Identification keys

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Successful use of the keys depends on the correct preparation of specimens, as described in the methods, so that specific characters can be seen.

Key to related genera in the *Grimmiaceae*

1. Cells in the leaf base elongate with conjointly thickened and sinuose walls; seta in dry state, seen in surface view, twisted from the right side below to the left side above..... ..... ***Racomitrium***

1a. Cells in the leaf base never elongate with conjointly thickened and sinuose walls; seta not as above 2

2. Costal cells in transverse section scarcely differentiated; seta in a dry state not twisted, at capsule dehiscence columella remains attached to operculum ..... ***Schistidium***

2a. Costal cells in transverse section differentiated; seta in a dry state twisted from the left side below to the right side above, at capsule dehiscence columella not attached to operculum ..... ***Grimmia***

Key to species of *Grimmia,* for plants bearing sporophytes

Due to the lack of sporophytes the following species are excluded from this identification key: *G. handelii, G. maido, G. nepalensis, G. pulla, G. torquata, G. tortuosa.*

Plants examined in a dry state and then in a wet state.

1. Seta straight 2

1a. Seta not straight 23

2. Seta elongate, longer than the capsule, capsule smooth..... 3

2a. Seta short, approximately same length as capsule, capsule smooth 21

3. Costa, seen in transverse section, at insertion with more than 8 basal cells, most of them being guide cells, costa, seen on dorsal side, indistinct from above leaf base to apex..... 4

3a. Costa, seen in transverse section, at insertion with 8, 6 or 4 basal cells, or 4 basal cells, the 2 outer ones contiguous with the basal cells, all being guide cells; costa, seen on dorsal side, distinct from leaf base to apex 7

4. Margin **(Fig. 23.7)** from insertion to transitional part on one side recurved; leaf, seen in transverse section **(Fig. 23.11)**, in laminal part bistratose with tristratose patches in places; leaf lingulate **(Fig. 23.5)**, apex rounded, rarely acute, hair-point bluntly denticulate. Calyptra cucullate, lobed; operculum conical, beak long, oblique ..... **23. *G. khasiana***

4a. Margin plane throughout; lacking above combination of characters 5

5. Leaf base short, ≈ 1/5 of leaf length **(Fig. 25.5)**; half-sheathing, in sheathing part cells toward margin transversely rectangular or oval **(Fig. 25.10)**, transverse walls thicker than longitudinal walls; margin **(Fig. 25.11)** unistratose from leaf base to below apex; in laminal part the 2 guide cells sunken in narrow channel, their adaxial cell walls strongly thickened. Calyptra mitrate, lobed; operculum conical, beak straight, blunt ..... **25. *G. laevigata***

5a. Leaf base long, ≈ 1/3 of leaf length; lacking above combination of characters..... 6

6. Apex muticous, rounded **(Fig. 51.5)**; costa, seen in transverse section, cells uniform **(Fig. 51.9)**, hydroids lacking. Calyptra mitrate, lobed, fugacious; operculum conical, beak short or elongate, straight ..... **51. *G. unicolor***

6a. Apices with denticulate hair-points of different lengths **(Figs. 38.7, 38)**; costa, seen in transverse section **(Fig. 38.14)**, cells not uniform, a central group of hydroids present. Calyptra cucullate; operculum conical, beak long, oblique ..... **38. *G. ovalis***

7. Costa, seen in transverse section **(Fig. 6.27)**, at insertion with 8 guide cells; apex muticous **(Fig. 6.6)**, acute, rarely cucullate; costa stout with a median band of substereids; bistratose alar cells **(Fig. 6.10)** on both sides, on one side only **(Fig. 6.13)**, or without alar cells **(Fig. 6.12)**. Calyptra mitrate-campanulate; operculum conical, rostrate, beak short or long, straight or oblique..... **6. *G. atrata***

7a. Costa, seen in transverse section, at insertion with 6 or 4 guide cells, or with 4 guide cells, the 2 outer ones contiguous with basal cells 8

8. Costa, seen in transverse section, at insertion with 6 guide cells.....9

8a. Costa, seen in transverse section, at insertion with 4 guide cells, or with 4 guide cells, the 2 outer ones contiguous with basal cells..... 11

9. Stem without central strand **(Fig. 20.4)**; cortical cells large, nearly uniform, sharply differentiated from brownish epidermis, constituted by at least 2 rows of stereids with very narrow lumina; cells in the leaf base **(Fig. 20.13)** short rectangular to isodiametric, walls smooth; occasionally with multicellular clusters **(Fig. 20.3)** of rounded gemmae at apex. Calyptra cucullate-mitrate; operculum conical, beak long, straight..... **20. *G. hartmanii***

9a. Stem with central strand; lacking above combination of characters 10

10. Basal paracostal cells rectangular **(Fig. 8.15)**, becoming shorter and nearly quadrate to the margin, walls smooth; costa, seen in transverse section **(Fig. 8.17)**, in laminal part on dorsal side prominent, rounded. Calyptra cucullate; operculum convex, mammillate..... **8. *G. bicolor***

10a. Basal paracostal cells elongate-rectangular **(Fig. 27.31)**, walls nodulose, transverse cell walls markedly thin; costa, seen in transverse section **(Fig. 27.47)**, in lower laminal part unevenly rounded or slightly angulate. Calyptra mitrate; operculum conical, rostellate, beak straight or slightly oblique ..... **27. *G. longirostris***

11. Costa, seen in transverse section, at insertion with 4 guide cells..... 12

11a. Costa, seen in transverse section, at insertion with 4 guide cells, the 2 outer ones contiguous with basal cells..... 20

12. Lamina, seen in surface view, striate; lamina cells, seen in transverse section **(Fig. 4.9)**, papillose and with joint thickenings; occasionally with multicellular clusters **(Fig. 4.1)** of rounded gemmae at apex. Calyptra cucullate-mitrate; operculum conical, beak long..... **4. *G. anomala***

12a. Lamina, seen in surface view, not striate; lacking above combination of characters..... 13

13. Lamina cells, seen in transverse section, bulging or mammillose..... 14

13a. Lamina cells, seen in transverse section, smooth 16

14. Lamina cells, seen in transverse section **(Fig. 5.14)**, bulging; margin plane throughout; costa, seen on dorsal side **(Fig. 5.4)**, of nearly uniform width; hair-points **(Fig. 5.7)** of different lengths, sharply denticulate. Calyptra not seen; operculum conical, rostrate, beak oblique ..... **5. *G. asperitricha***

14a. Lamina cells, seen in transverse section, mammillose; lacking above combination of characters 15

15. Margin in upper part of leaf inflexed **(Fig. 9.13)**; costa, seen on dorsal side **(Fig. 9.7)**, small in leaf base, enlarged in apical part; hair-points **(Fig. 9.8)** short, nearly smooth; secondary costae **(Fig. 9.10)** present occasionally in lower half of leaf. Calyptra cucullate, small, fugacious; operculum conical, obtuse..... **9. *G. caespiticia***

15a. Margin in upper part of leaf **(Fig. 35.10)** slightly incurved; costa, seen on dorsal side, stout in leaf base, becoming strikingly enlarged **(Figs. 35.19, 24, 26)** in upper laminal part; hair-points short, denticulate; secondary costae lacking. Calyptra not seen; operculum conical, blunt ..... **35. *G. nivalis***

