

Stacy 10-1

A KEY TO EPIDERMAL CHARACTERS OF POINT REYES DEER FORAGE SPECIES

by

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Introduction

The following is a dichotomous key to the accompanying set of microphotographic prints of 60 species of plants considered to embody the main grassland diet of deer and cattle at Point Reyes National Seashore. It is to be used to identify microscopic epidermal plant fragments from the rumens of these animals for a food habits study.

The key is in partical fulfillment of a contract between the University of California, Davis, and the National Park Service at Point Reyes; and part of a three-year study on the effects of competition between three species of deer, and cattle at Point Reyes National Seashore.

The microphotographs are of epidermal fragments from the stem and both sides of the leaves of individual plants of each species. The fragments have been cleared, stained, and mounted on glass slides to form a permanent reference collection of Point Reyes plants. The slides were photographed through a microscope at magnifications of from 100 to 450 times.

The key presents a set of easily recognizable epidermal characters which are consistently defined and used. But the objectivity required of a key limits the kind of characters included. Some characteristics may be definitive, but subtle and difficult to put into a few words and therefore are not included. In the end, there is no substitute for experience.

- a. Cells definitely linear, parallel, and usually elongated.....1
- Not as above 1b

GRASSES, RUSHES, AND GRASSLIKE FORBS AND BROWSE

- 1. Stomata obvious.....15
- Stomata not obvious, or ill-defined, or extremely sparse.....2
- 2. Stomata encircled by small round cells unlike the bricklike cells of the rest of the epidermis..... Pinus muricata
- Not as above.....3
- 3. Covered by smooth balloon like unicellular asperites.....4
- Not as above.....5
- 4. Asperites always convex and often round..... Distichlis spicata
- Asperites usually elongated and often constricted in the middle Iris Douglasiana
- 5. More than two consecutive suberised short cells over the veins.Danthonia californica
- Not as above.....6
- 6. Covered with hairs..... Holcus lanatus
- Not covered with hairs.....7
- 7. Cell outline distinct, and brick like in form and arrangement.....9
- Cell outline vague and wavy or blending.....8
- 8. Cells very wavy and with a dark spot in each..... Potentilla californica st
- Macro hair bases present Lupinus bicolor st
- 9. Cell walls undulating; short cells present.....10
- Cell walls undulating; no short cells present
- Cell walls smooth; no short cells present.....11
- 10. Many opals..... Deschampsia caespitosa
- No opals..... Festuca dertonensis 11
- 11. Cells net-like in shape and arrangement..... Juncus sp.ul
- Cell walls thick, mortar like..... Iris Douglasiana ul
- Cells not as above.....12
- 12. Short cells present.....13
- No short cells present.....14
- 13. Cell end walls (perpendicular)..... Festuca dertonensis 11
- Cell end walls often diagonal.....Polypogon monspeliensis st
- 14. Each long cell gathered..... Lolium perenne 11
- Long cell very long (at least 15 times as long as wide); thin cell wall..... Polypogon monspeliensis st
- Long cells relatively short, with thick cell walls..... Juncus phaeocephalus st

GRASSES ET AL (CONT)

15. Hairy-long hairs or thorn like asperites.....16
 Bald - no hairs, but sometimes very short rounded asperites.....19
16. Both short and long hairs.....17
 Short hairs only.....18
 Long hairs only; stomata in neat single rows...Bromus mollis & B. rigidus ul
17. Hairs mostly on or near veins.....Festuca dertonensis ul
 Hairs all over surface, small ones usually on veins; cells
 net like..... Holcus lanatus 11
18. Short thorn like hairs on veins only..... Lolium perenne ul
 Asperites all over surface.....Hordeum geniculatum 11
19. Stomata squarish and with sharp corners..... 20
 Stomata no as above (eg. streamlines or round)..... 23
20. Stomata irregularly distributed, smooth tapering; heavy
 cell walls.....Pteridium aquilinum st
 Stomata more or less in rows..... 21
21. Paired short cells, undulating lone cell walls.....Deschampsia caespitosa 11
 No short cells..... 22
22. Cell walls smooth; stomatal rows every 3-6 rows..... Juncus phaeocephalus
 Cell walls undulating; stomatal rows in bands of 9 every 6 rows or
 in pairs every 9-16 rows.....Juncus sp. 11, st
23. Long cells tapered so as to have a net like appearance.....24
 Not as above.....25
24. Very net-like, with stomata at junctions of long cells..... Poa annua ul
 Less net-like; many vertical and walls..... Poa annua 11
25. Long smooth, tapered cell; stomata in cell rows next to veins;
 stomata elongate.....26
 Not as above.....30
26. Short asperites along veins and sometimes elsewhere.....27
 No asperites.....28
27. Stomata about 12 intercostal rows apart; asperites thorn like
Phalaris tuberosa st, 11
 Stomata about 6 intercostal rows apart.....Aira caryophyllea 11
28. Cell walls undulating next to veins only; one or two rows of stomata
 next to veins..... Lolium perenne ul
 Cell walls not undulating anywhere..... 29
29. First non-epidermal layer of intercostal cells square....Phalaris tuberosa ul
 First non-epidermal layer of intercostal cell elongate..Hordeum geniculatum ul

