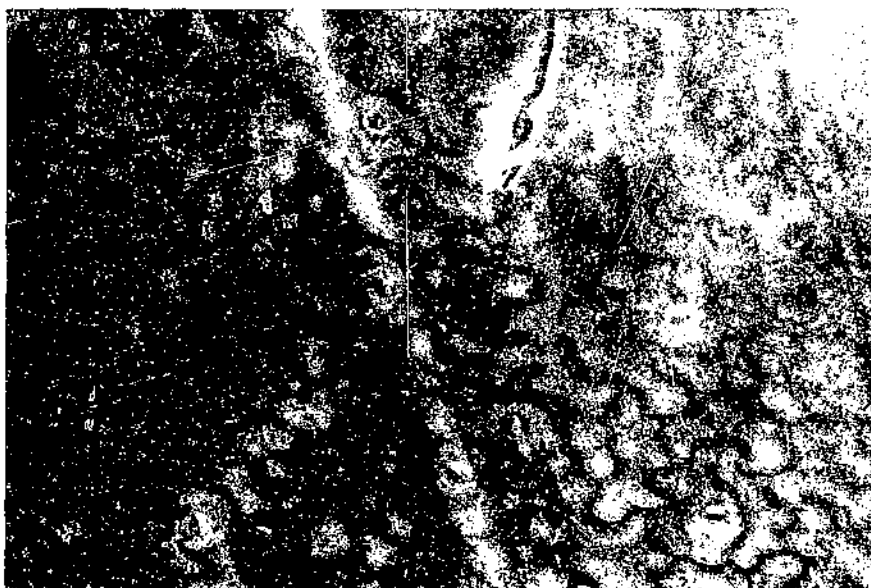
Prairie pepperweed

Code

LEDE

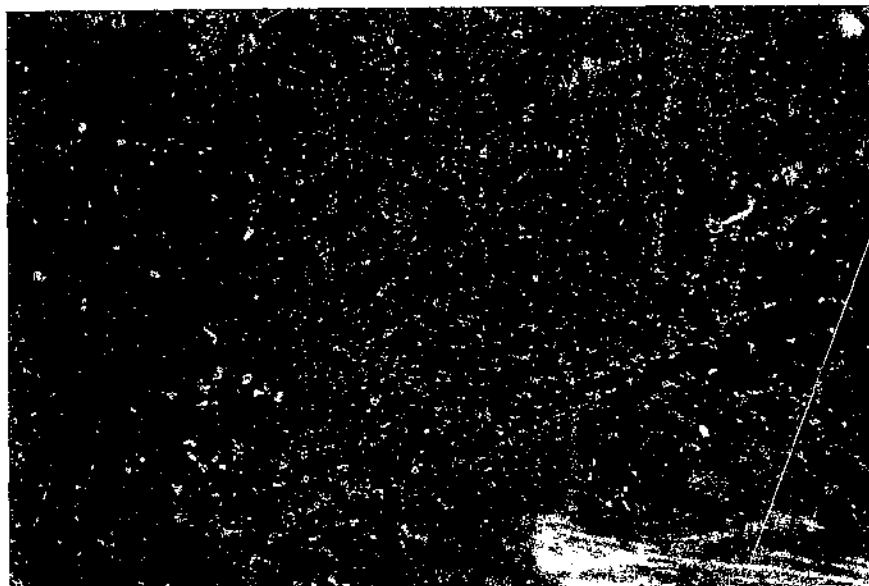


PN-6164

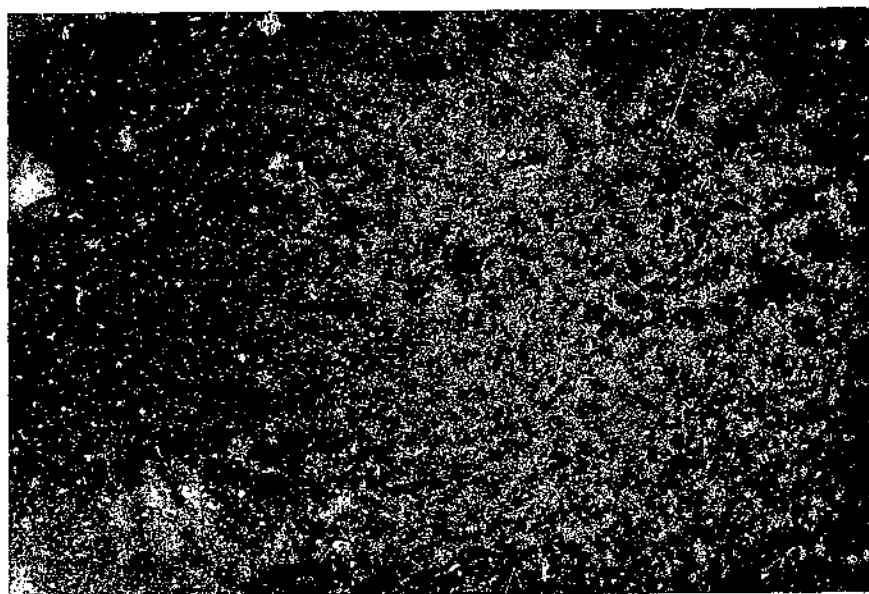


PN-6165

Resembles: Distinct



PN-6166



PN-6167

Characters: Very wavy cell walls near clean surfaces; small stomata with dark centers.

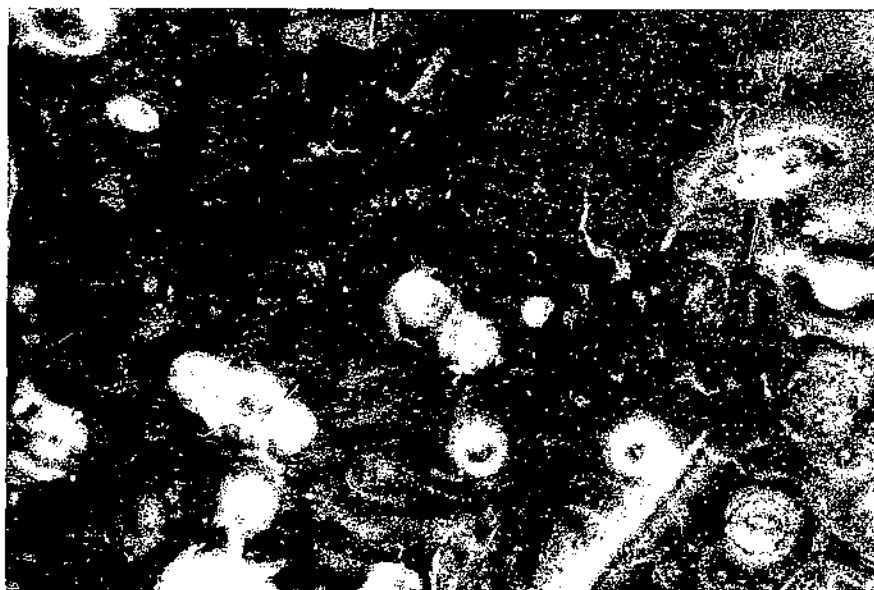
Botanical Name
Liatris punctata Hook.

Common Name
Dotted gayfeather

Code
LIPU

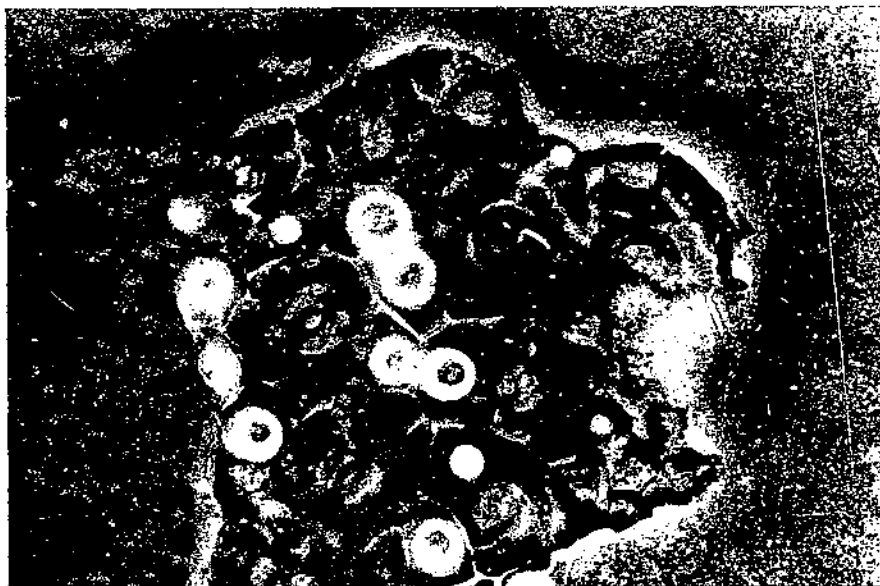


PN-6168

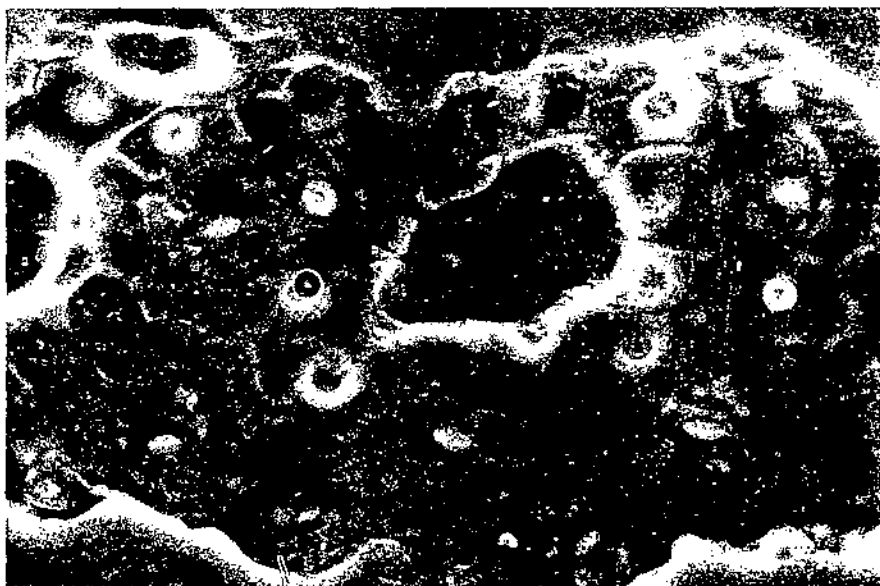


PN-6169

Resembles: Distinct



PN-6170



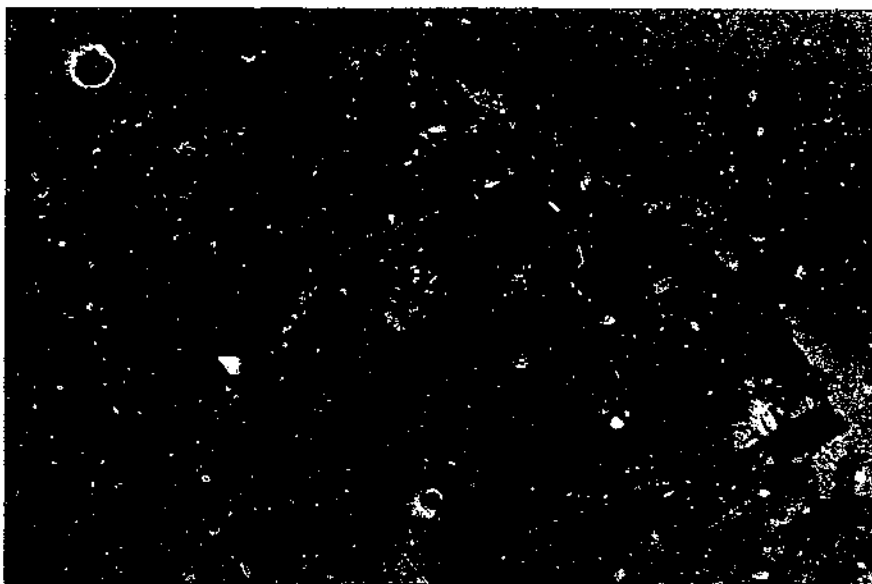
PN-6171

Characters: All cells and components very clear but dark except for large, refractive silica bodies, which are single or in groups of 2 or 3 but only 1 per epidermal cell; large, open stomata.