16. Margin plane or incurved..... 17

16a. Margin recurved on both sides or on one side only..... 18

17. Margin plane; basal paracostal cells elongate-rectangular **(Fig. 14.7)**; toward margin some rows of elongate-retangular, hyaline cells, longitudinal and transversal cell walls evenly thin and smooth, the rows gradually vanishing, the outermost row reaching to above broadest part of leaf, thus forming between the hyaline and thicker walled chlorophyllose cells a delimitation, running obliquely from costa to margin; leaf in lower laminal part keeled **(Fig. 14.9)**, in upper part narrowly so. Calyptra mitrate, lobed; operculum conical, mammillate ..... **14. *G. donniana***

17a. Margin **(Figs. 32.15, 18)** from leaf base to apex gradually strongly incurved on both sides; basal paracostal cells **(Fig. 32.10)** rectangular, toward margin cells becoming short-rectangular or quadrate; leaf in lower part concave, in upper part keeled. Calyptra cucullate; operculum conical, rostrate or rostellate, beak straight or oblique..... ..... **32. *G. montana***

18. Margin **(Fig. 8.14)** recurved from insertion to mid-leaf on one side, on the opposite side recurved in mid-leaf only; basal cells **(Fig. 8.24)** rectangular, becoming shorter toward margin; costa, seen in transverse section **(Fig. 8.17)**, on dorsal side in leaf base rounded, in laminal part prominent. Calyptra cucullate; operculum convex, mammillate..... ..... **8. *G. bicolor***

18a. Margin recurved on one side only; lacking above combination of characters 19

19. Basal paracostal cells **(Fig. 27.9)** elongate-rectangular, walls nodulose, transverse cell walls markedly thin; marginal cells quadrate to rectangular; costa, seen in transverse section **(Fig. 27.47)**, in lower laminal part unevenly rounded or slightly angulate. Calyptra mitrate; operculum conical, rostellate, beak straight or slightly oblique..... ..... **27. *G. longirostris***

19a. Basal paracostal cells **(Fig. 16.10)** elongate-rectangular, walls smooth or weakly nodulose, transverse walls thickened; at margin 3-4 rows of narrowly elongate-rectangular, hyaline, thin-walled cells, gradually vanishing, the outermost row ascending to above broadest part of leaf, the marginal cells gradually becoming short-rectangular to quadrate; costa, seen in transverse section **(Fig. 16.41)**, in lower laminal part rounded, smooth. Calyptra mitrate-cucullate; operculum conical, blunt ..... **16. *G. elongata***

20. Lamina appearing striate due to variable stratosity; margin plane, erect in upper part of leaf; costa, seen in transverse section **(Fig. 2.11)**, in laminal part on dorsal side prominent, somewhat angulate, on ventral side recessed in furrow. Calyptra cucullate, fugacious; operculum conical, blunt ..... **2. *G. alpestris***

20a. Lamina appearing not striate; margin **(Fig. 22.12)** at leaf base slightly recurved on one side; costa, seen in transverse section **(Fig. 22.13)** of the laminal part of leaf, with exterior cell walls markedly thicker than the interior cell walls, lamina ending as subula **(Fig. 22.30)**, the cells being homogeneous. Calyptra conico-mitrate, lobed; operculum conical, blunt ..... **22. *G. incurva***

21. Margin **(Figs. 40.9-10)** on one or both sides recurved; leaf, seen in transverse section **(Fig. 40.10)**, in laminal part broadly keeled or keeled, at insertion 6-8 basal cells **(Fig. 40.17)**, 2 of them with enlarged lumina, arranged in leaf axis and reaching apex, no hydroids. Calyptra not seen; operculum conical, rostrate ..... **40. *G. pilifera***

21a. Margin plane; lacking above combination of characters 22

22. Leaf concave throughout **(Fig. 47.7)**; basal paracostal cells **(Fig. 47.8)** rectangular, walls smooth, at insertion near margin cells short-rectangular or isodiametric, walls smooth; in laminal part, seen in transverse section **(Fig. 47.9)**, the 2 guide cells only slightly distinct or indistinct from the lamina cells, due to similarity with the contiguous lamina cells. Calyptra mitrate; operculum conical, rostrate or rostellate, beak straight..... ..... **47. *G. tergestina***

22a. Leaf concave in leaf base **(Fig. 24.12)**, above broadest part broadly keeled; basal cells **(Fig. 24.20)** from costa to margin elongate-rectangular, thick-walled, more or less nodulose; in laminal part, seen in transverse section **(Fig. 24.33)**, the 2 guide cells distinct, different from the contiguous lamina cells. Calyptra not seen; operculum conical, beak long, oblique ..... **24. *G. kidderi***

23. Seta arcuate, curved 24

23a. Seta inclined or in an S-form, approximately of same length as capsule 48

24. Capsule smooth 25

24a. Capsule shrivelled or ribbed 27

25. Margin **(Fig. 28.6)** recurved from above leaf base to mid-leaf on one side; revolute from insertion to mid-leaf on opposite side; apex acute, apiculate or with short **(Fig. 28.5)**, hyaline greenish or brownish tinged hair-points, or with elongate hair-points appearing twisted by somewhat obliquely arranged cells, decurrent in apical part as border of 2 rows of elongate-rectangular thick-walled cells, distally bluntly protruding, lumina distinct in all shapes of hair-points; lamina, seen in transverse section **(Fig. 28.9)**, with smooth cells. Calyptra cucullate; operculum conical, beak straight, blunt .... **28. *G. macrotheca***

25a. Margin recurved on one side from insertion to mid-leaf; lacking above combination of characters 26

26. Basal cells **(Fig. 18.7)** rectangular, walls more or less nodulose; leaf, seen in transverse section, lamina cells smooth **(Fig. 18.28)** or lamina cells slightly bulging on dorsal and ventral sides **(Fig. 18.9)**, above broadest part of leaf guide cells narrowly elliptical, obliquely arranged to leaf axis. Calyptra mitrate, lobed; operculum conical, beak obtuse, of different length ..... **18. *G. fuscolutea***

26a. Basal cells **(Fig. 39.7)** short-rectangular, walls smooth; leaf, seen in transverse section, lamina cells mammillose **(Fig. 39.8)**, lamina irregularly bistratose by doubled longitudinal cell rows, appearing in surface view **(Fig. 39.9)** as irregular ridges on lamina; guide cells horizontally arranged. Calyptra not seen in mature state; operculum conical, blunt ..... **39. *G. percarinata***

27. Capsule shrivelled; leaf markedly narrowed at insertion **(Fig. 11.6)**, widest above mid-leaf, apex rounded, hyaline to variable extent; basal cells **(Fig. 11.9)** from costa to margin elongate-rectangular, walls smooth; seen in transverse section **(Fig. 11.13)**, leaf at insertion and in leaf base concave, in laminal part keeled, margin unistratose throughout, plane or slightly recurved in upper part of lamina; costa **(Fig. 11.25)** passing through hyaline apical part excurrent into faintly denticulate hair-point. Calyptra cucullate; operculum conical, beak short, obtuse ..... **11. *G. crinita***

