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A Taxonomic Study of the Genus *Galium* in Minnesota

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Galium is quite a commonplace, cosmopolitan genus in Minnesota. Most naturalists are familiar with one or more species such as the Northern Bedstraw, *G. boreale*, and Goosegrass, *G. aparine*. However, it may come as a surprise to many to learn that there are a total of eleven species and two varieties of *Galium* found growing within the boundaries of the state.

Because of the difficulties met with in trying to tell the species apart, it was realized soon after this study was initiated that a need existed for a clarification of their taxonomy as it related to the state flora. Furthermore, it was concluded that a clear and logical key to the species would provide a ready means for anyone interested in the group to identify unknown specimens.

This report is based exclusively upon specimens of *Galium* on permanent file in the Herbarium of the University of Minnesota. The descriptions of species are sufficiently broad to encompass the variation observable in the study specimens. One or more typical specimens of each species forms the basis for the illustrations. Reference is made to the specimen used in preparing each figure by citing the Herbarium Accession Number stamped on the sheet to which the specimen is attached.

I wish to express my thanks to my adviser, Dr. Gerald B. Ownbey, Dept. of Botany, University of Minnesota, for his great assistance in all phases of the study, and to Miss Wilma Monserud, Departmental Artist, for her excellent diagrams illustrating each species.

Galium L.

Flowers 3-4-merous; calyx-teeth obsolete; corolla rotate, valvate in the bud, with 3 or 4 short lobes; stamens 4, rarely 3, short; ovary 2-celled and 2-ovuled, the styles 2, short, the stigmas capitate; fruit dry or fleshy, globular, twin, sometimes bristly, separating when ripe into 2 seed-like, indehiscent, 1-seeded carpels. Annual or perennial herbs, with slender, 4-angled stems, whorled leaves and mostly small, cymose flowers.

KEY TO THE MINNESOTA SPECIES

- a. Ovaries and fruits bristly.
- b. Leaves with 1 main vein, bristle-tipped, not lanceolate, principally in whorls of 5-8; flowers in simple cymules; fruits with radiate, hooked bristles.
- c. Leaves narrowly oblanceolate, with retrorse bristles on the midveins beneath and on the margins, principally in whorls of 8; ribs of the

stems with retrorse bristles on the internodes; annual. 1. *G. aparine*.

- c. Leaves elliptic-lanceolate (rarely to oblanceolate), with retrorse bristles on the midveins beneath, the marginal bristles not retrorse, principally in whorls of 6; ribs of the stems most commonly without bristles, except for awl-shaped ones immediately above the nodes, and occasionally on the upper internodes; perennial 2. *G. triflorum*.

- b. Upper leaves, at least, with 3 main veins, pointed but not bristle-tipped, lanceolate, principally in whorls of 4; flowers in panicles of cymules; fruits with curved, unhooked, more or less appressed bristles 3. *G. boreale*.

- a. Ovaries and fruits glabrous.
- d. Flowers in close, many-flowered panicles of cymules; erect plants with little lateral branching of the main stem below the inflorescence.

e. At least the upper leaves with 3 main veins, all the leaves with dull upper surfaces, lanceolate, principally in whorls of 4; corollas white. 3a. *G. boreale* var. *hyssopifolium*.

e. All the leaves with 1 main vein, the upper surfaces shiny, linear, principally in whorls of 6-8; corollas yellow. 4. *G. verum*.

- d. Flowers on simple peduncles, simple cymules, or in loose, few-flowered panicles; matted, reclining or loosely ascending plants.

f. Leaves blunt or rounded at the apices.

g. Corollas with 3 (rarely 4) obtuse lobes, the length and width of the lobes subequal.

h. Inflorescences terminal or axillary, of simple, 1-flowered peduncles or 2-4-flowered cymules, the peduncles, or in the latter instance, the pedicels at maturity retrorsely scabrous or glabrous, 5-20 mm. long; leaves principally in whorls of 4-6.

i. Peduncles when 1-flowered or pedicels of the 2-3-flowered cymules at least in part filiform, arcuate and scabrous, 5-20 mm. long; leaves in whorls of 4 or fewer. 5. *G. trifidum*.

i. Peduncles when 1-flowered or the divaricate pedicels of the 2-4-flowered cymules stouter, straight, glabrous; at

¹Costs of reproducing the figures have been met from the Junior F. Hayden Memorial Fund, Dept. of Botany, University of Minnesota. Received: Sept. 24, 1963.