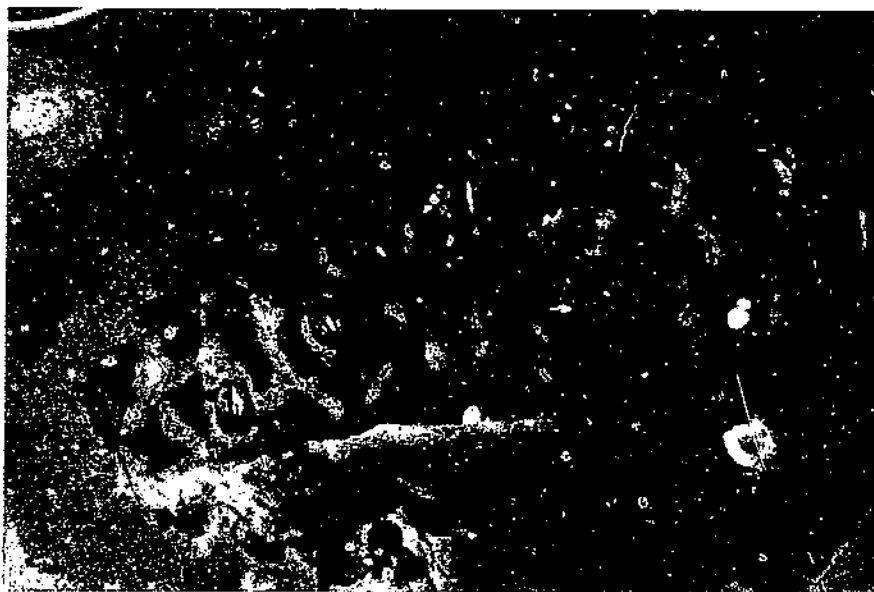
Botanical Name
Linaria dalmatica (L.) Mill.

Common Name
Dalmatian toadflax

Code
LIDA



PN-6172

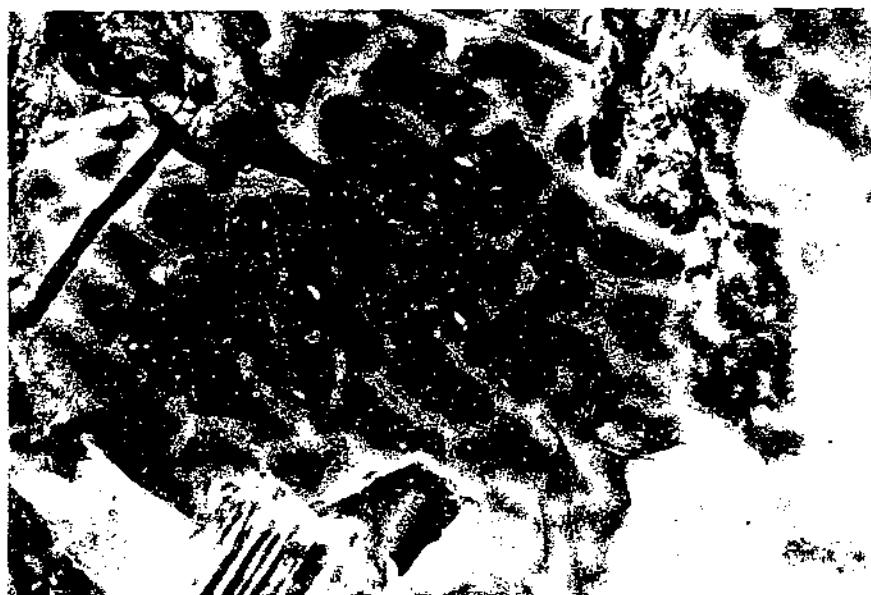


PN-6173

Resembles: Distinct



PN-6174



PN-6175

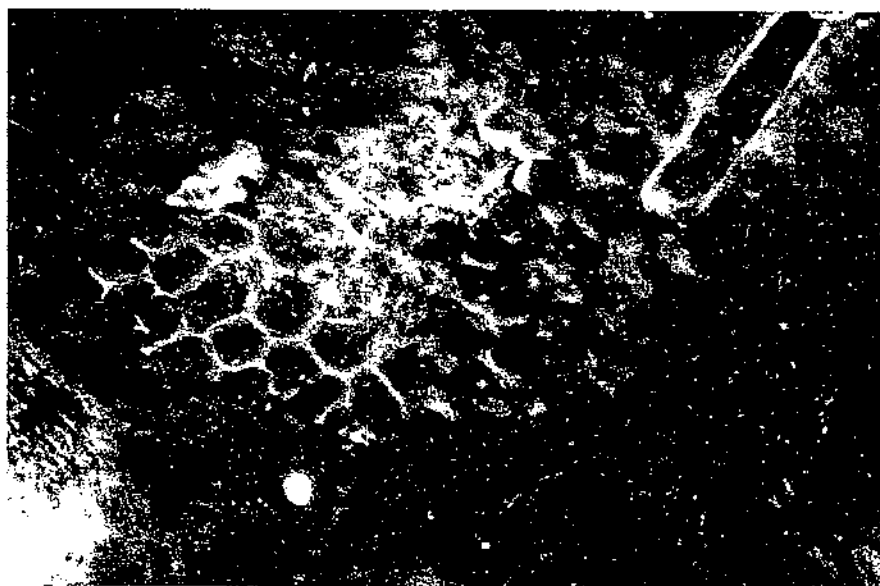
Characters: Clear, medium to large, open stomata; distinct, slightly wavy cell walls.

Botanical Name*Lithospermum incisum* Lehm**Common Name**

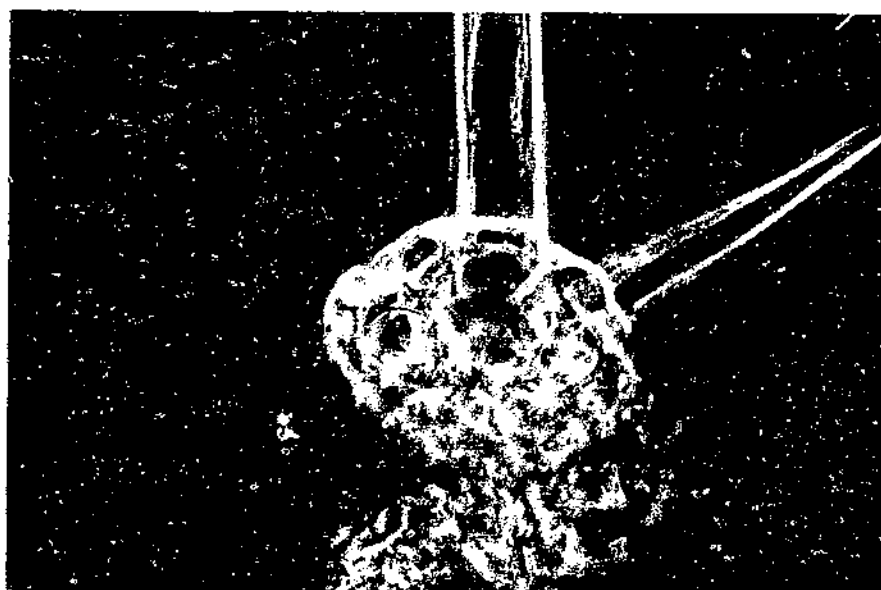
Narrowleaf gromwell

Code

LIIN

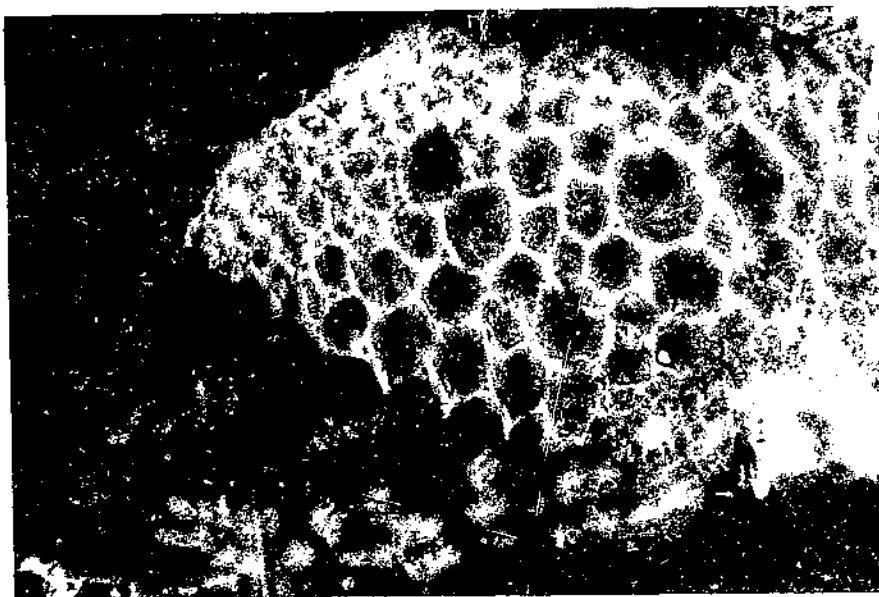


PN-6176



PN-6177

Resembles: *Achillea millefolium*



PN-6178



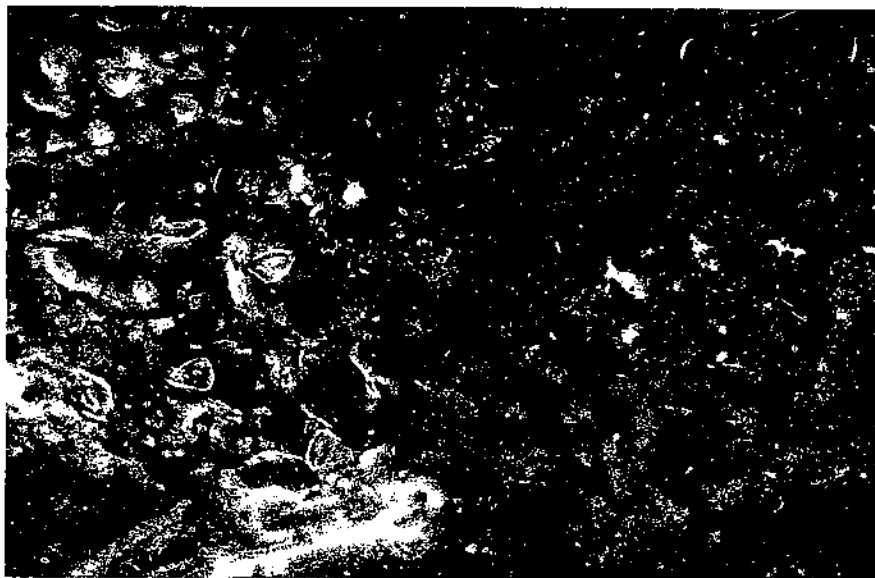
PN-6179

Characters: Sunken, hardly visible stomata; large half-dome refractive bases with long hair sometimes attached.