27a. Capsule ribbed; lacking above combination of characters 28

28. Costa, seen in transverse section **(Figs. 15.10, 19-20, 24)**, at insertion a variable number of 6-8 basal cells, 2-3 of them are guide cells; dorsally added is a second row of 2-3 cells with large lumina, the other costal cells nearly uniform, neither stereids nor hydroids present; lamina bistratose in upper part **(Fig. 15.10)**, cells mostly mammillose, rarely smooth. Calyptra mitrate, lobed, conical; operculum conical, beak long, straight ..... **15. *G. elatior***

28a. Costa, seen in transverse section, at insertion with 6-8 basal cells, all are guide cells; lacking above combination of characters 29

29. Costa, seen in transverse section, at insertion with 8 guide cells 30

29a. Costa, seen in transverse section, at insertion with 6 guide cells or less than 6 guide cells 32

30. Costa, seen in transverse section **(Fig. 45.9)**, on dorsal side in upper part of lamina strongly winged; costal cells in the winged part uniform, the adaxial walls of costal cells markedly thickened; hydroids lacking throughout. Calyptra not seen; operculum rostrate, beak oblique ..... **45. *G. ramondii***

30a. Costa, seen in transverse section, on dorsal side in upper part of lamina not winged; lacking above combination of characters 31

31. Costa, seen in tranverse section **(Fig. 26.29)**, on dorsal side rounded throughout; basal cells **(Fig. 26.34)** rectangular to short-rectangular, at margin 1-2 rows of very short rectangular to quadrate cells, walls mostly smooth, occasionally slightly nodulose. Calyptra mitrate; operculum conical, beak long, straight. Propagule development on dorsal side of leaf base ..... **26. *G. lisae***

31a. Costa, seen in transverse section **(Fig. 12.38),** on dorsal side in upper part of lamina slightly angulate or uneven; basal cells **(Fig. 12.8)** markedly elongate, walls thickened, nodulose, toward margin a sharply contrasting band of several rows of short-rectangular and quadrate cells, walls thickened. Calyptra mitrate; operculum conical, subulate, beak straight. Propagule development lacking..... **12. *G. decipiens***

32. Costa, seen in transverse section, at insertion with 6 guide cells..... 33

32a. Costa, seen in transverse section, at insertion with less than 6 guide cells..... 36

33. Basal cells markedly elongate 34

33a. Basal cells not markedly elongate..... 35

34. Basal cell walls **(Fig. 12.8)** nodulose, thickened, toward margin a sharply contrasting band of several rows of short-retangular and quadrate cells present, walls thickened; margin **(Fig. 12.14)** on one side revolute from insertion to mid-leaf, on opposite side recurved; costa, seen in transverse section **(Fig. 12.13)**, on dorsal side in upper part of lamina slightly angulate or uneven. Calyptra mitrate; operculum conical, subulate, beak straight..... **12. *G. decipiens***

34a. Basal cell walls **(Fig. 1.6)** smooth, not thickened, from costa toward margin uniform; margin **(Fig. 1.5)** on both sides from insertion to mid-leaf more or less strongly revolute; costa, seen in transverse section **(Fig. 1.8)**, in upper part of lamina on dorsal side smooth. Calyptra mitrate; operculum conical, beak obtuse ..... **1. *G. abyssinica***

35. Basal cells **(Fig. 26.21)** rectangular to short-rectangular, walls smooth or slightly nodulose; costa, seen on dorsal side **(Fig. 26.6)**, stout, diminishing in apical part, seen in transverse section **(Fig. 26.22)**, on dorsal side smooth throughout; lamina, seen in surface view, not striate. Calyptra mitrate; operculum conical, beak long, straight. Propagule development on dorsal side of leaf base..... **26. *G. lisae***

35a. Basal cells **(Fig. 36.7)** from costa to margins short-rectangular to quadrate, walls smooth; costa, seen on dorsal side **(Fig. 36.5)**, at insertion and in leaf base stout, diminishing in laminal part, seen in transverse section **(Fig. 36.8)**, on dorsal side in leaf base uneven, in laminal part exterior cell walls bulging; lamina, seen in surface view, striate due to variable stratosity. Calyptra cucullate-lobed; operculum conical, beak long, oblique. Propagule development lacking..... **36. *G. nutans***

36. Costa, seen in transverse section, at insertion with 4 guide cells..... 37

36a. Costa, seen in transverse section, at insertion with 4 guide cells, the 2 outer ones contiguous with basal cells..... 45

37. Margin plane; costa, seen in transverse section **(Fig. 44.10)**, from insertion to mid-leaf the 2 median guide cells of narrow elliptical shape in mid-leaf arranged obliquely to leaf axis; basal paracostal cells **(Fig. 44.7)** elongate-rectangular, walls nodulose, in transitional part **(Figs. 44.9, 21)** cells rectangular, small, walls sinuose; stem leaves arranged in tiers. Calyptra mitrate; operculum conical, beak short ..... **44. *G. pygmaea***

37a. Margin recurved on one side or on both sides; lacking above combination of characters 38

38. Margin recurved on one side 39

38a. Margin recurved on both sides 42

39. Costa, seen in transverse section **(Fig. 31.9)**, from insertion to apical part the 2 median guide cells of narrow elliptical shape, from above leaf base to apical part arranged obliquely to leaf axis; basal paracostal cells **(Fig. 31.20)** elongate-rectangular, walls thickened, nodulose, in transitional part **(Fig. 31.8)** cells short-rectangular, walls sinuose; stem leaves arranged in tiers. Calyptra mitrate, lobed; operculum conical, rostrate, beak straight. Propagule development on dorsal side of leaf base..... **31. *G. meridionalis***

39a. Costa, seen in transverse section, from insertion to apical part the guide cells of rounded shape, arranged horizontally to leaf axis; lacking above combination of characters..... 40

40. Costa, seen in transverse section **(Fig. 7.11)**, cells uniform except for guide cells, hydroids lacking; basal cells **(Fig. 7.14)** elongate-rectangular, thick-walled, nodulose, at margin 2 rows of elongate-rectangular smooth-walled cells; on one side near costa a plica present **(Fig. 7.7)**, vanishing in lower laminal part. Calyptra mitrate, lobed; operculum conical, beak long, straight. Propagule development on basal dorsal side of costa ..... **7. *G. austrofunalis***

40a. Costa, seen in transverse section, cells not uniform, hydroids present; propagules present; lacking above combination of characters 41

41. Costa, seen in transverse sections **(Figs. 13.9, 19)**, at insertion and in leaf base somewhat angulate or flat, in leaf base a row of hydroids, from transitional part to above mid-leaf enlarged to a band of hydroids, the exterior walls of dorsal costal cells markedly thickened; basal paracostal cells **(Fig. 13.18)** broad rectangular, slightly nodulose, near margin some rows of nearly isodiametric cells, walls smooth. Calyptra mitrate, lobed; operculum conical, beak long, straight. Propagule development on dorsal side of lower part of lamina, destroying cells but preserving costa ..... **13. *G. dissimulata***