- least some of the leaves in whorls of 5 or 6.
- j. Flowers in cymules of 2-4 (typically 3). 6. *G. tinctorium*.
 - j. Flowers borne singly on peduncles, or sometimes a few of them in 2-3-flowered cymules. 6a. *G. tinctorium* var. *subbiflorum*.
 - h. Inflorescences axillary, of simple, 1-flowered peduncles or infrequently of 2-flowered cymules, the peduncles, or in the latter instance, the pedicels glabrous, 0.5-4 mm. long; leaves principally in whorls of 4. 7. *G. brevipes*
 - g. Corollas with 4 (rarely 3) acute lobes, the length of the lobes obviously greater than the width.
 - k. Leaves with acicular bristles on the midveins beneath, narrowly elliptical, 1-8 mm. wide, not reflexed, principally in whorls of 5 or 6; cymules terminal, the older cymules rarely overtopped by the younger ones on the lateral branches. 8. *G. obtusum*
 - k. Leaves without bristles (rarely with a few acicular ones) on the midveins beneath, narrowly oblanceolate, 1-3 mm. wide, generally soon reflexed, principally in whorls of 4; the older cymules usually overtopped by the younger ones on the lateral branches. 9. *G. labradoricum*.
 - f. Leaves sharply acute, cuspidate or bristle-tipped.
 - 1. Leaves linear to narrowly elliptic-lanceolate, the margins smooth or infrequently with apically facing, conical bristles. 10. *G. concinnum*.
 - 1. Leaves narrowly obovate, the margins with retrorse, conical bristles. 11. *G. asprelium*.

1. *GALIUM APARINE* L.

Annual; stems weak, prostrate or scandent, the ribs possessing retrorse, conical bristles, changing to straight, awl-shaped bristles just above the nodes; leaves principally in whorls of 8 (frequently 5-7), with 1 main vein, bristle-tipped, typically narrowly oblanceolate, the bristles on the midveins beneath and on the margins retrorse and conical, those on the upper surfaces pointing apically, awl-shaped and incurved; inflorescences of simple, axillary, 1-3 flowered cymules; corollas white, with 4 acute lobes; fruits with radiate, hooked bristles. Figs. 1-3.

G. aparine may be confused with *G. triflorum*. Many obvious differences exist, however, between the two, and the most important of these are pointed out in the key.

2. *GALIUM TRIFLORUM* Michx.

Perennial; stems slender, prostrate or scandent, the ribs glabrous, rarely bristly on the internodes, but with

awl-shaped, straightish, bristles just above the nodes at least in the upper parts (never bristly just below the nodes); leaves principally in whorls of 6, with 1 main vein, elliptic-lanceolate, bristle-tipped, having retrorse, conical bristles on the midveins beneath and awl-shaped, apically facing bristles near the margins above, commonly with similar bristles also on the midveins above, or infrequently over the entire upper surface; inflorescences of axillary, 3-flowered cymules; corollas greenish-white, with 4 acute lobes; fruits with radiate, hooked bristles. Figs. 4-7.

This species is similar to *G. aparine*, as is pointed out above.

3. *GALIUM BOREALE* L.

Perennial; stems erect, smooth, or ribs occasionally with retrorse bristles; nodes with short, white bristles giving a matted effect; leaves principally in whorls of 4, at least the upper ones with 3 main veins, lanceolate, with apically facing bristles on the upper marginal surface, the bristles on the midveins beneath and on the midveins above toward the apices extremely thin, straightish, and awl-shaped; inflorescences of compact, many-flowered panicles of cymules; corollas white, with 4 acute lobes; fruit (except var. *hyssopifolium*), with curved, unhooked, somewhat adherent bristles. Figs. 8-11.

In addition to the typical variety, another variety can be satisfactorily distinguished:

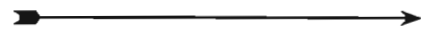
3a. *GALIUM BOREALE* L. var. *HYSSOPIFOLIUM* (Hoffm.) DC.

Fruits glabrous (with a few bristles in rare exceptions); white bristles present or absent from the nodes of the stem.

G. boreale var. *intermedium*, although listed by Fernald in ed. 8 of Gray's Manual, is not recognized in this paper. It seems to the writer that var. *intermedium*, if recognized, tends to obscure the otherwise meaningful differences between vars. *boreale* and *hyssopifolium*. Specimens which might be assigned to this intermediate group are better placed with one or the other of the recognized varieties.