Botanical Name
Lupinus plattensis Wats.

Common Name
Nebraska lupine

Code
LUPL



PN-6180

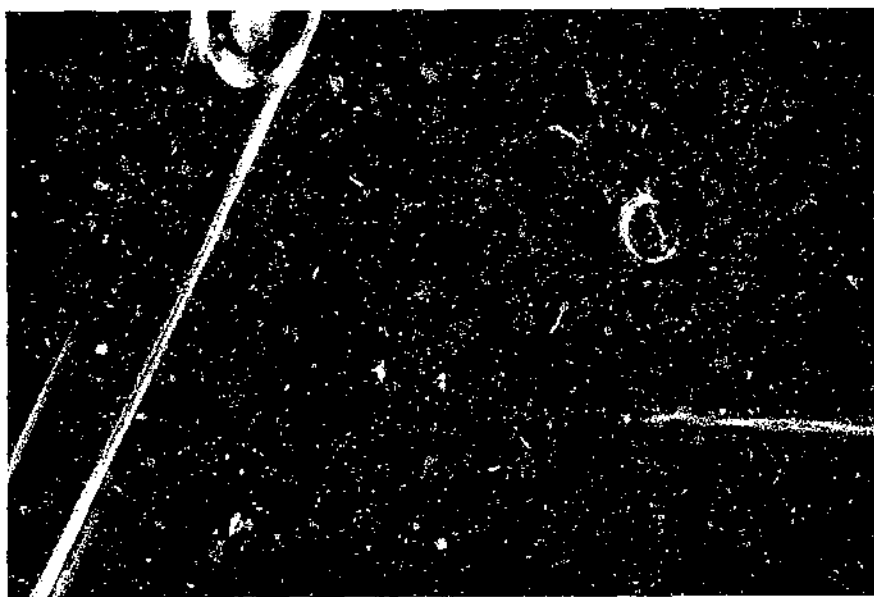


PN-6181

Resembles: *Astragalus adsurgens*



PN-6182



PN-6183

Characters: Excellent cell and stomata differentiation; edges of stomata appear to be rolled upward.

Botanical Name*Lygodesmia juncea* (Pursh) D. Don**Common Name**

Rush skeletonplant

Code

LYJU



PN-6185

Resembles: Distinct



PN-6186



PN-6187

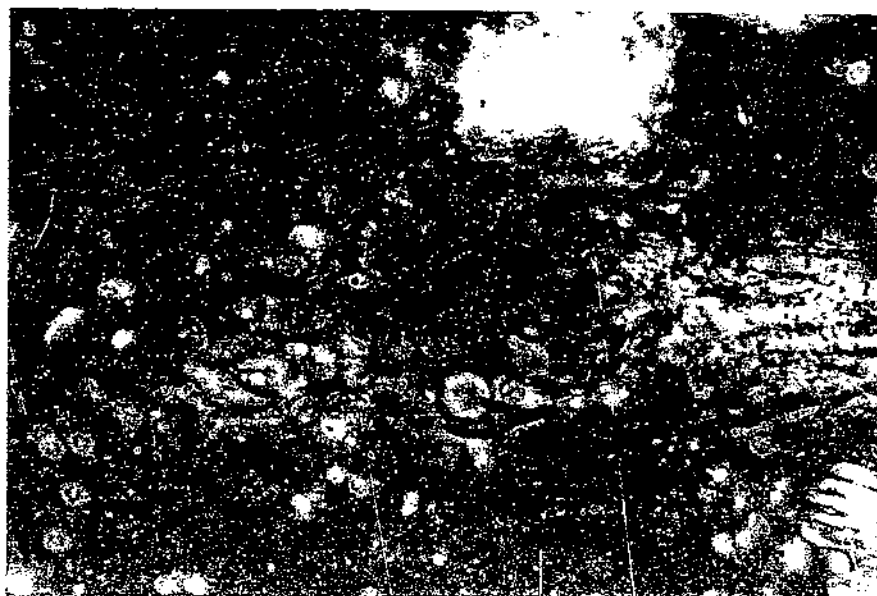
Characters: Somewhat linear cells with large open stomata at 90° angle to them.

Botanical Name*Machaeranthera canescens* (Pursh) A. Gray**Common Name**

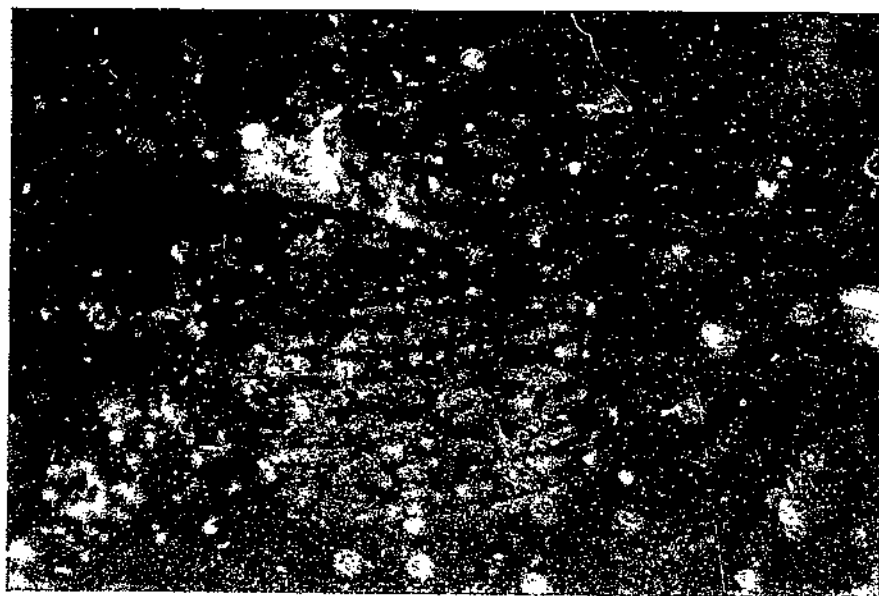
Hoary aster

Code

MACA

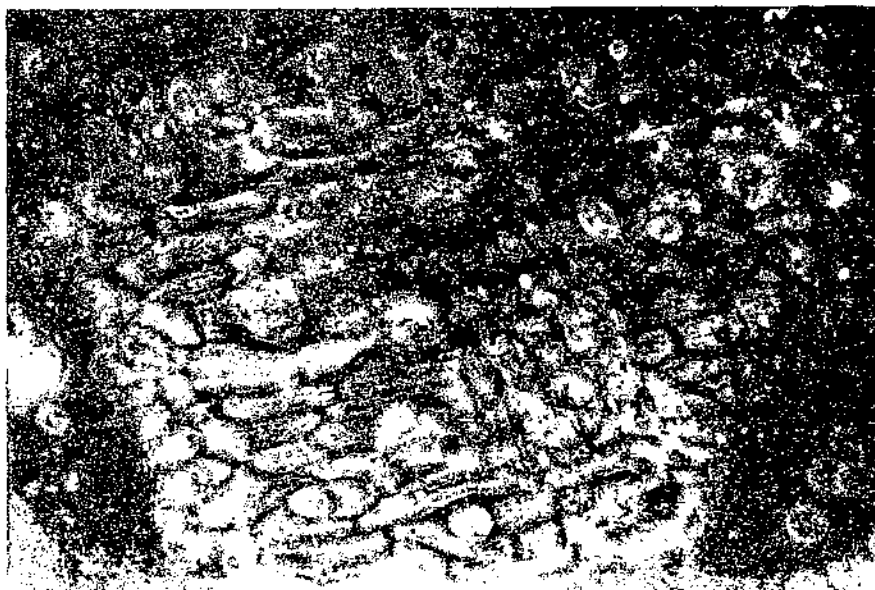


PN-6188

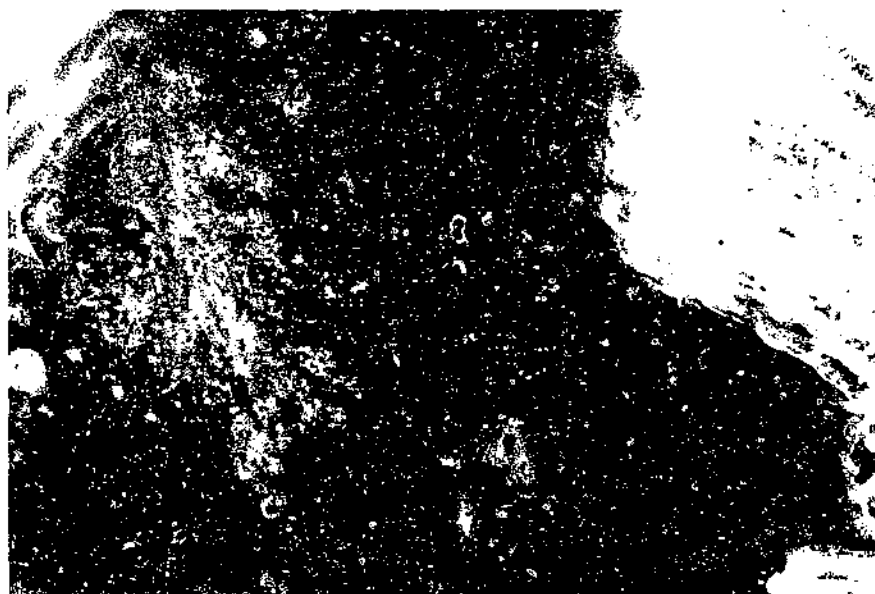


PN-6189

Resembles: *Chrysothamnus nauseosus*



PN-6190



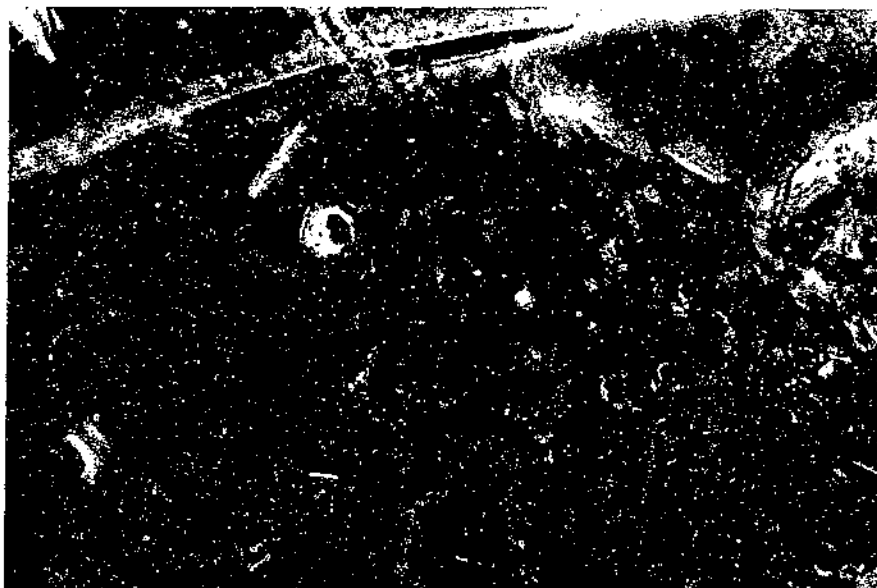
PN-6191

Characters: Stomata with subsidiary cells; some debris on fragments obscuring structure.