GRASSES ET AL (CONT)

30. Cell walls appear serrated with black dots; stomata irregularly shaped..... Juncus sp. st
Not as above..... 31
31. More than two consecutive suberized short cells over veins,
alternating x- and dumbbell shaped.....Danthonia californica ull
Not as above..... 32
32. Hairs or asperites..... 33
Bald..... 34
33. Short rounded asperites along veins; very undulating cell walls;
cells arranged in bricklike layers, couplets every other long
cell or stoma.....Aira caryophylleg ul
Long hairs between long cells in non-stomatal rows; very round short cells
mark bases of hairs..... Bromus mollis st
34. High density of couplets over veins.....35
Low or medium density of couplets.....36
35. Subsidiary cells parallel sided; cell wall sharply undulating
..... Festuca dertonensis st 11
Subsidiary cells dome shaped; cell walls mildly undulating
.....Festuca arundinacea st, ull
36. Veins pronounced; stomata in relatively regular rows.....37
Veins not pronounced; stomata in relatively regular rows..Juncus bufonis st, 11
37. Very sharply undulating cell walls; stomata within a row often separated by
short cells otherwise identical to long cells; subsidiary cells
often parallel sided and shorter than guard cells..Hordeum geniculatum et
Not as above.....38
38. One or two stomatal rows between each vein in about 8 rows..Bromus rigidus st
Four or five stomatal rows between each vein in about 10 rows.....
..... Polypogon monspeliensis 11
- Two to four stomatal rows between each vein in about 18 rows..... Poa annua st

FORBS AND BROWSE

4.

- 1b. Hairs, asperites, or wooly fuzz 2
No hairs, or asperites, but may be macrohair bases 24
2. Wooly fuzz 3
No wool 4
3. One black spot in center of each guard cell; other black spots; small hairs only slightly larger than stomata and larger hairs -- about 40 times the size of stomata Cirsium vulgare 11

No other hairs; stomata dark all over; linear cell pattern on stem Eriogonum latifolium st 11

Smooth polygonal cells Carduus pycnocephalus ull
4. Hairs very large -- at least 40 times the size of the stomata 5
Hairs small or medium -- 10 or 20 times the size of the stomata 8
5. Hairs unicellular 6
Hairs multicellular 7
6. Hairs in a whole range of sizes; black speckles; long thin hairs and stubbier ones; also short mushroom like glandular hairs Geranium dissectum ull

Hairs longitudinally striated but transparent, stomata small and elliptical; some black flecks Hypochoeris radicata ull

Hairs longitudinally striated and opaque, tiny, thorn shaped, stomata sized hairs; dark spot at center of each polygonal cell Cirsium vulgare ul
7. Hairs sparse and of two types: large ones broken off after three cells, small ones whole; stomata only about 1/10th the area of other epidermal cells; darkly outlined; cell walls smooth . Stellaria media ul

Hairs in a range of sizes, many with suction cup like glands; stomata only slightly smaller than other epidermal cells.
Cell walls slightly undulating Madia elegans ull
8. Globular asperites cover entire surface 9
Asperites, if any, do not cover entire surface 10
9. Linear cell pattern; asperites elongate, often constricted in the middle Iris Douglasiana 11

Non-linear cell pattern, veins branching; asperites round; macro hair bases Salix lasiolepis 11
10. Dark staining asperites shaped like mountaineer's hat; elliptical stomata each with a pair of large non-staining paracytic subsidiary cells Cystisus scoparius st