41a. Costa, seen in transverse section **(Fig. 50.27)**, at insertion and in leaf base rounded, below the guide cells (dorsally) a layer of 1-3 slightly smaller cells than the guide cells **(Figs. 50.10-11)** present; basal cells **(Fig. 50.7)** elongate-rectangular, walls smooth, near margin 2-3 rows of shorter elongate-rectangular cells, they may appear hyaline. Calyptra conico-mitrate, lobed; operculum conical, rostrate, beak oblique, rarely straight. Propagule development on dorsal side of leaf base ..... **50. *G. trichophylla***

42. Margin recurved from insertion to mid-leaf on one side, slightly recurved from above leaf base to mid-leaf on the opposite side 43

42a. Margin recurved from below to above mid-leaf on both sides 44

43. Margin recurved on broader, nearly straight side, on rounded side near mid-leaf, conferring an asymmetric shape on the leaf **(Figs. 33.26, 29)**; basal paracostal **(Fig. 33.8)** cells elongate-rectangular or rectangular, walls nodulose, toward margin short-retangular to quadrate, walls smooth; costa, seen in transverse section **(Fig. 33.12)**, in leaf base on dorsal side rounded, in upper laminal part angulate **(Fig. 33.14)** or winged **(Fig. 33.28)**; costal cells in the upper laminal part uniform. Calyptra conico-mitrate, lobed; operculum rostrate, beak straight. Propagule development on both sides of leaf base ..... **33. *G. muehlenbeckii***

43a. Margin curvature not altering the symmetric shape of the leaf; basal paracostal cells **(Fig. 43.21)** short-rectangular, at margin some rows of nearly quadrate cells, transverse walls thickened, smooth; costa, seen in transverse section **(Fig. 43.9)**, dorsally rounded throughout; costal cells in the upper laminal part differentiated. Calyptra mitrate, lobed; operculum conical, rostrate, beak straight, length variable. Propagule development lacking ..... **43. *G. pulvinata***

44. Basal cells **(Fig. 36.7)** short-rectangular to quadrate from costa to margin, walls smooth; costa, seen on dorsal side **(Fig. 36.5)**, at insertion and in leaf base stout, seen in transverse section **(Fig. 36.8)**, on dorsal side in leaf base uneven, in laminal part exterior walls bulging; lamina, seen in surface view, striate due to variable stratosity. Calyptra cucullate, lobed; operculum conical, beak long, oblique ..... **36. *G. nutans***

44a. Basal cells **(Fig. 37.18)** elongate-rectangular near costa, walls nodulose, cells rectangular to quadrate near margin, transverse walls thickened, smooth; costa, seen on dorsal side **(Fig. 37.5)**, narrowed in leaf base, seen in transverse section **(Fig. 37.9)**, at insertion the dorsal cell walls bulging, from above leaf base to apex costa smooth; lamina, seen in surface view, not striate. Calyptra cucullate; operculum conical, mammillate .... **37. *G. orbicularis***

45. Basal paracostal cells **(Fig. 21.7)** rectangular, walls smooth; toward margin cells becoming quadrate, rarely oblate, transverse walls thickened; leaves **(Fig. 21.5)** from scarcely narrowed leaf base tapering to acute or acuminate apex, conferring to laminal part a triangular shape; seen in transverse section **(Fig. 21.8)**, at insertion and in leaf base broadly concave, in laminal part keeled, margin plane ..... **21. *G. humilis***

45a. Basal paracostal cells elongate-rectangular, walls scarcely or strongly nodulose; lacking above combination of characters 46

46. Basal paracostal cells **(Fig. 18.7)** scarcely nodulose; cells in the transitional part **(Fig. 18.8)** small, rectangular, walls sinuose; lamina, seen in transverse section **(Fig. 18.9)**, cells slightly bulging on dorsal and ventral sides; costa, seen in transverse section **(Fig. 18.9)**, above broadest part of leaf guide cells narrowly elliptical, obliquely arranged to leaf axis. Calyptra mitrate, lobed; operculum conical, beak obtuse, of different length ..... **18. *G. fuscolutea***

46a. Basal paracostal cells strongly nodulose; lacking above combination of characters 47

47. Marginal cells **(Fig. 10.7)** in leaf base broad, short-rectangular to quadrate, walls smooth forming a group of 3-4 rows of cells, separated clearly from the paracostal cells; costa, seen on dorsal side **(Figs. 10.23, 34)**, from insertion to broadest part of leaf strikingly small and thin, becoming stout and prominent to apical part, seen in transverse section **(Fig. 10.35)**, in laminal part the 2 guide cells rounded and arranged horizontally; no young shoots observed. Calyptra mitrate, lobed, conical; operculum conical, rostrate, beak straight or slightly oblique; propagule development on dorsal side of lamina in transitional part, destroying cells..... **10. *G. consobrina***

47a. Marginal cells **(Fig. 17.28)** in leaf base small, short-rectangular to quadrate, walls smooth; costa, seen on dorsal side **(Fig. 17.30)**, from insertion to apex percurrent in S-shape, seen in transverse section **(Fig. 17.9)**, in laminal part the 2 guide cells narrowly elliptical, to leaf axis obliquely arranged; from older stem parts grow the characteristic catenulate young shoots **(Fig. 17.18)**. Calyptra mitrate, lobed; operculum conical, beak straight, obtuse. Propagule development lacking ..... **17. *G. funalis***

48. Seta inclined, capsule smooth 49

48a. Seta in an S-form, approximately of same length as capsule, capsule smooth 52

49. Basal cells uniform from costa to margin 50

49a. Basal cells not uniform from costa to margin 51

50. Basal cells **(Fig. 16.10)** near costa elongate-rectangular, walls smooth or weakly nodulose, transverse walls thickened, at margin 3-4 rows of narrowly elongate-rectangular, hyaline, thin-walled cells, gradually vanishing, the outermost row ascending to above broadest part of leaf, the marginal cells gradually becoming short-rectangular to quadrate; margin **(Fig. 16.8)** on one side recurved from insertion to mid-leaf. Calyptra mitrate-cucullate; operculum conical, blunt ..... **16. *G. elongata***

50a. Basal cells **(Fig. 14.21)** elongate-rectangular from costa to margin, transverse and longitudinal cell walls evenly thin, smooth and hyaline, the rows gradually vanishing, the outermost row reaching to above broadest part of leaf, thus forming between hyaline and thicker walled chlorophyllose cells a delimitation, running obliquely from costa to margin; margin **(Fig. 14.6)** plane throughout. Calyptra mitrate, lobed; operculum conical, mammillate..... **14. *G. donniana***

51. Basal cells **(Fig. 30.6)** rectangular near costa, walls smooth, towards margin cells isodiametric with rounded lumina or corner-thickenings **(Fig. 30.17)**, some rows of transversely rectangular or oval cells; leaf, seen in transverse section **(Fig. 30.7)**, concave throughout, margin plane; costa, seen on dorsal side **(Figs. 30.4, 16)**, at insertion and in leaf base broad, above transitional part to apex indistinct, covered by mammillose lamina cells. Calyptra cucullate; operculum conical, subulate, beak oblique ..... **30. *G. mammosa***