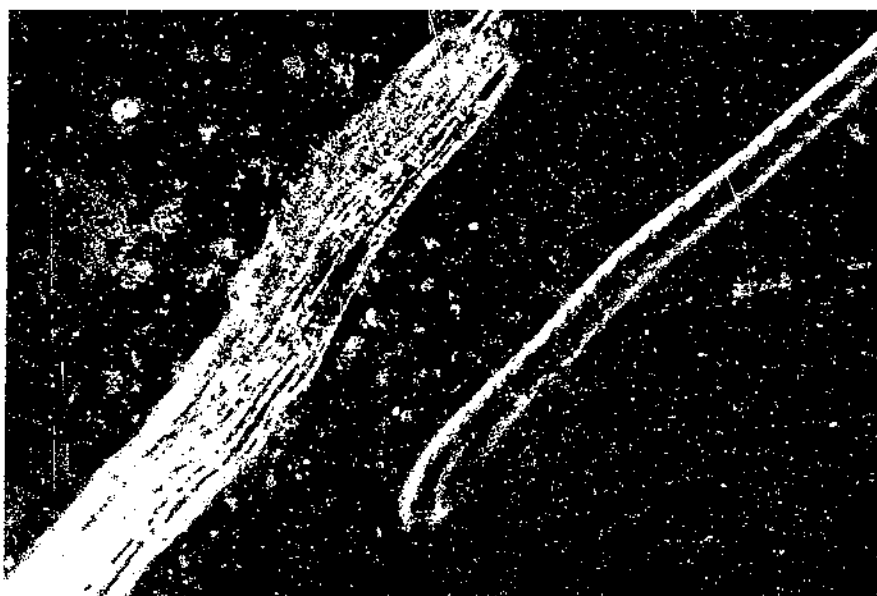
Botanical Name
Medicago sativa L.

Common Name
Alfalfa

Code
MESA

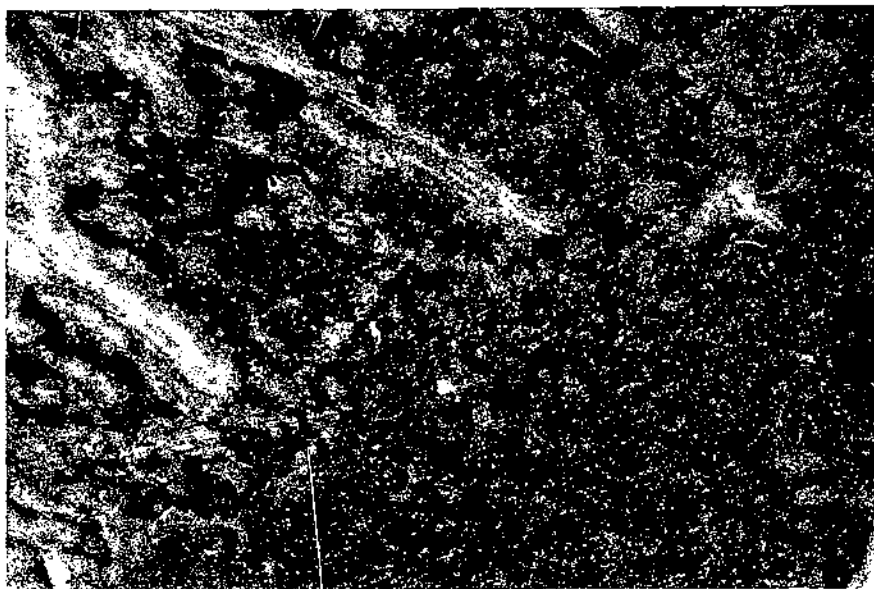


PN-6192



PN-6193

Resembles: Distinct



PN-6194



PN-6195

Characters: Most epidermal fragments more than 1 cell layer thick; difficult to see stomata in most samples.

Botanical Name*Melilotus officinalis* (L.) Lam.**Common Name**

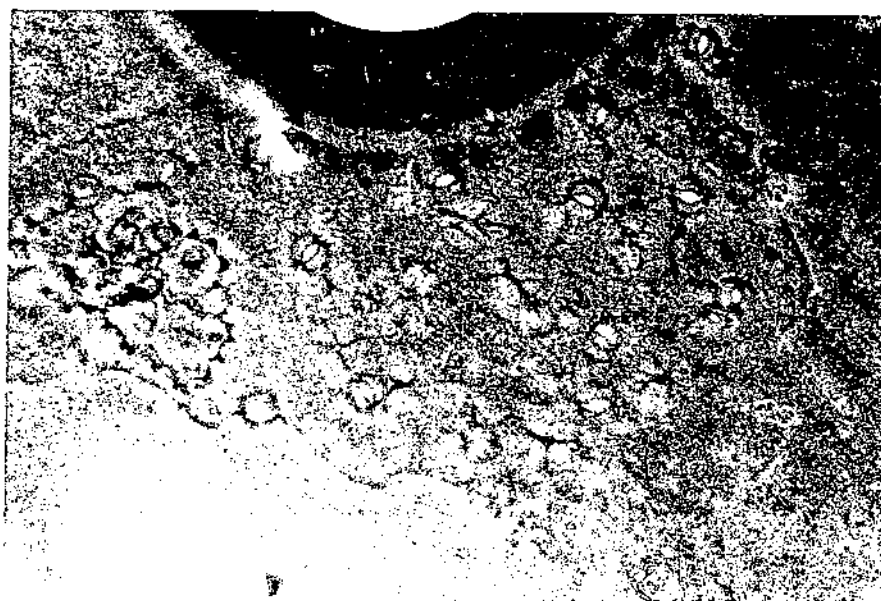
Yellow sweetclover

Code

MEOF

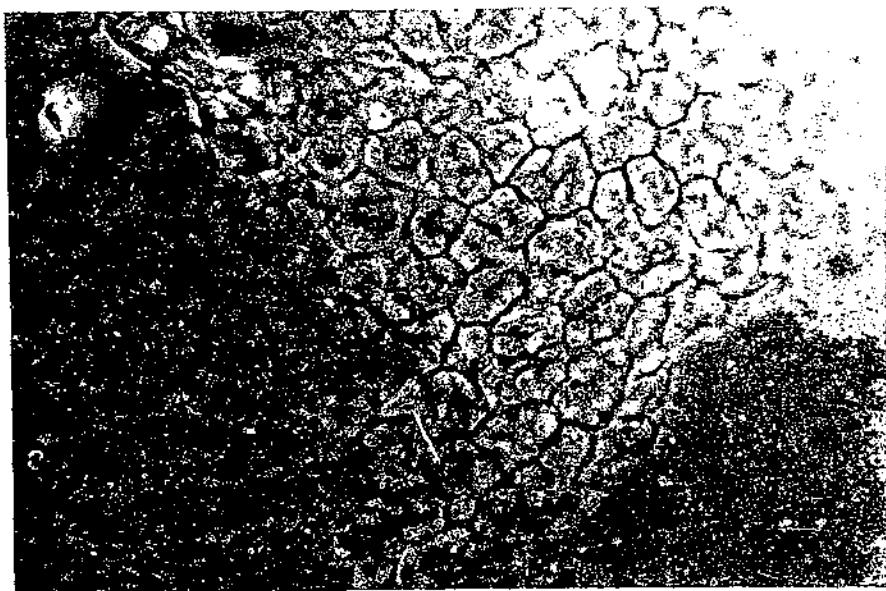


PN-6196

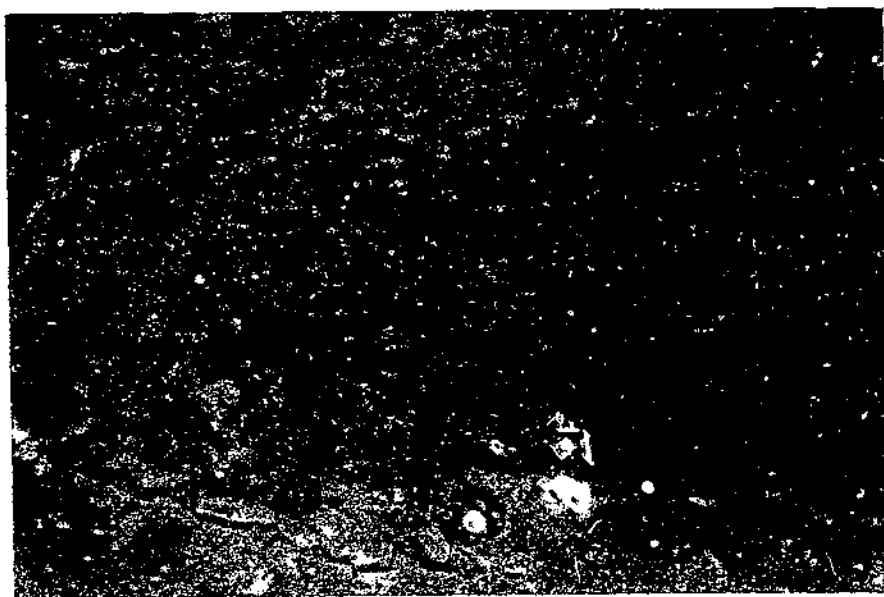


PN-6197

Resembles: Distinct



PN-6198



PN-6199

Characters: Open, clear stomata appear submerged as if on back side of fragment.