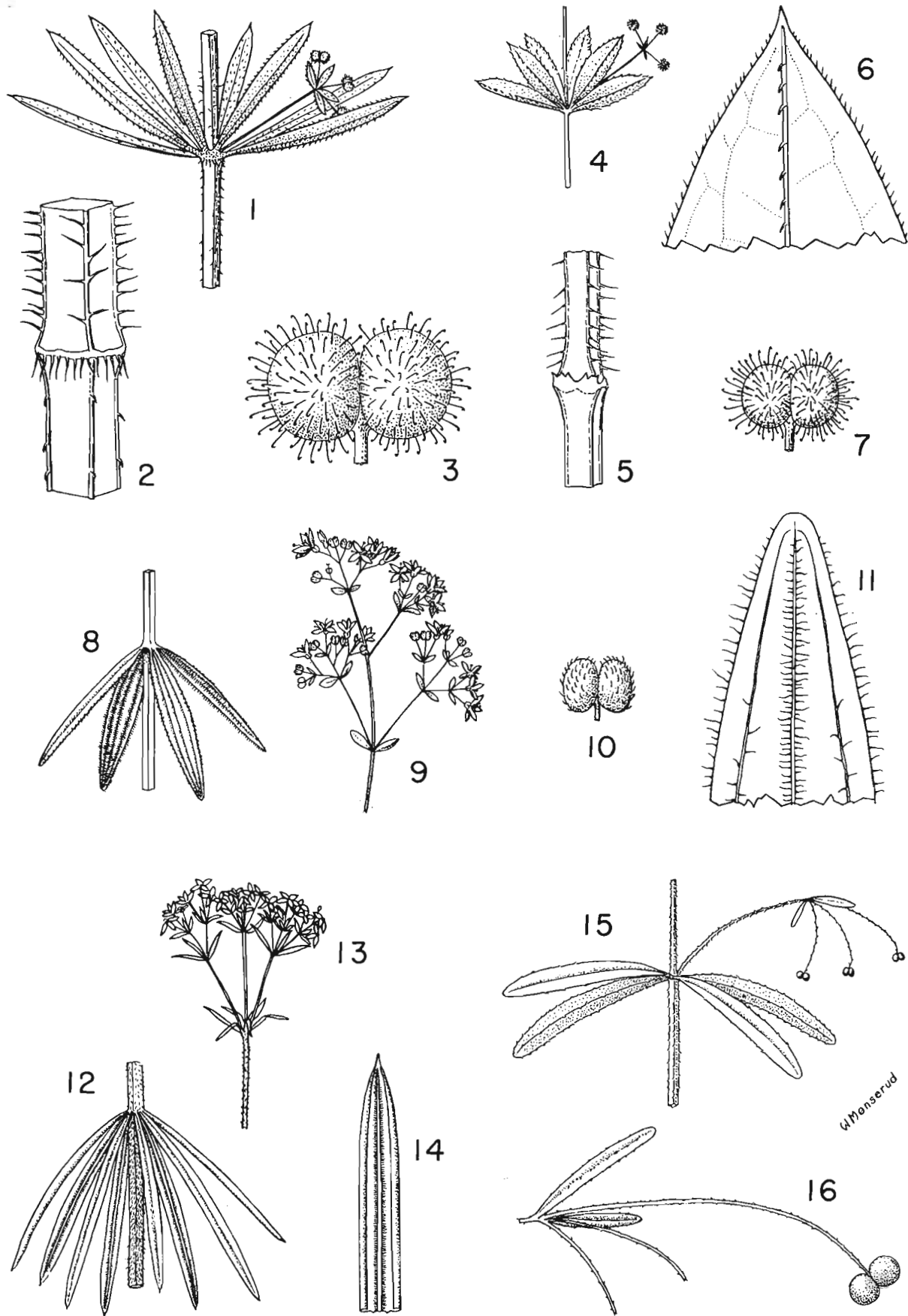
4. *GALIUM VERUM* L.