51a. Basal cells **(Fig. 46.9)** of lower stem leaves elongate-rectangular from costa to margin besides 2-3 marginal rows of short-rectangular to quadrate cells, transverse walls thickened, all walls smooth; basal cells **(Fig. 46.8)** of upper stem leaves elongate-rectangular from costa to margin, transverse walls thickened, all walls smooth, leaf, seen in transverse section **(Fig. 46.7)**, at insertion and leaf base concave, in laminal part narrowly keeled, margin plane or occasionally recurved on one side from above insertion to transitional part; costa, seen on dorsal side **(Fig. 46.5)**, at insertion and in leaf base small, enlarged above transitional part, excurrent, distinct throughout. Calyptra cucullate; operculum conical, blunt ..... **46. *G. sessitana***

52. Leaf broadly concave, seen in transverse section **(Fig. 47.29)**, mostly bistratose in laminal part; costa, seen on dorsal side **(Fig. 47.27)**, broadest at insertion, becoming smaller to lower laminal part, not clearly distinct in upper part of leaf; seen in transverse section **(Fig. 47.9)**, at insertion 6-8 basal cells, in leaf base 6 guide cells, in transitional part reduced to 3-4, from above transitional part to apical part 2 guide cells, hardly distinct or indistinct from the lamina cells, due to similarity with the contiguous lamina cells. Calyptra mitrate; operculum conical, rostrate or rostellate, beak straight ..... **47. *G. tergestina***

52a. Leaf not broadly concave, seen in transverse section, mostly unistratose in laminal part; lacking above combination of characters 53

53. Leaf broad, ovate **(Fig. 41.5)**, seen in transverse section **(Fig. 41.7)**, in laminal part broadly keeled, margin plane; basal cells **(Fig. 41.8)** from costa to margin short-rectangular or quadrate, walls smooth; leaf, seen in transverse section **(Fig. 41.9)**, leaf base and lamina unistratose, or in apical part lamina **(Fig. 41.22)** partly bistratose, rarely the marginal cell rows bistratose. Calyptra mitrate; operculum conical, mammillate; peristome present ..... **41. *G. plagiopodia***

53a. Leaf lanceolate or oblong **(Figs. 3.5, 21)**, seen in transverse section **(Fig. 3.7)**, laminal part keeled, margin plane; basal cells **(Fig. 3.22)** near costa elongate-rectangular, toward margin cells rectangular to quadrate, walls smooth; leaf, seen in transverse section **(Fig. 3.23)**, leaf base unistratose, lamina unistratose or irregularly bistratose at places, in laminal part one or 2 marginal cell rows bistratose. Calyptra mitrate, lobed, fugacious; operculum convex, mucronate; peristome lacking ..... **3. *G. anodon***

Key to species of *Grimmia,* for plants without sporophytes

On account of the scanty information available *Grimmia nepalensis* is excluded from this identification key.

Plants examined in a wet state

1. Guide cells at insertion of variable number, 8 or more than 8 guide cells 2
1a. Guide cells at insertion of defined number, 8 or less than 8 guide cells 8

2 Guide cells at insertion arranged in 2 rows **(Figs. 15.10, 24)**; costa dorsally prominent; costal cells except guide cells nearly uniform, hydroids and stereids lacking; lamina bistratose in laminal part, lamina cells mostly mammillose **(Fig. 15.21)**, rarely smooth... ..... **15. *G. elatior***
2a. Guide cells at insertion arranged in one row 3

3. Leaf, seen in transverse section, concave 4
3a. Leaf, seen in transverse section, keeled 7

4. Lamina cells on dorsal and ventral sides **(Fig. 30.7)** strongly mammillose, due to bulging distal cell walls; clearly defined guide cells lacking ..... **30. *G. mammosa***
4a. Lamina cells on dorsal and ventral sides smooth; clearly defined guide cells present 5

5. Basal paracostal cells **(Fig. 25.10)** rectangular, walls smooth or faintly nodulose, towards margin cells isodiametric, transversely rectangular or oval, transverse walls thicker than longitudinal walls; costa, seen in transverse section **(Fig. 25.11)**, in laminal part 2 guide cells, sunken into narrow channel, their adaxial cell walls strongly thickened, at insertion a small median band of substereids, interrupted by 3 groups or one large central group of hydroids, vanishing in apical part ..... **25. *G. laevigata***
5a. Basal paracostal cells elongate-rectangular, walls smooth, toward margin cells scarcely different from paracostal cells; lacking above combination of characters 6

6. Costa, seen in transverse section **(Fig. 38.11)**, cells differentiated, with hydroids from insertion to apical part, hair-points rarely lacking ..... **38. *G. ovalis***
6a. Costa, seen in transverse section **(Fig. 51.9)**, cells uniform, without hydroids from insertion to apical part, hair-points **(Fig. 51.5)** always lacking ..... **51. *G. unicolor***

7. Leaf, seen in surface view, striate lengthwise; at insertion and in leaf base margin plane; basal cells **(Fig. 29.6)** near to broadened costa rectangular, toward margin isodiametric ..... **29. *G. maido***
7a. Leaf, seen in surface view, not striate; at insertion and in leaf base **(Fig. 23.7)** margin recurved on one side; basal cells **(Fig. 23.20)** elongate-rectangular, walls more or less nodulose, at margin some rows of short-rectangular or quadrate cells... **23. *G. khasiana***

8. Costa at insertion with 8 guide cells 9
8a. Costa at insertion with 6 guide cells or less than 6 guide cells 15

9. Leaf concave 10
9a. Leaf keeled 11

10. Costa, seen in transverse section **(Fig. 51.9)**, in laminal part guide cells clearly distinct from laminal cells, the adaxial cell walls thickened, hydroids and stereids lacking throughout; lamina, seen in transverse section, in upper part tri- to multistratose; apex **(Fig. 51.5)** muticous, broad, rounded, often cucullate ..... **51. *G. unicolor***
10a. Costa, seen in transverse section **(Fig. 47.9)**, in laminal part the central guide cells only slightly distinct or indistinct from the lamina cells, due to similarity with the contiguous lamina cells, from insertion to apex a central group of hydroids, hydroids occasionally transformed to substereids; apex rounded **(Fig. 47.22)** or acute **(Fig. 47.6)**, hair-point slightly denticulate ..... **47. *G. tergestina***

11. Apex without a hair-point 12
11a. Apex with a hair-point 13

12. Apex acute, obtuse or cucullate; costa, seen in transverse section **(Fig. 6.27)**, dorsally rounded throughout; at insertion bistratose alar cells **(Fig. 6.10)** on both sides or on one side only **(Fig. 6.13)**, or alar cells lacking **(Fig. 6.12)** ..... **6. *G. atrata***
12a. Apex acute, dentate, cells mostly chlorophyllose, rarely hyaline; costa, seen in transverse section **(Fig. 45.9)**, above lower laminal part irregularly angulate, in upper third of leaf winged; at insertion without bistratose alar cells ..... **45. *G. ramondii***