Botanical Name*Mertensia lanceolata* (Pursh) A. DC.**Common Name**

Lanceleaf bluebells

Code

MELA



PN-6200

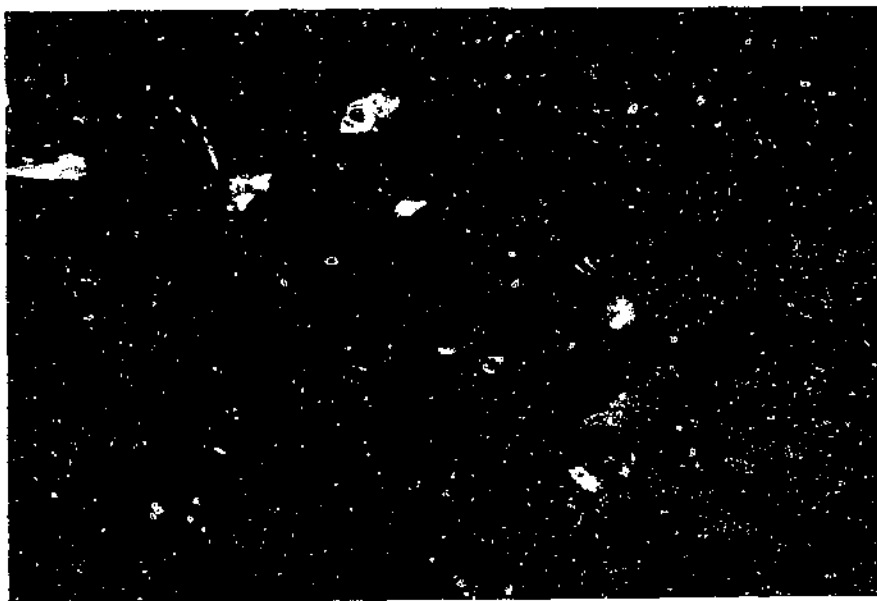


PN-6201

Resembles: *Lithospermum incisum*



PN-6202



PN-6203

Characters: Submerged, dim stomata; dark debris within some cells.

Botanical Name*Oxybaphus linearis* (Pursh) Robinson**Common Name**

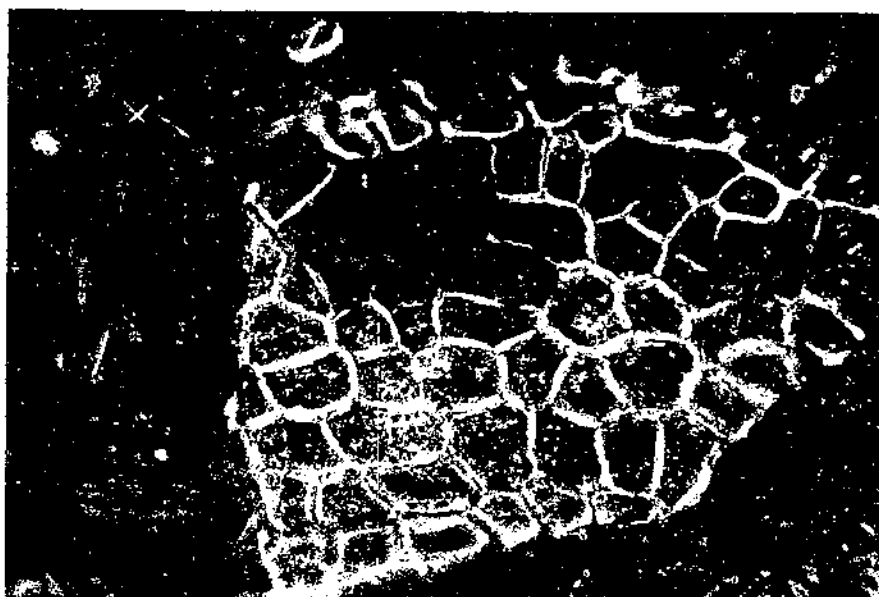
Narrowleaf umbrellawort

Code

OXLI



PN-6204



PN-6205

Resembles: Distinct



PN-6206



PN-6207

Characters: Gray, mottled background within cells; dark, blurred stomata with open guard cells.

Botanical Name*Oxytropis sericea* Nutt.**Common Name**

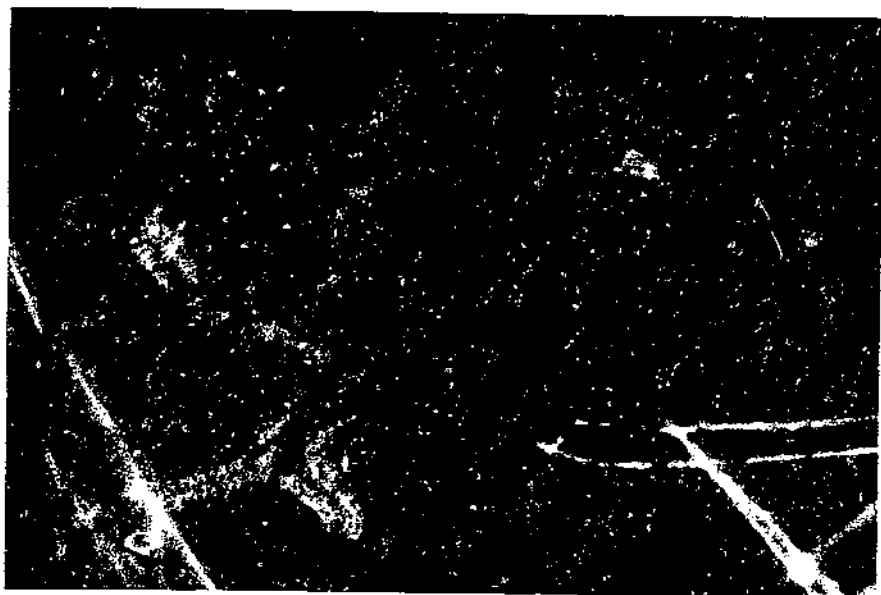
Silky loco

Code

OXSE

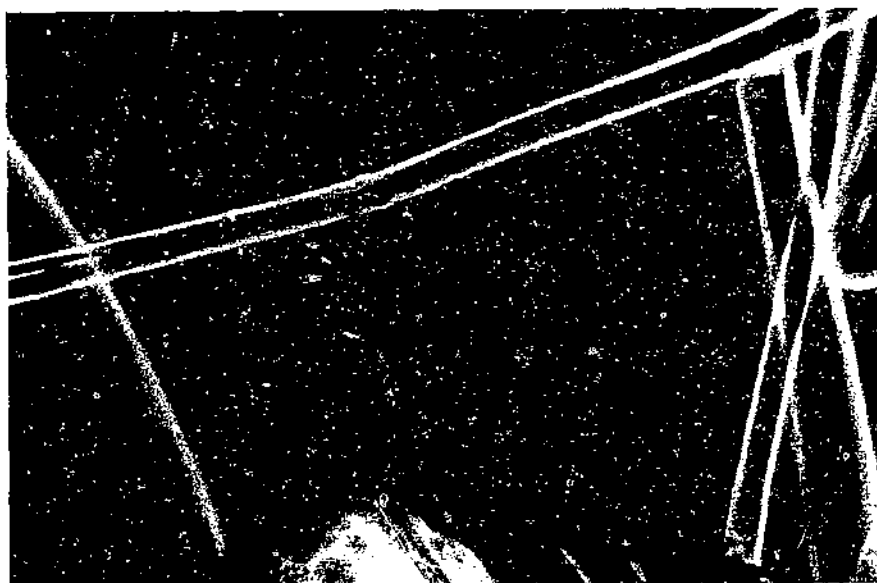


PN-6208

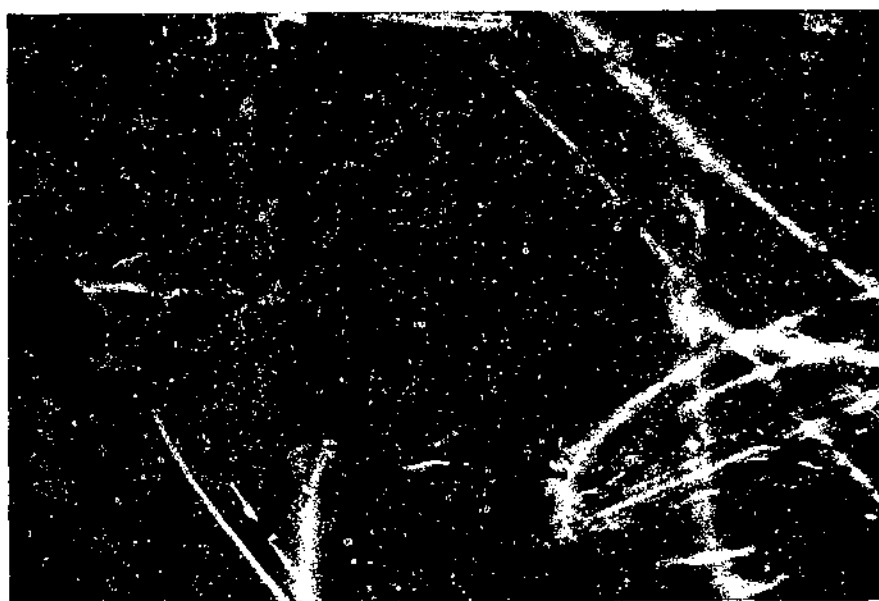


PN-6209

Resembles: Distinct



PN-6210



PN-6211

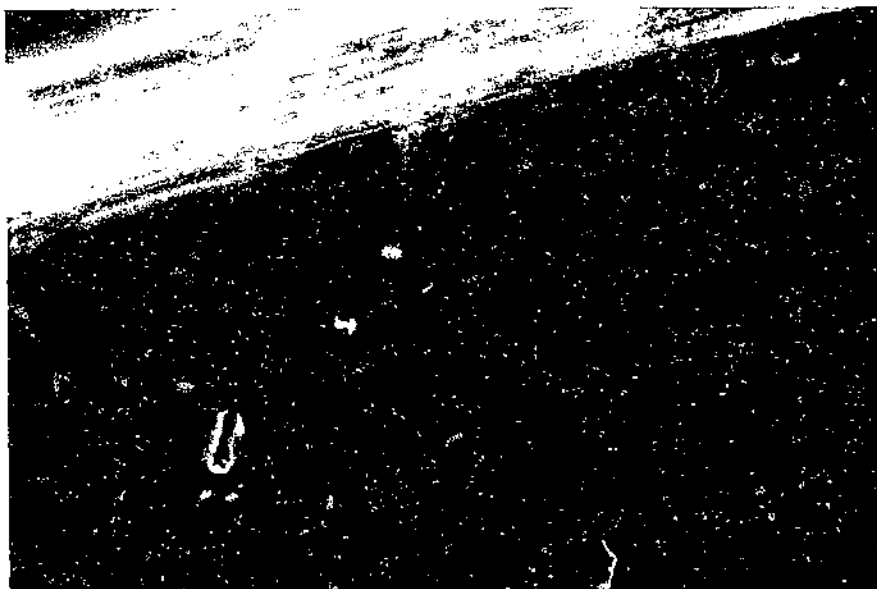
Characters: Circular trichome bases for long, slender hairs; some bases with hair attached; readily visible stomata.