Perennial; stems erect, the ribs usually bristly, the greatest concentration of the acicular, straightish bristles

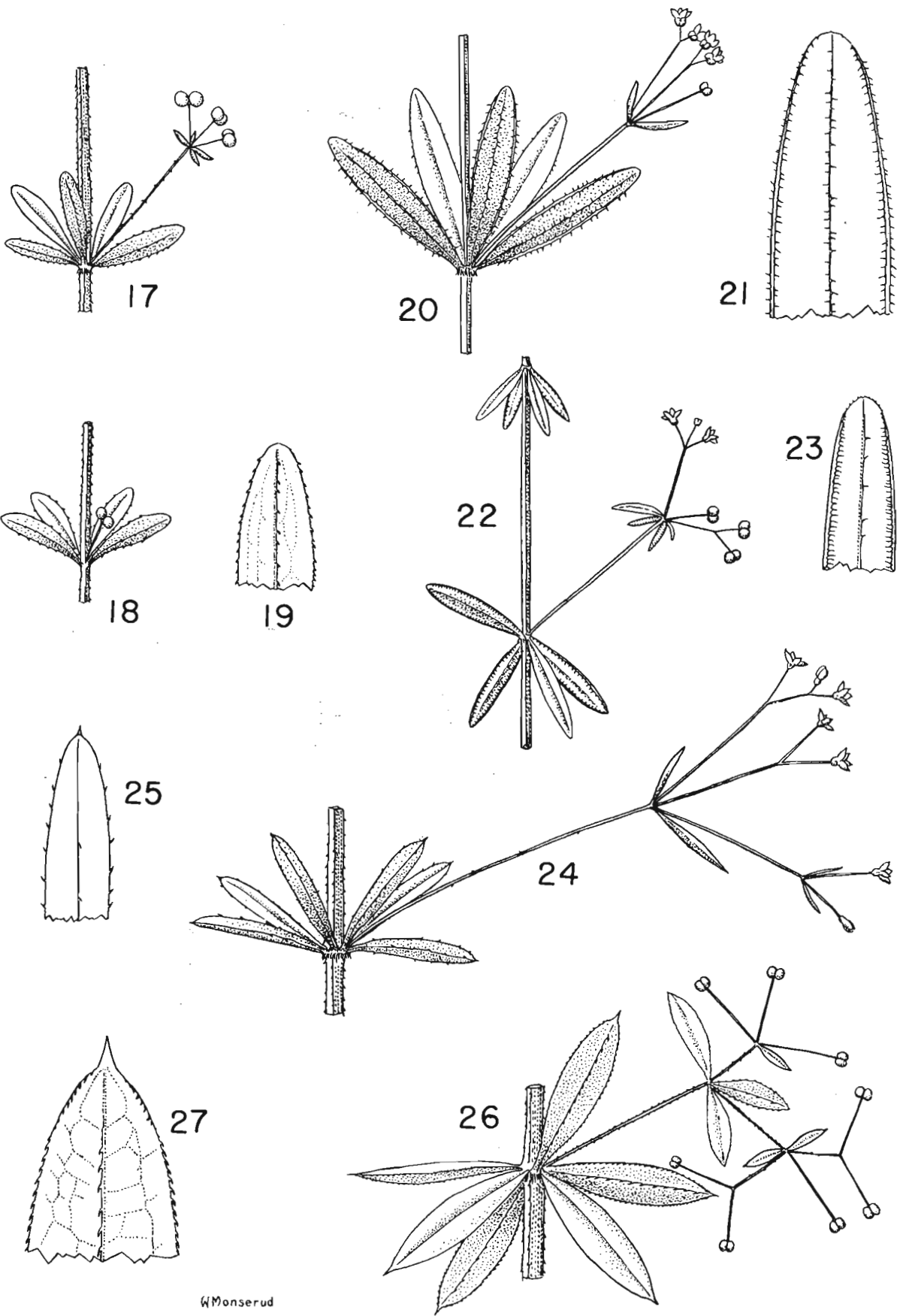


Legends to figures 1-16. *Galium aparine*: Fig. 1. Node of stem with associated parts $\times \frac{2}{3}$ (503015). Fig. 2. Node of stem with the leaves removed $\times 7$ (542799). Fig. 3. Fruit $\times 7$ (542799). *G. triflorum*: Fig. 4. Node of stem and associated parts $\times \frac{2}{3}$ (497451). Fig. 5. Node of stem with the leaves removed $\times 7$ (497451). Fig. 6. Apex of leaf, under surface $\times 7$ (497451). Fig. 7. Fruit $\times 7$ (497451). *G. boreale*: Fig. 8. Node of stem with associated parts $\times \frac{2}{3}$ (368871). Fig. 9. Flowering shoot $\times 2$ (381472). Fig. 10. Fruit $\times 7$ (368871). Fig. 11. Apex of leaf, under surface $\times 7$ (368871). *G. verum*: Fig. 12. Node of stem with associated parts $\times 2$ (449028). Fig. 13. Flowering shoot $\times 2$ (481519). Fig. 14. Apex of leaf, under surface $\times 7$ (449028). *G. trifidum*: Fig. 15. Node of stem with associated parts $\times 2$ (375124, 462506). Fig. 16. Detail of fruiting inflorescence $\times 7$ (375124).