13. Costa, seen in transverse sections **(Figs. 12.14-15)** on dorsal side slightly angulate or uneven in upper part of lamina; basal cell walls **(Fig. 12.8)** nodulose, thickened, toward margin a sharply contrasting band of several rows of short-retangular and quadrate cells, walls thickened; margin **(Fig. 12.14)** on one side from insertion to mid-leaf revolute, on opposite side recurved ..... **12. *G. decipiens***
13a. Costa, seen in transverse section, on dorsal side smooth throughout; lacking above combination of characters 14

14. Leaf lanceolate or broad lanceolate from ovate, slightly decurrent leaf base, tapering to acute apex, not forming strongly expressed shoulder; basal cells rectangular, walls slightly nodulose **(Fig. 26.44)** or smooth **(Fig. 26.40)**; lamina, seen in transverse section **(Fig. 26.35)**, from insertion to apical part unistratose, occasionally bistratose patches at places; propagule development on dorsal side of leaf base ..... **26. *G. lisae***
14a. Leaf **(Fig. 40.5)** from broad ovate leaf base narrowed to lanceolate laminal part, thus forming strongly expressed shoulder; basal cells **(Fig. 40.7)** elongate-rectangular, walls thickened, nodulose; lamina, seen in transverse section **(Fig. 40.10)**, bistratose from above leaf base to apical part; propagule development lacking ..... **40. *G. pilifera***

15. Costa at insertion with 6 guide cells 16
15a. Costa at insertion with 4 guide cells, or with 4 guide cells, the 2 outer ones contiguous with the basal cells 27

16. Costa on dorsal side rounded above leaf base 17
16a. Costa on dorsal side not rounded above leaf base 24

17. Basal paracostal cells with smooth walls 18
17a. Basal paracostal cells with nodulose walls 21

18. Cells in the transitional part **(Fig. 1.7)** rectangular, small, becoming shorter to margin, walls sinuose and thickened; leaf in lower lamina **(Fig. 1.8)** on one side with a plica, margin on one side recurved from insertion or leaf base to mid-leaf, on opposite side revolute from leaf base to mid-leaf ..... **1. *G. abyssinica***
18a. Cells in the transitional part short-rectangular or quadrate, walls smooth, not thickened; lacking above combination of characters 19

19. Costa, seen on dorsal side **(Fig. 29.3)**, markedly broadened at insertion, in upper part of leaf not clearly distinct; lamina, seen in surface view, striate lengthwise .... **29. *G. maido***
19a. Costa, seen on dorsal side, not markedly broadened, distinct throughout; lamina, seen in surface view, not striate 20

20. Costa, seen in transverse section **(Fig. 50.9)**, of uniform width throughout; at insertion and in leaf base **(Figs. 50.10-11)** a dorsally arranged second layer of 1-3 cells is present, these cells slightly smaller than the guide cells; lamina unistratose except for some bistratose patches in the apical part, cells rounded or oval; propagule development on dorsal side of leaf base ..... **50. *G. trichophylla***
20a. Costa, seen in transverse section **(Fig. 8.17)**, in laminal part prominent; at insertion and in leaf base a second layer of cells slightly smaller than the guide cells lacking; lamina in upper part of leaf bistratose or with extended bistratose patches, cells small, rectangular; propagule development lacking ..... **8. *G. bicolor***

21. Margin plane; leaf, seen in transverse section **(Fig. 38.8)**, in leaf base broadly concave, in mid-leaf concave, in apical part tubulose; costa, seen on dorsal side **(Fig. 38.7)**, above transitional part indistinct ..... **38. *G. ovalis***
21a. Margin recurved on one side; leaf, seen in transverse section, keeled throughout; lacking above combination of characters 22

22. Costa, seen on dorsal side **(Fig. 23.6)**, above transitional part indistinct; leaf, seen in transverse section **(Fig. 23.11)**, in laminal part bistratose with tristratose patches in places; leaf lingulate **(Fig. 23.5)**, apex rounded, rarely acute, hair-points bluntly denticulate ..... **23. *G. khasiana***

22a. Costa, seen on dorsal side, distinct throughout; lacking above combination of characters 23

23. Leaf, seen in transverse section **(Fig. 26.10)**, unistratose throughout, occasionally bistratose patches in upper part; costa never ending in subula; propagule development on dorsal side of leaf base..... **26. *G. lisae***

23a. Leaf, seen in transverse section **(Fig. 40.10)**, in leaf base unistratose, in lamina bistratose at places or completely bistratose; costa often ending as subula; propagule development lacking ..... **40. *G. pilifera***

24. Basal paracostal cells **(Fig. 20.13)** short-rectangular, walls smooth; costa, seen in transverse sections **(Figs. 20.14-18)**, in upper laminal part irregularly shaped, often angulate or winged; stem without central strand **(Fig. 20.4),** cortical cells large, nearly uniform, sharply differentiated from brownish epidermis, constituted by at least 2 rows of stereids with very narrow lumina; occasionally with multicellular clusters **(Fig. 20.3)** of rounded gemmae at apex..... **20. *G. hartmanii***

24a. Basal paracostal cells elongate-rectangular, walls nodulose; lacking above combination of characters 25

25. Costa stout in lower part of leaf **(Figs. 12.5-6)**, seen in transverse sections **(Figs. 12.13-18)**, ventrally broadly channelled; in leaf base margin revolute on one side .... **12. *G. decipiens***

25a. Costa small in lower part of leaf, seen in transverse section, ventrally narrowly channelled; in leaf base margin recurved on one side..... 26

26. Costa, seen in transverse sections, in upper laminal part winged **(Figs. 33.12-13)** or angulate **(Fig. 33.14),** seen in surface view distinct throughout; transverse and longitudinal walls of cells in the leaf base of the same thickness; propagule development on both sides of leaf base ..... **33. *G. muehlenbeckii***

26a. Costa, seen in transverse sections, in lower laminal part unevenly rounded **(Figs. 27.14-19)**, somewhat angulate, seen in surface view in apical part of leaf indistinct; transverse walls of cells in the leaf base markedly smaller than longitudinal walls; propagule development lacking..... **27. *G. longirostris***

27. Costa at insertion with 4 guide cells 28

27a. Costa at insertion with 4 guide cells, the 2 outer ones contiguous with the basal cells 53

28. Basal cells nodulose, marginal cells excluded..... 29

28a. Basal cells smooth, marginal cells included 40

29. Leaf concave in leaf base 30
29a. Leaf not concave in leaf base 32

30. Leaf, seen in transverse section **(Fig. 24.12)**, broadly keeled above broadest part of leaf; unistratose at insertion and leaf base, in laminal part bistratose in places, apex bistratose, margin with several rows of bistratose cells; costa, seen in transverse section with hydroids **(Fig. 24.11)** or without hydroids **(Fig. 24.30)**; in transitional part cells smooth **(Fig. 24.9)** or sinuose **(Fig. 24.10)** ..... **24. *G. kidderi***
30a. Leaf, seen in transverse section, above broadest part of leaf not broadly keeled; lacking above combination of characters 31