No asperites 11

11. Hairs at least 15 times longer than wide. 12
 No long hairs 19
12. Hairs sometimes in pairs; bases polygonal and dark,
 rest transparent Sidalcea malvaeflora st, ull
 Single hairs not as above 13
13. Hairs sparse 14
 Hairs densely distributed 15
14. Hairs restricted to veins; cells regular . . . Lonicera hispidata 11
 Hairs not restricted to veins; cell walls
 sharply undulating Vicia angustifolia 11
15. Hairs with pale ring around base . . . Pteridium aquilinum ul
 No pale ring 16
16. Stem like, linear cell pattern 17
 Not linear 18
17. Cell walls indistinct; lines of cells seem to diverge
 where hairs emerge Frageria californica st
 Cell walls distinct; cells do not diverge; stomata
 like deer tracks Ranunculus californica st
18. Hairs mostly on veins; very stiff looking . . . Frageria californica 11
 Hairs all over, emerge from whorls of cells; paracytic
 stomata same size as epidermal cells . . . Ranunculus californica ull
 Hairs emerge from circle of non-whorled regular
 cells, anomocytic stomata smaller than other
 epidermal cells Lupinus bicolor
19. Cells jigsaw shaped 20
 Cells regular or linear 21
20. Hairs densely distributed, heavy, thornlike, and restricted to veins;
 few if any stomata Pteridium aquilinum 11
 Hairs few, round, and deflated looking; stomata very numerous
 and paracytic Vaccinium ovatum 11
21. Cells regular except over veins (where elongate) 22
 Cells linear (stem). 23
22. Hairs short, delicate, deflated looking, many, over veins only; cells
 slightly larger than stomata; stomata paracytic and only on
 lower leaf Polygonum sp. ull
 Hairs sparse, not much longer than linear vein cells from which
 they emerge Ceanothus thrysiflorus 11
23. Hairs straight and sparse; stomata paracytic;
 cells elongate Geranium dissectum st
 Hairs short and very densely distributed; cells
 roundish and arranged in corn rows . . . Rhamnus californica st

24.	Macro hair bases; cells regular	25
	Not as above	35
25.	Macro hair bases of varying sizes; cells elongate, blending into one another	26
	Not as above	27
26.	Macro hair bases and cell walls very smooth; cells elongate and wavy <u>Lupinus bicolor</u> st	
	Macro hair bases irregularly shaped; cell walls rough <u>Baccharis pilularis</u> st	
27.	Cells elongate and arranged linearly in alternating bands of two types: shorter, fatter cells, and macrohair bases; and longer, thinner cells, and no more macro hair bases. <u>Polygonum</u> sp st	
	Not as above	28
28.	Stomata	29
	No stomata	32
29.	Stomata about same size as other epidermal cells	30
	Stomata much smaller than other epidermal cells; no obvious subsidiary cells	31
30.	Cells smooth polygons; stomata, anomocytic and egg shaped <u>Rumex Acetosella</u> ull	
	Cells smooth or slightly rough polygons; stomata anomocytic and round <u>Lupinus bicolor</u> ll	
31.	Cell walls smooth; cells polygon to star shaped; stomata paracytic <u>Myrica californica</u> ll	
	Cell walls smooth; cells appear to flow around stomata and into macro hair bases, which often extend upward in piles of round cells; stomata paracytic <u>Baccharis pilularis</u> ll	
32.	Macro hair bases larger than other epidermal cells	33
	Macro hair bases same size as other epidermal cells	34
33.	Cell walls smooth; cells tend to be rectangular or elongate; surface muddy looking <u>Salix lasiolepis</u> ul	
	Cell walls distinct and minutely indulating; cells tend to be triangular, often in pairs <u>Myrica californica</u> ul	
34.	Veins straight and at right angles to one another <u>Polygonum</u> sp. ul	
	Veins straight or curved and branching off at a variety of angles <u>Rubus vitifolius</u> ul	
35.	Cells elongate and or linearly arranged throughout (as stems)	36
	Cells not linear except over veins	58
36.	Cell walls smooth	37
	Not as above	55
37.	Cell walls very smooth and indistinct; cells wavy	38
	Not as above	39