Botanical Name*Plantago patagonica* Jacq.**Common Name**

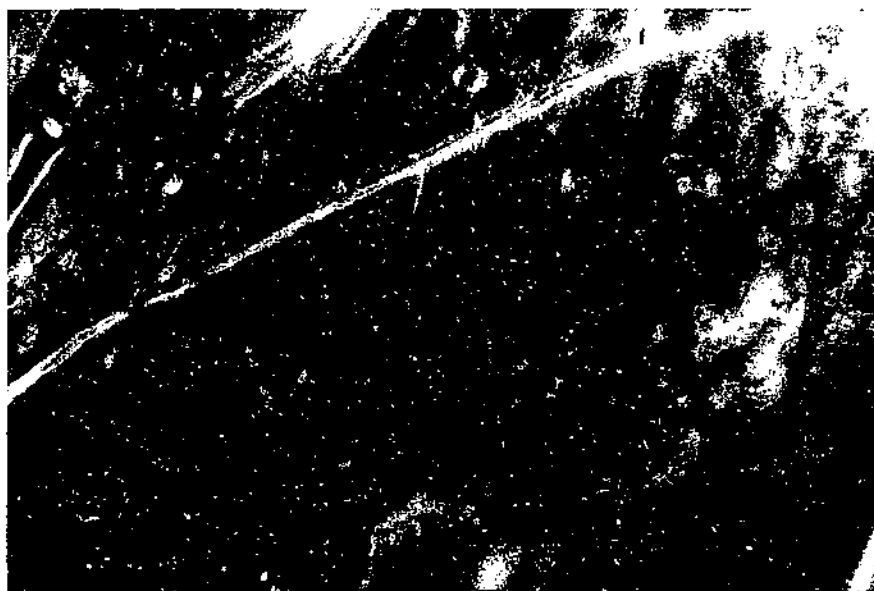
Wooly plantain

Code

PLPA



PN-6212

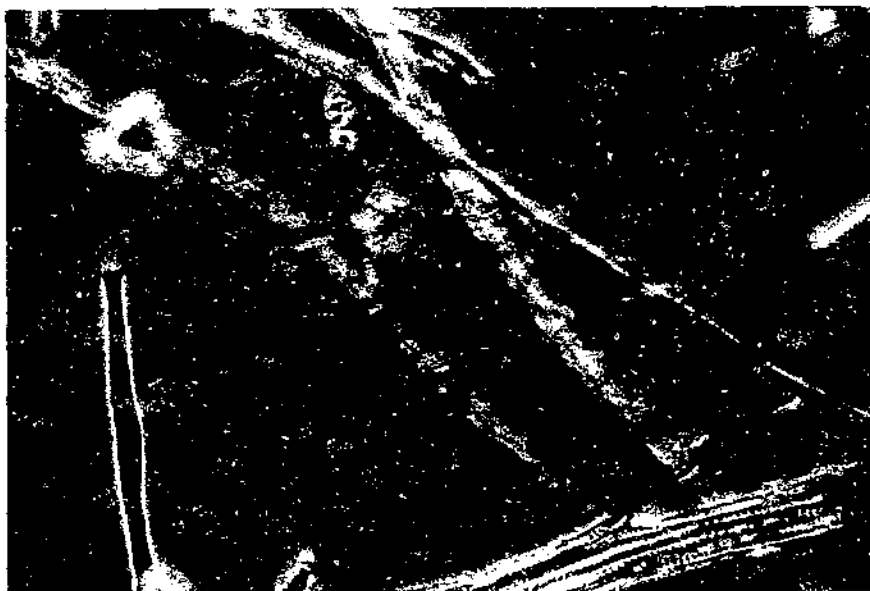


PN-6213

Resembles: Distinct



PN-6214



PN-6215

Characters: Numerous, round, readily visible stomata; some long slender hairs attached to epidermis or as debris.

Botanical Name*Potentilla pensylvanica* L.**Common Name**

Pennsylvania cinquefoil

Code

POPE

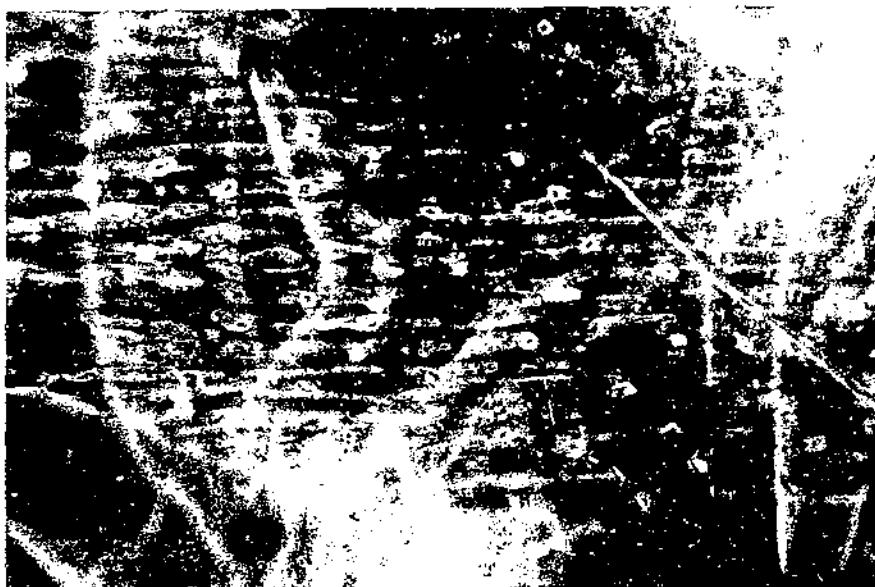


PN-6216

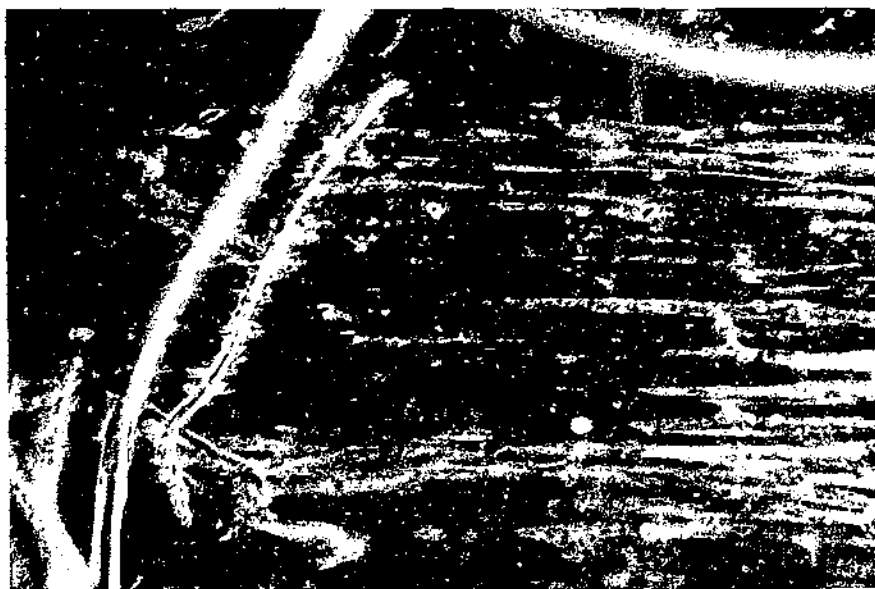


PN-6217

Resembles: Distinct



PN-6218



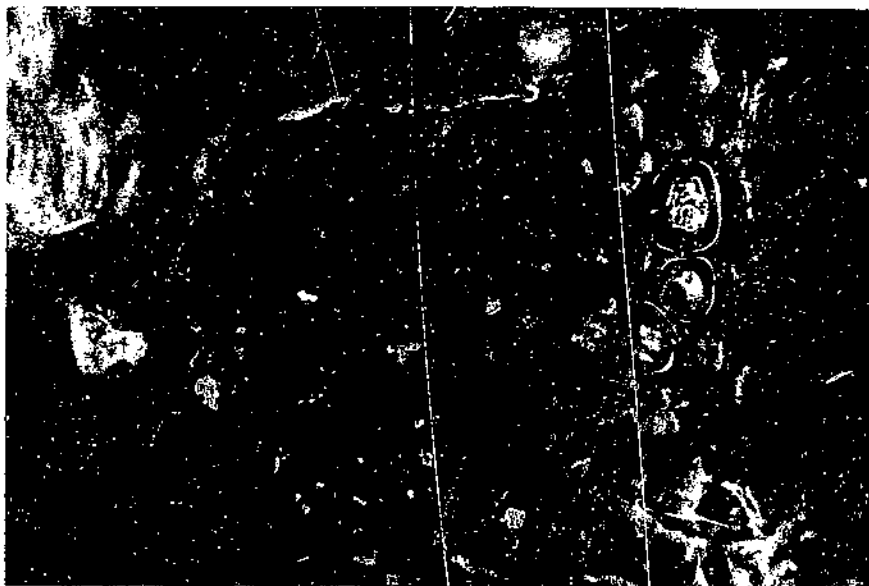
PN-6219

Characters: Linear cells, more than 1 layer thick; stomata almost never seen; hairs curved when attached, some with knob on attached end.

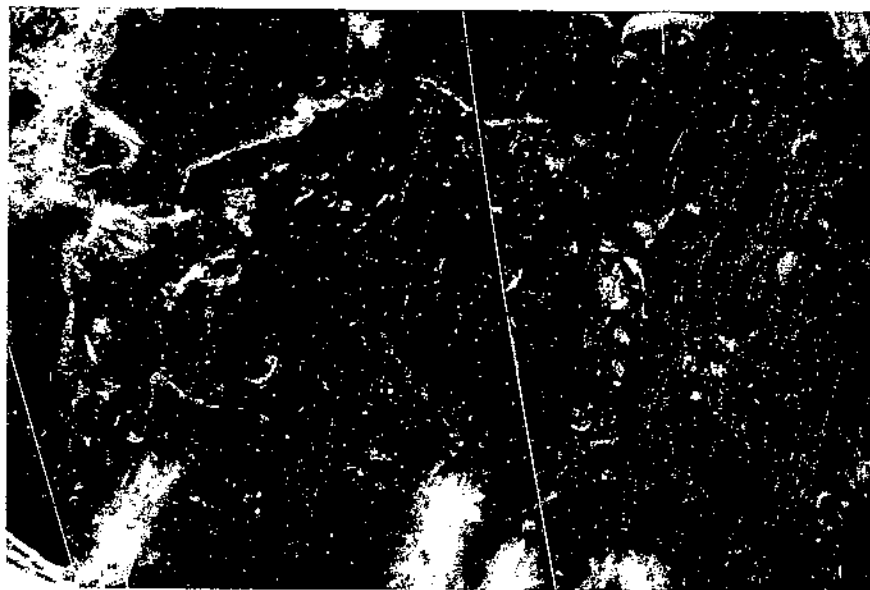
Botanical Name
Salsola kali L.