31. Costa, seen in transverse section **(Fig. 44.10)**, at insertion the dorsal cell walls slightly bulging, from insertion to mid-leaf the 2 median placed guide cells of narrow elliptical shape arranged obliquely to leaf axis; margin from above transitional part to apical part, in 1-3 rows bi- or tristratose; in transitional part, lamina cells **(Figs. 44.9, 21)** elongate-rectangular, walls sinuose ..... **44. *G. pygmaea***
31a. Costa, seen in transverse section **(Fig. 37.9)**, at insertion the dorsal cell walls bulging, from insertion to apical part the guide cells rounded, arranged horizontally; margin unistratose, at most one bistratose cell row on one side in apical part; in transitional part **(Fig. 37.8)**, lamina cells short-rectangular or isodiametric, walls smooth or slightly sinuose ..... **37. *G. orbicularis***

32. Costa, seen in transverse section, with hydroids 33
32a. Costa, seen in transverse section, without hydroids 37

33. Costa, seen in transverse sections **(Figs. 13.9, 19)**, at leaf base a row of large hydroids; from transitional part to apical part enlarged to a band of hydroids, in upper part of lamina 2 markedly enlarged guide cells present; exterior walls of dorsal costal cells strongly thickened; propagule development on dorsal side of lower part of lamina, destroying cells but not costa ..... **13. *G. dissimulata***
33a. Costa, seen in transverse section, hydroids arranged at leaf base in a central group; lacking above combination of characters 34

34. At margin **(Figs. 16.10, 29, 32)** 3-4 rows of narrowly elongate-rectangular, hyaline, thin-walled cells, gradually vanishing, the outermost row ascending to above broadest part of leaf, the marginal cells gradually becoming short-rectangular to quadrate; margin **(Fig. 16.8)** on one side recurved from insertion to mid-leaf; lamina unistratose, rarely a bistratose patch ..... **16. *G. elongata***
34a. At margin the cell rows arranged differently; lacking above combination of characters 35

35. Margin at leaf base revolute or recurved on both sides **(Fig. 28.9)**; leaf **(Fig. 28.4)** lanceolate to broad lanceolate, tapering to acute, apiculate apex, or to short, hyaline, greenish or brownish tinged hair-points, or to bluntly denticulate hair-points **(Fig. 28.5)**, or to elongate hair-points appearing twisted by somewhat obliquely arranged cells, decurrent at apical part as border of 2 rows of elongate cells, their thick-walled ends bluntly protruding distally..... ..... **28. *G. macrotheca***

35a. Margin at leaf base recurved on one side; lacking above combination of characters 36

36. Costa, seen in transverse section **(Fig. 31.9)**, in lower laminal part rounded, from leaf base to apical part the 2 median guide cells of narrow elliptical shape, from above leaf base to apical part arranged obliquely to leaf axis; stem leaves arranged in tiers; propagule development on dorsal side of leaf base ..... **31. *G. meridionalis***

36a. Costa, seen in transverse section **(Fig. 27.48)**, in lower laminal part unevenly rounded or slightly angulate, the median guide cells rounded and arranged horizontally to leaf axis; stem leaves loosely arranged on stem; propagule development lacking..... ..... **27. *G. longirostris***

37. Costa, seen in transverse section, smooth dorsally.....38

37a. Costa, seen in transverse section, not smooth dorsally 39

38. Costa, seen in transverse section **(Fig. 7.11)**, cells homogeneous; near costa **(Fig. 7.7)** a plica present that ends in lower laminal part; hair-point of different length; no young shoots present; propagule development on basal dorsal side of costa .... **7. *G. austrofunalis***

38a. Costa, seen in transverse sections **(Figs. 19.12, 15)**, cells differentiated, with stereids; lamina without plica; apex muticous, acute; characteristic young shoots of bristly aspect present **(Fig. 19.1)**; propagule development lacking..... **19. *G. handelii***

39. Cells in the leaf base with transverse and longitudinal walls of the same thickness; costa, seen in transverse sections, in upper laminal part winged **(Figs. 33.12-13)** or angulate **(Fig. 33.14)**; propagule development on both sides of leaf base ..... **33. *G. muehlenbeckii***

39a. Cells in the leaf base with transverse walls markedly smaller than longitudinal walls; costa, seen in transverse sections **(Figs. 27.14-19)**, in lower laminal part unevenly rounded, somewhat angulate, in mid-leaf prominent; propagule development lacking.... ..... **27. *G. longirostris***

40. Lamina cells smooth..... 41

40a. Lamina cells not smooth..... 48

41. Cells in the leaf base elongate-rectangular..... 42

41a. Cells in the leaf base short-rectangular..... 45

42. Costa, seen in transverse section, with hydroids..... 43

42a. Costa, seen in transverse section, without hydroids..... 44

43. Basal cells **(Fig. 14.21)** elongate-rectangular, from costa to margin hyaline, transverse and longitudinal cell walls evenly thin, these rows gradually vanishing, the outermost row reaching to above broadest part of leaf, thus forming a delimitation between hyaline and thicker walled chlorophyllose cells, running obliquely from costa to margin; margin **(Fig. 14.6)** plane throughout ..... **14. *G. donniana***

43a. Basal cells **(Fig. 46.8)** of upper stem leaves elongate-rectangular from costa to margin, transverse walls thickened, basal cells **(Fig. 46.9)** of lower stem leaves elongate-rectangular from costa to margin except 2-3 marginal rows of short-rectangular to quadrate cells, transverse walls thickened; margin plane **(Fig. 46.33)** or occasionally recurved **(Fig. 46.26)** on one side from above insertion to transitional part..... **46. *G. sessitana***

44. Basal cells **(Fig. 50.7)** elongate-rectangular, walls smooth, near margin 2-3 rows of shorter elongate-rectangular hyaline cells; costa, seen in transverse section **(Fig. 50.27)**, at insertion and in leaf base rounded, **(Figs. 50.10-11)** a dorsally arranged second layer of 1-3 cells slightly smaller than the guide cells present; propagule development on dorsal side of leaf base..... **50. *G. trichophylla***

44a. Basal cells **(Figs. 49.7-8)** elongate-rectangular, walls smooth, from costa to margin hyaline, transverse and longitudinal cell walls evenly thin, the rows gradually vanishing, the outermost row reaching to above broadest part of leaf, thus forming a delimitation between hyaline and thicker walled chlorophyllose cells, running obliquely from costa to margin; costa, seen in transverse sections **(Figs. 49.10-11)** prominent, without a second layer of slightly smaller cells than the guide cells; propagule development lacking .... **49. *G. tortuosa***

45. Leaf **(Fig. 32.18)** keeled from mid-leaf to apical part; from ovate base abruptly lanceolate, thus forming shoulder **(Fig. 32.7)**; margin **(Figs. 32.15, 18)** from leaf base to apex gradually strongly incurved; costa, seen in transverse section **(Fig. 32.15)**, prominent above leaf base..... **32. *G. montana***

45a. Leaf keeled from leaf base to apical part; lacking above combination of characters 46

46. Leaf with a short, brownish, irregularly serrate and bluntly denticulate leaf apex **(Fig. 42.3)**; seen in transverse section **(Fig. 42.6)**, leaf broadly keeled from insertion to apex..... **42. *G. pulla***

46a. Leaf without a short, brownish irregularly serrate and knotted leaf apex but with a hyaline hair-point; seen in transverse section, leaf keeled..... 47