38. Buckwheat pancake type black flecks all over; stomata
anomocytic Vicia angustifolia st
Each cell with one black spot in it; stomata
not apparent Potentilla californica st
39. No stomata 40
Stomata 43
40. Cells rectangular 41
Not as above 42
41. Cell walls thick; cells in bricklike arrangement Iris Douglasiana ul
Cell walls thinner; some cells with diagonal
end-walls to give an almost dogtooth pattern . . . Spergularia sp st
42. Cell walls thick; cells elongate and blending into
one another Polystichum munitum st
Small polygonal cells in discontinuous and
slightly curving rows Alnus rubra st
43. Stomata lock zipped and paracytic . . . Equisetum Telmateia st, ul
Not as above 44
44. Majority of cells in strict rows 45
Not as above 47
45. Cells elongate 46
Cells not elongate; cells in bands of two types:
linear and not so linear. Conium maculatum st
46. Cell walls unusually thick; stomata squarish . Pteridium aquilinum st
Cell walls somewhat indistinct; cells brick-like
in shape and arrangement; stomata surrounded by several
small distorted cells; surface mottled and speckled Medicago hispida st
47. Cell walls unusually thick; stomata anomocytic and slightly
smaller than other epidermal cells . . . Madia elegans st, ul
Not as above 48
48. Cells short small polygons in corn rows; stomata, including
subsidiary cells, somewhat larger than other epidermal
cells Lonicera hispidata st
Not as above, most cells elongate 49
49. Stomata definitely smaller than other epidermal cells 50
Stomata close to the size of other epidermal cells 52
50. Most cells long and slender, and a few evenly
distributed blimp shaped ones; stomata tucked
in interstices Castilleja franciscana st
Not as above 51
51. Cells usually at least 5 times as long as wide; stomata
assymetrical Anagallis arvensis st
Cells usually no more than 4 times as long as wide;
cells often in pairs Lotus corniculatus st

52. One or two black spots on each cell, not necessarily in the center Silybum marianum st
Not as above 53
53. Cells roughly brick or carrot shaped; usually 4 or 5 times as long as wide; stomata dark and assymetrical; bands of cells in two patterns Chenopodium sp st
Not as above 54
54. Cells elongate polygons 2 to 10 times as long as wide; stomata paracytic, irregularly spaced, with linear subsidiary cells Trifolium Wormskjoldii st
Cells elongate polygons 2 to 5 times as long as wide; stomata rare, surrounded by several small cells; opals Erechetites prenanthoides st
55. Cells in strict rows 56
Cells in discontinuous rows 57
56. Cells brick-like in shape and arrnagement; stomata in single rows; each stoma encircled by roundish cells . Pinus muricata needle
Extremely grasslike; cells brick-like; short cells; irregularly distributed stomata, with grass-like stomata Armeria merittima st
57. Cell walls indistinct and undulating largely; cells rumpled looking; stomata anomocytic assymetric and eliptical; buckwheat pancake pattern of black flecks Vicia angustifolia ul
Cell walls very distinct and non-staining; cells, stain darkly, vary from star-shaped to long and thin; where stomata are present more cells are jigsaw shaped Polystichum munitum ull
58. Cell walls smooth; usually polygonal 59
Cells walls undulating; usually jigsaw shaped 77
59. Cells covered with black flecks 60
Cells not covered with black flecks 64
60. Each cell contains a roseate cluster, often with a dark center; stomata absent Frageria californica ul
Stomata 61
61. Stomata much smaller than other epidermal cells 62
Stomata about same size as other epidermal cells 63
62. Cell walls thin, and curved or straight; stomata egg-shaped Rumex Acetoselle st, ll
Cells very straight sided and polygonal; one or two dark flecks per cell; stomata anisocytic, apple-like, dark border Silybum marianum ll
Stomata less darkly bordered Carduus pycnocephalus ul

63. Cell walls indistinct; many large dark spots per polygonal cell; stomata elliptical, paracytic . . . Hypochaeris radicata st
One or two large spots and many tiny flecks per cell;
stomata apple-shaped, anomocytic . . . Plantago lanceolate
64. Stomata 65
No stomata 74
65. Stomata smaller than other epidermal cells 66
Stomata about same size as other epidermal cells 70
66. Stomata anisocytic Silybum marianum ul
Stomata not anisocytic 67
67. Stomata round 68
Stomata elliptical 69
68. Great variation in size of cells; stomata same size as smallest and 1/5th of largest . . . Medicago hispida ll
Cells polygonal to round, most about 8 times size of stomata Lupinus bicolor ll
69. Cell walls indistinct; some cells irregular Potentilla californica ll
Cell walls distinct, curved; cells even dimensioned polygons . . . Lotus corniculatus ull or Trifolium Wormskjoldii ull
70. Stomata anomocytic Eriogonum latifolium ul
Stomata paracytic, with linear subsidiary cells 71
71. Intricate venation 72
No intricate venation 73
72. Cell walls distinct; vein cells in pairs; stomata look protuberant Rhamnus californica ll
Cell walls indistinct in places; vein cells brick-like; stomata look flat or recessed Alnus rubra ll
73. Stomata round Castilleja franciscana ll
Stomata elliptical Ceanothus thrysiflorus st
74. Cells not so regular 75
Cell walls distinct; cells smooth polygons 76
75. Cells roundish with a line through each, like cats' eyes Rhamnus californica ul
Cell walls thin; cell somewhat irregular in shape though not undulating or jigsaw shaped . . . Potentilla californica ul
76. Intricate venation; some cells in pairs; vein cells often identical to other epidermal cells . . . Ceanothus thrysiflorus ul
Cell walls generally straight; many cells in pairs or quadruplets; vein cells brick-like Alnus rubra ul