Common Name
Russian thistle

Code
SAKA

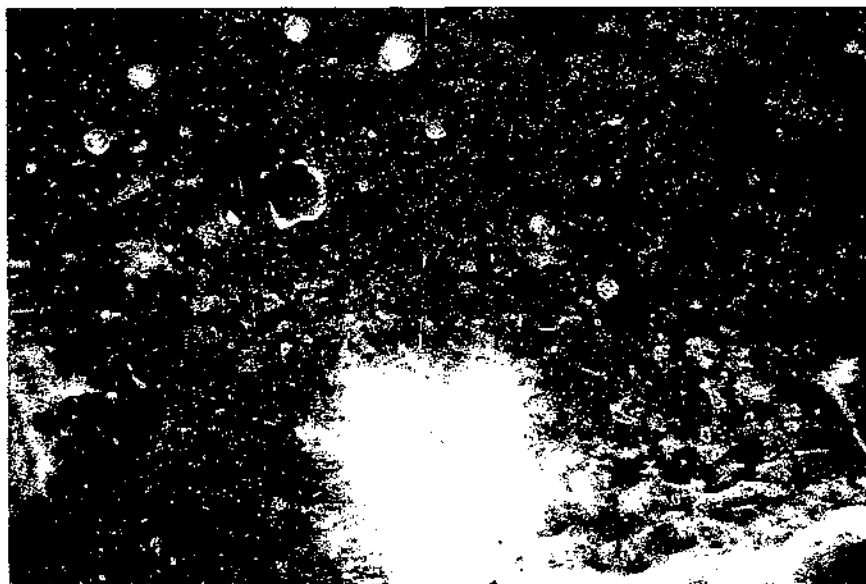


PN-6220

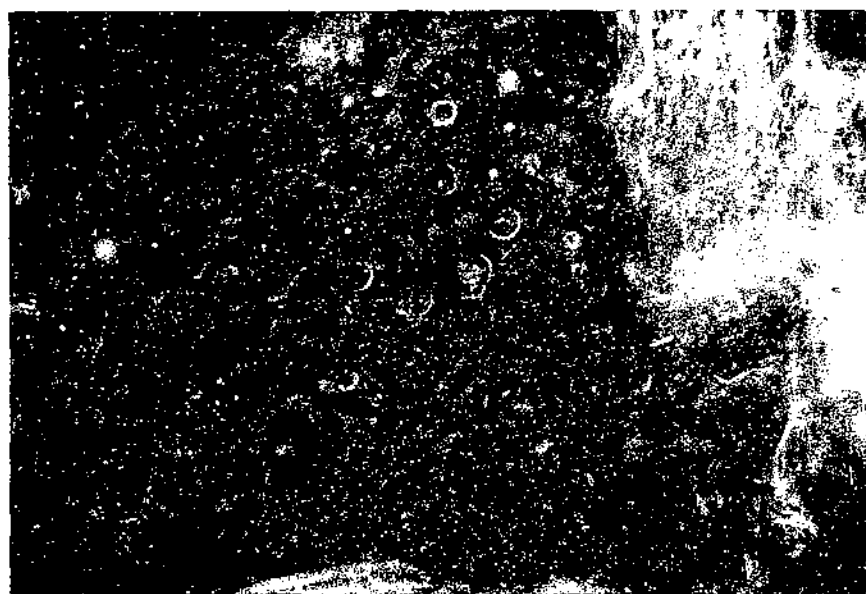


PN-6221

Resembles: Distinct



PN-6222



PN-6223

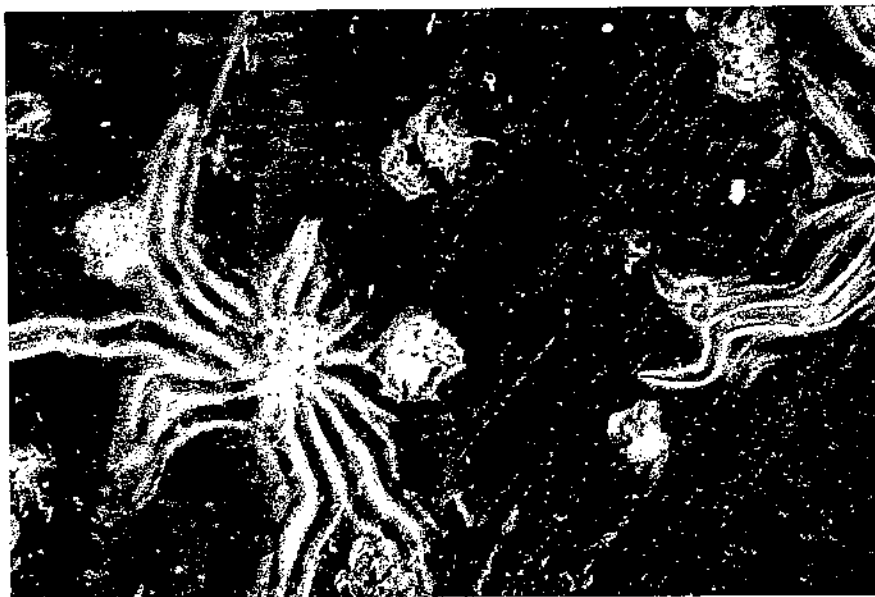
Characters: Some debris over epidermal cells; stomata blend in with surrounding cells.

Botanical Name*Sphaeralcea coccinea* (Pursh) Rydb.**Common Name**

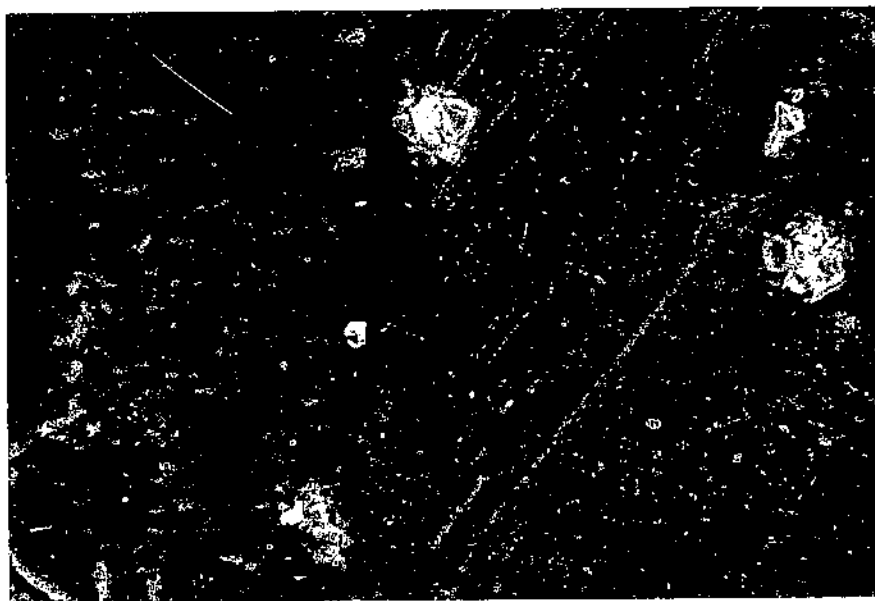
Scarlet globemallow

Code

SPCO

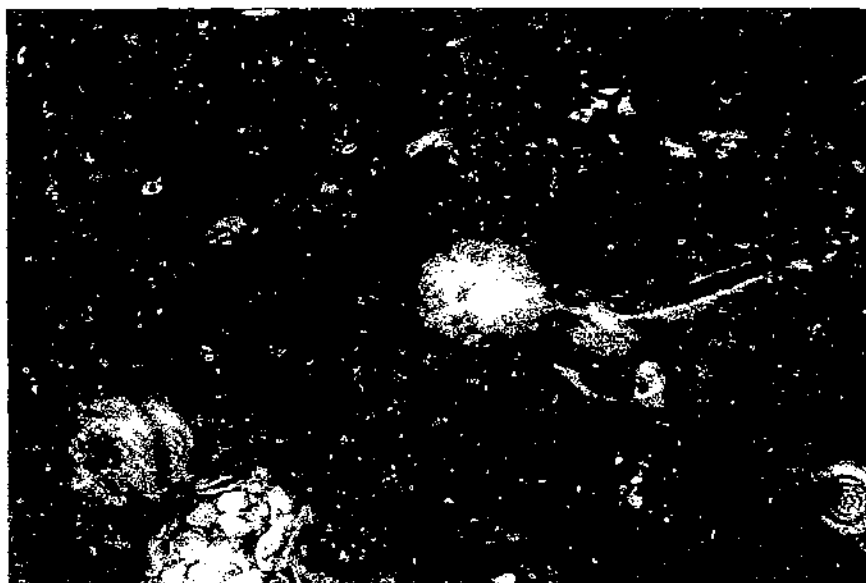


PN-6224



PN-6225

Resembles: *Artemisia frigida*, *Ceratoides lanata*



PN-6226



PN-6227

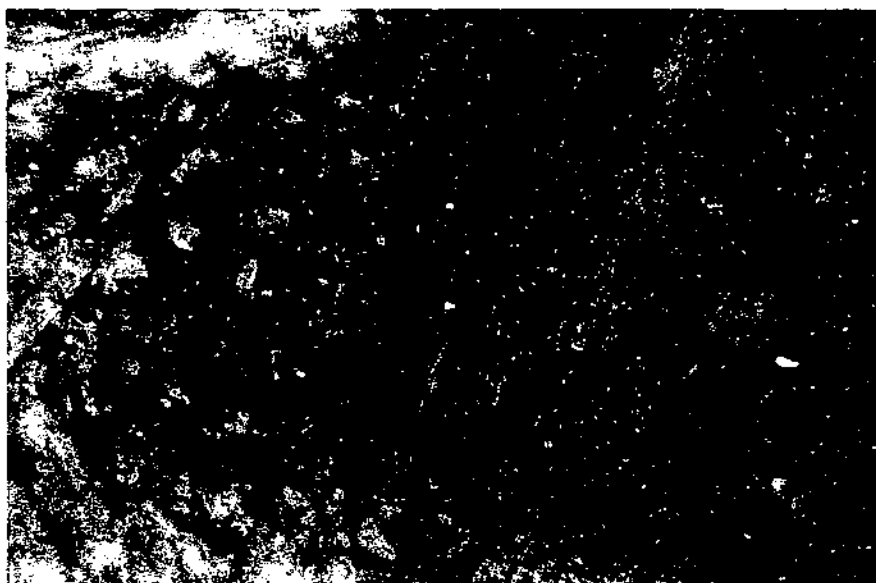
Characters: Stellate hairs with 16 arms, mostly on same plane, often attached; large refractive bases for hairs not attached; dim stomata, most easily found by viewing open guard cells.