47. Costa, seen in transverse section **(Fig. 43.9)**, rounded throughout; lamina, seen in transverse section, unistratose from insertion to apex, cells rounded; some marginal cell rows in laminal part bi- or tristratose, in apical part occasionally bi- or tristratose on one side only..... **43. *G. pulvinata***

47a. Costa, seen in transverse section **(Fig. 8.17)**, in laminal part prominent; lamina, seen in transverse section, in upper part of leaf bistratose or with extended unistratose patches, cells small rectangular; marginal cells same as lamina cells ..... **8. *G. bicolor***

48. Costa, seen in transverse section **(Fig. 4.9),** without hydroids; lamina, seen in surface view, striate; lamina cells, seen in transverse section **(Fig. 4.18)**, papillose and with joint thickenings; plants occasionally with multicellular clusters **(Fig. 4.1)** of rounded gemmae at apex ..... **4. *G. anomala***

48a. Costa, seen in transverse section, with hydroids; lacking above combination of characters 49

49. Costa, seen in transverse section, recessed in furrow 50

49a. Costa, seen in transverse section, not recessed in furrow 51

50. Leaf margin inflexed **(Fig. 9.26)**, lamina plicate, exterior cell walls dorsally and ventrally mammillose; costa, seen on dorsal side **(Fig. 9.7)**, enlarged below apical part; hair-point **(Fig. 9.8)** short, nearly smooth, cell lumina discernible; secondary costae **(Fig. 9.10)** in lower half of leaf present in some leaves..... **9. *G. caespiticia***

50a. Leaf margin in upper part of leaf slightly incurved **(Figs. 35.9-10)**, lamina not plicate, exterior cell walls dorsally and ventrally bulging or mammillose; costa, seen on dorsal side **(Figs. 35.19, 24, 26)**, stout in leaf base, becoming strikingly enlarged in upper laminal part; hair-point short, denticulate, cell lumina not discernible; secondary costae not observed..... **35. *G. nivalis***

51. Leaf broadly keeled in laminal part; seen in transverse section **(Fig. 39.8)**, lamina cells mammillose, lamina irregularly bistratose by doubled longitudinal cell rows, appearing in surface view **(Fig. 39.9)** as irregular ridges on the lamina..... **39. *G. percarinata***

51a. Leaf keeled in upper half of lamina; lacking above combination of characters 52

52. Costa, seen on dorsal side **(Fig. 36.5)**, at insertion and in leaf base stout, becoming smaller in laminal part, seen in transverse section **(Fig. 36.8)**, in laminal part exterior costal cell walls bulging; lamina, seen in transverse section, exterior cell walls slightly bulging, seen in surface view, lamina striate, due to variable stratosity; hair-points of different lengths, weakly denticulate ..... **36. *G. nutans***

52a. Costa, seen on dorsal side **(Fig. 5.4)**, of nearly uniform width throughout, seen in transverse section **(Fig. 5.14)**, exterior costal cell walls bulging throughout; lamina, seen in transverse section, exterior cell walls bulging, seen in surface view, lamina not striate; hair-points **(Fig. 5.7)** of different lengths, sharply denticulate ..... **5. *G. asperitricha***

53. Basal cells smooth, short-rectangular to quadrate..... 54

53a. Basal cells nodulose, elongate-rectangular..... 58

54. Margin erect; costa, seen in transverse section **(Fig. 2.11)**, in laminal part on dorsal side prominent, somewhat angulate, on ventral side recessed in furrow, exterior walls of lamina cells slightly bulging; lamina, in surface view, appearing striate, due to variable stratosity..... **2. *G. alpestris***

54a. Margin not erect; lacking above combination of characters 55

55. Costa, seen in transverse section, in laminal part broadly keeled 56
55a. Costa, seen in transverse section, in laminal part keeled..... 57

56. Leaf **(Fig. 21.5)** from scarcely narrowed leaf base tapering to acute or acuminate apex, conferring a triangular shape to the laminal part; seen in transverse section **(Fig. 21.8)**, lamina uni- to bistratose ..... **21. *G. humilis***
56a. Leaf obovate from broad leaf base, broadest at mid-leaf **(Fig. 41.6)**; seen in transverse sections **(Figs. 41.9, 23)**, lamina unistratose, rarely bistratose in apical part .... **41. *G. plagiopodia***

57. Leaf markedly narrowed at insertion **(Fig. 11.6)**, widest above mid-leaf, apical part variably hyaline, apex rounded, margin plane or rarely slightly recurved in upper part of lamina; seen in transverse section **(Fig. 11.13)**, lamina and margin unistratose throughout; costa **(Fig. 11.25)**, passing through hyaline apical part excurrent into faintly denticulate hair-point..... **11. *G. crinita***
57a. Leaf lanceolate or oblong **(Figs. 3.5, 21)**, apical part not hyaline, apex obtuse, margin plane; seen in transverse sections **(Figs. 3.24-25),** lamina unistratose or irregularly bistratose in places, in laminal part 1-2 marginal cell rows bistratose; costa excurrent into weakly denticulate hair-point..... **3. *G. anodon***

58. Costa, seen in transverse section, guide cells narrowly elliptical obliquely arranged to leaf axis 59
58a. Costa, seen in transverse section, guide cells rounded, horizontally arranged to leaf axis 60

59. Costa, seen on dorsal side **(Fig. 17.30)**, percurrent in an S-shape; cells in the transitional part **(Fig. 17.8)** near costa short-rectangular, walls sinuose, towards margins isodiametric, walls smooth; lamina cells, seen in transverse section **(Fig. 17.29)** smooth; young shoots have characteristic catenulate aspect **(Fig. 17.18)** ..... **17. *G. funalis***
59a. Costa, seen on dorsal side, not percurrent in an S-shape; cells in the transitional part **(Fig. 18.8)**, from costa to margin small, rectangular, walls sinuose; lamina cells, seen in transverse section **(Fig. 18.9)**, slightly bulging on dorsal and ventral side; young shoots not as above ..... **18. *G. fuscolutea***

60. Lamina cells, seen in transverse section **(Fig. 48.7)** bulging; the dorsal costal cell walls **(Fig. 48.13)** mammillose, often hyaline; on dorsal side of costa multicellular propagules on short stalks may be found; young shoots with leaflets spreading ..... **48. *G. torquata***
60a. Lamina cells, seen in transverse section, smooth; lacking above combination of characters 61

61. Costa, seen on dorsal side **(Figs. 10.23, 34)**, from insertion to broadest part of leaf strikingly small and thin, becoming stout and prominent towards the apical part; seen in transverse sections **(Figs. 10.9, 27)**, in the upper laminal part, where the costa becomes stout, appears a group of hydroids; leaf auriculate, decurrent; propagule development on dorsal side of lamina in transitional part, destroying cells ..... **10. *G. consobrina***

61a. Costa, seen on dorsal side **(Figs. 22.5, 7)** of uniform width, slightly weaker at insertion; seen in transverse section **(Fig. 22.13)**, in laminal part the exterior cell walls markedly thicker than the interior cell walls, lamina ending as subula **(Fig. 22.30)**, cells homogeneous; leaf caducous; propagule development lacking ..... **22. *G. incurva***