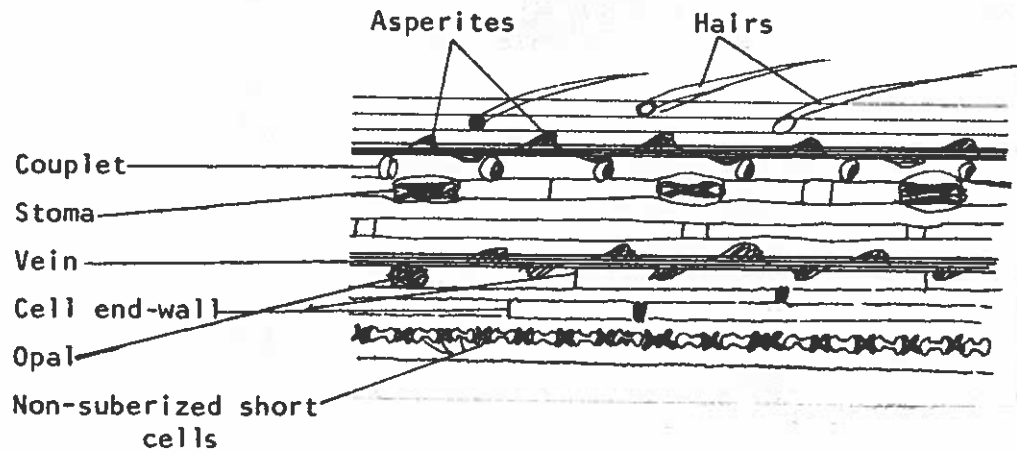
- Cell walls more curved; cells independent; vein cells
elongate but rounded Lonicera hispidata ul
77. No stomata 78
Stomata 79
78. Cell walls thin; cells perfectly jigsaw shaped . Gaultheria Shallon ul
Cell walls thicker, more shallowly undulating;
cells even dimensioned Vaccinium ovatum ul
79. Cells shaped so that surface appears to be fractured
along lines radiating from points regularly spaced between
stomata; cell walls undulating; cells tend to be triangular;
stomata same size as, or larger than, other
epidermal cells Eriogonum latifolium ll
Not as above 80
80. Stomata about same size as other epidermal cells 81
Stomata smaller than other epidermal cells 84
81. Stomata puckered or bumpy and anomocytic . . . Chenopodium sp, ull
Not as above 82
82. Perfect jigsaw shaped cells; stomata paracytic . Gaultheria Shallon ll
Not as above 83
83. Cells assymetric and angular; stomata anomocytic,
elliptical but not always symetrical Anagallis arvensis ll
Cells assymetric and less angular in undulations;
stomata rounder Conium maculatum ull
84. Stomata diacytic Spergularia sp ull
Not as above 85
85. Stomata with a black spot in center of each
guard cell Erechtites prenanthoides ull
Not as above 86
86. Stomata anisocytic; cells smoothly jigsaw shaped
with black flecks Castilleja franciscana ll

ABBREVIATIONS:

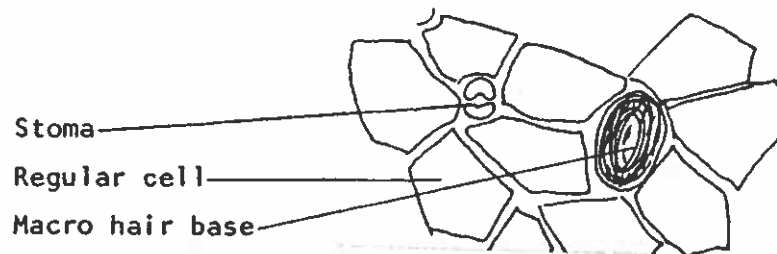
st stem
ll lower leaf = underside of leaf
ul upper leaf = top side of leaf
ull upper and lower leaf