Botanical Name*Taraxacum officinale* Wiggars**Common Name**

Dandelion

Code

TAOF



PN-6228

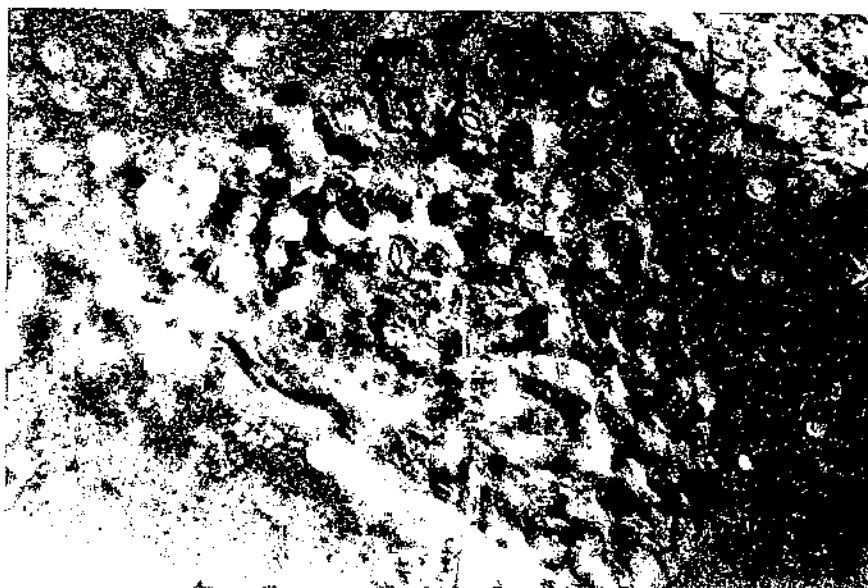


PN-6229

Resembles: Distinct



PN-6230



PN-6231

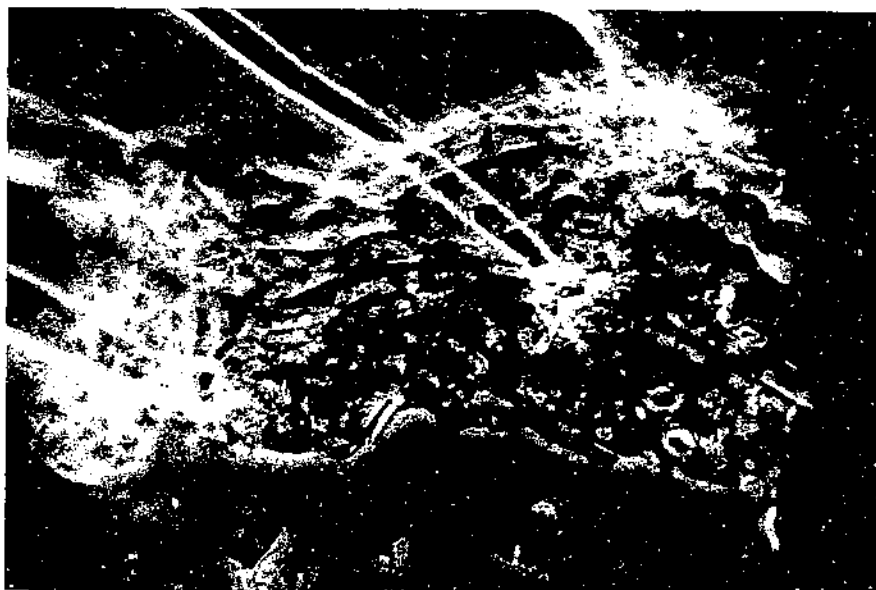
Characters: Highly visible stomata with open guard cells, when not covered with additional cell layers.

Botanical Name*Thermopsis rhombifolia* Nutt. ex Rich**Common Name**

Prairie thermopsis

Code

THRH

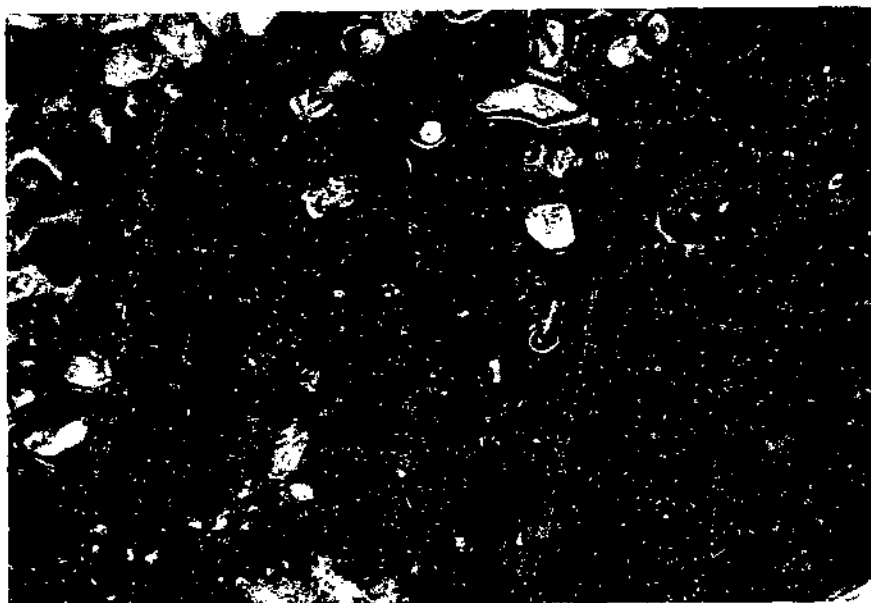


PN-6232

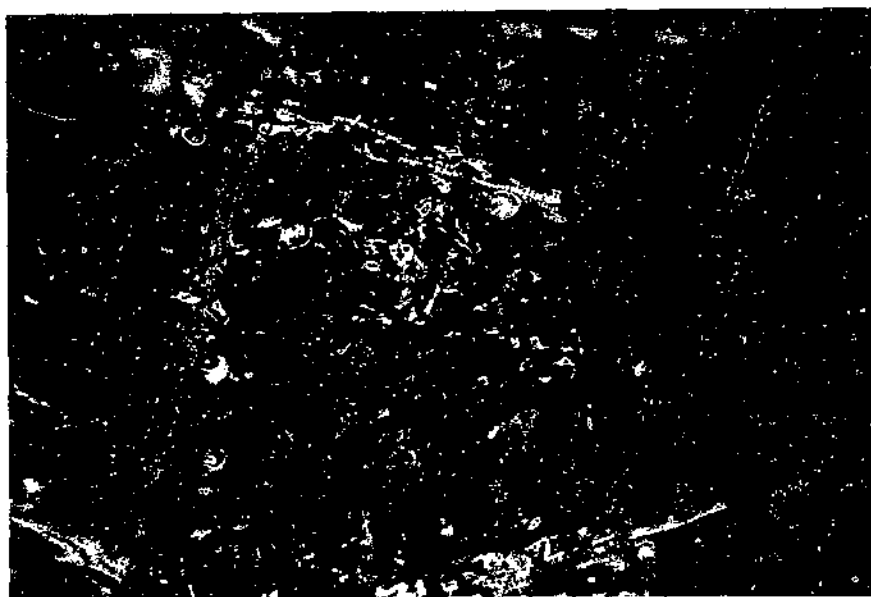


PN-6233

Resembles: Distinct



PN-6234



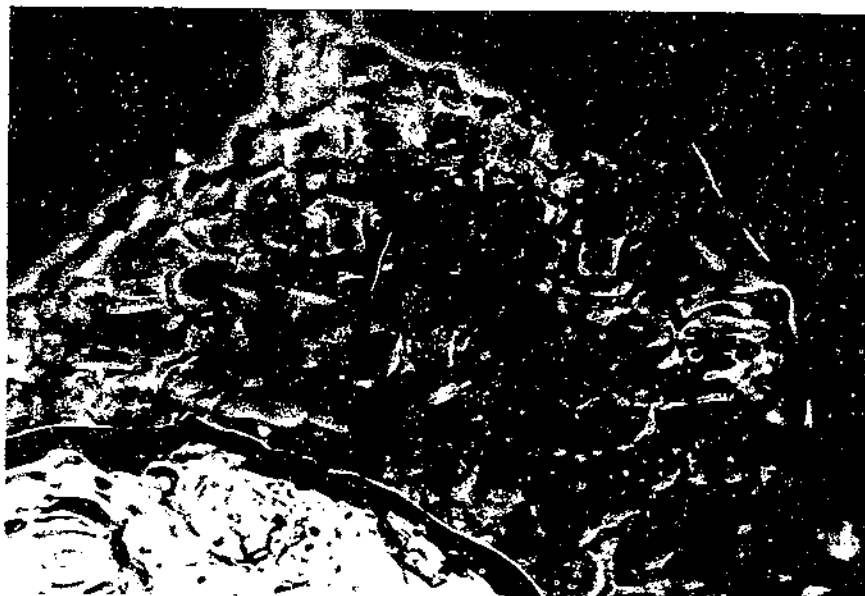
PN-6235

Characters: Considerable debris with dim stomata about same shade as cells.

Botanical Name
Yucca glauca Nutt.

Common Name
Small soapweed

Code
YUGL



PN-6236

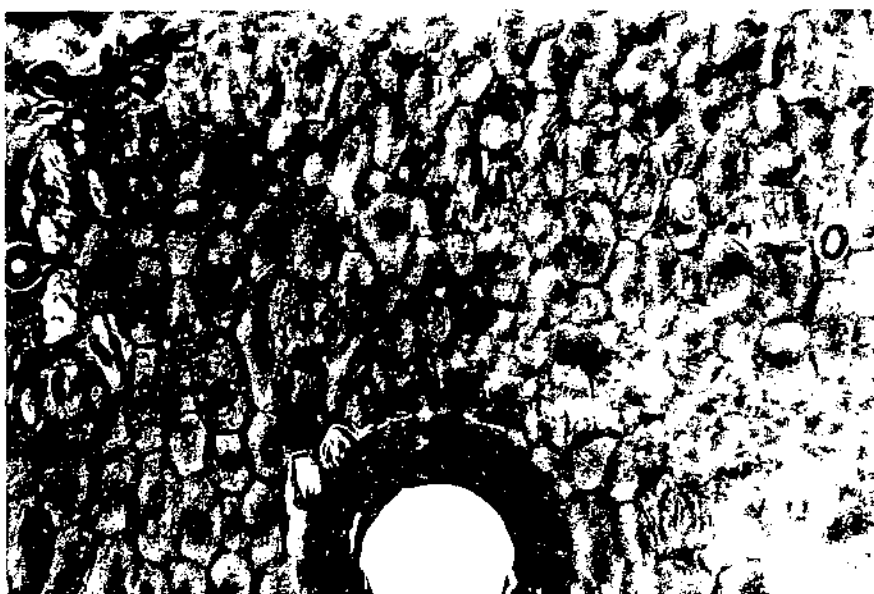


PN-6237

Resembles: Distinct



PN-6238



PN-6239

Characters: Perhaps easiest forb to identify; square stomata with large subsidiary cells.

END