GLOSSARY OF EPIDERMAL CHARACTERS

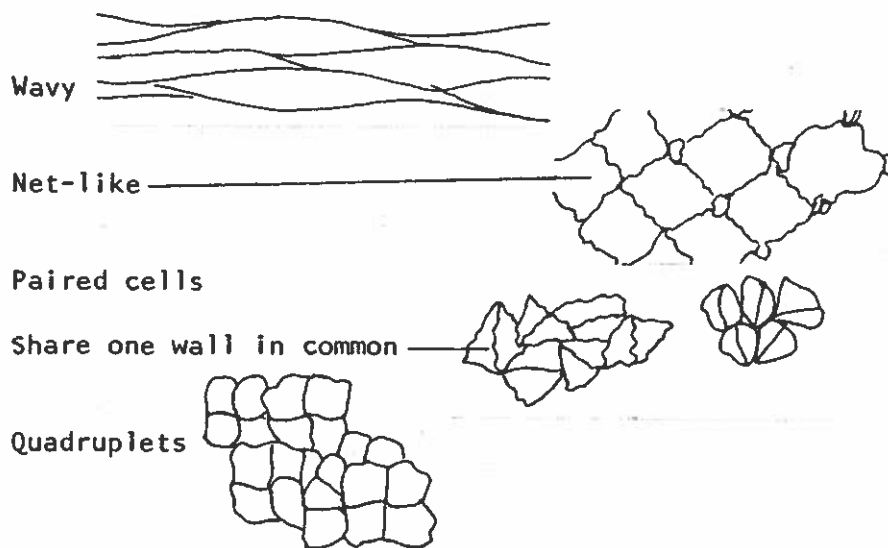
GRASS



FORB



CELL PATTERNS



GLOSSARY OF EPIDERMAL CHARACTERS

CELL TYPES

Even dimensioned cells are those whose perimeters are very roughly everywhere the same distance from the center.

Polygonal cells are ~~even~~ convex and flat sided, and even dimensioned unless otherwise stated.

Regular cells are even dimensioned, polygonal, and all about the same size.

Brick-like cells are rectangular.

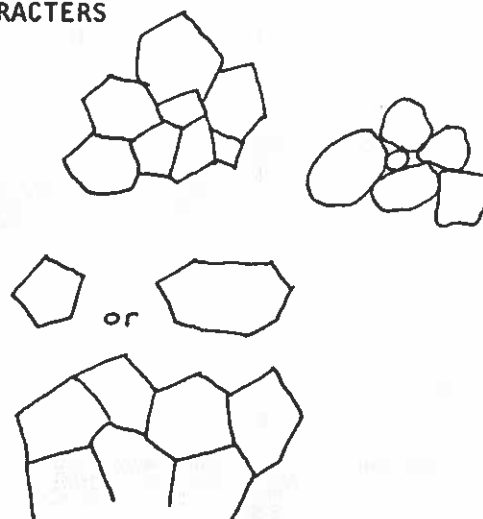
Linear



Jigsaw-shaped



Gathered



CELL WALL TYPES

Undulating: sharply



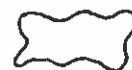
mildly



Smooth



largely



minutely



HAIRS

Long



Short



Thorn-like



Mushroom-like



Glandular

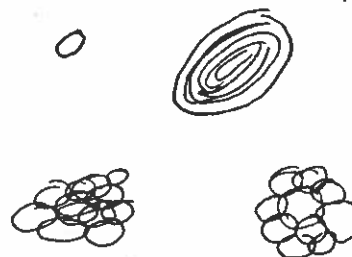
Macro hair bases are the specialized cell bases of macro hairs which have commonly fallen off.

ASPERITES

usual



Mountaineer's hat



GLOSSARY OF EPIDERMAL CHARACTERS

STOMATAL TYPES

Anomocytic stomata have no specialized subsidiary cells.

Anisocytic stomata have subsidiary cells of a variety of sizes.

Paracytic stomata have two matched subsidiary cells.

Diacytic stomata are positioned at right angles to the juncture between the two adjacent cells.

Elliptical



Deer track shaped



Round



Apple-like



Egg-shaped



Puckered



Square



Zippered



Assymetric stomata seem to have guard cells of different shapes or sizes.

VEINATION

Intricate