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immediately below and on the nodes and, rarely, a few scattered bristles immediately above the nodes, or stems wholly glabrous; leaves principally in whorls of 6-8, each with 1 main vein, linear to oblanceolate, the apices acute, bristly on either side of the midveins beneath with acicular bristles, the upper surfaces of the leaves with small, curved, acicular, apically facing bristles; inflorescences of compact, axillary, many-flowered cymes, equalling or longer than the adjacent internodes; corollas yellow; fruits glabrous. Figs. 12-14.

This is the only species of *Galium* in Minnesota with yellow corollas.

5. *GALIUM TRIFIDUM* L.

Perennial; stems matted, slender and weak, the ribs and nodes possessing retrorse, flattened, triangular bristles, or rarely glabrous; leaves principally in whorls of 4, oblanceolate to spatulate, with round apices, and retrorse, triangular, flattened bristles on the midveins beneath and the lower sides of the margins, the upper marginal surfaces glabrous or with small, acicular, apically facing bristles; flowers borne singly on terminal or axillary, simple peduncles or in 2-4-flowered cymes, at least some of the peduncles, or in the latter instance, the pedicels, filiform, arcuate, irregularly scabrous, 5-20 mm. long; corollas whitish, with 3 (rarely 4) obtuse lobes, the length and width of the lobes subequal; fruits glabrous. Figs. 15-16.

Of all the species of *Galium*, those with corollas having three obtuse lobes are the most difficult to key out. This is mainly due to inconsistencies in the inflorescences, upon which identification is primarily based. The following discussion should facilitate identification of these species.

There is great similarity between *G. tinctorium* and *G. brevipes*. Dr. H. H. Iltis (Notes on herbarium specimens, Minnesota), feels that *G. brevipes* may simply be a northern ecotype of *G. tinctorium*. Possibly hybridization between these two species also occurs. However, two characters separate nearly all specimens of these two species: (1) The leaf number per whorl. *G. tinctorium* and its var. *subbiflorum* commonly have five or six principal leaves per whorl, at least somewhere on the plant, while *G. brevipes* has only four (2) *G. brevipes* has single, axillary peduncles (rarely 2 or 3-flowered cymes occur), which are less than five mm. long. *G. tinctorium* and its var. *subbiflorum* have 1-3-flowered terminal or axillary cymes in which each pedicel is



Legends to figures 17-27. *Galium tinctorium*: Fig. 17. Node of stem with associated parts $\times 2$ (228743). *G. brevipes*: Fig. 18. Node of stem with associated parts $\times 2$ (446733). Fig. 19. Apex of leaf, under surface $\times 7$ (446733). *G. obtusum*: Fig. 20. Node of stem with associated parts $\times 2$ (507099). Fig. 21. Apex of leaf, under surface $\times 7$ (507099). *G. labradoricum*: Fig. 22. Nodes of stem with associated parts $\times 2$ (228728). Fig. 23. Apex of leaf, under surface $\times 7$ (228728). *G. concinnum*: Fig. 24. Node of stem with associated parts $\times 2$ (106458, 193304). Fig. 25. Apex of leaf, under surface $\times 7$ (193304). *G. asprellum*: Fig. 26. Node of stem with associated parts $\times 2$ (412897). Fig. 27. Apex of leaf, under surface $\times 7$ (412897).



5-10 mm. long. When only one pedicel occurs in the latter two varieties, as is commonly found in var. *subbiflorum*, it is subtended by a bract, that is, a bract separates the pedicel from the peduncle. In *G. brevipes*, the short, axillary peduncles have no bract. This is a useful point in identification.

The most reliable character separating *G. trifidum* from the other species is the presence of retrorse, triangular, flattened bristles on at least some of the ultimate flowering stalks. At least some of the ultimate stalks are normally arcuate and filiform, rarely some in a specimen are thicker, as in *G. tinctorium*. *G. trifidum* may be separated from *G. tinctorium* not only by the above means, but also by leaf number per whorl. Like *G. brevipes*, the former species has four principal leaves per whorl.

6. *GALIUM TINCTORIUM* L.

Perennial; stems weak, matted, with retrorse, flattened, triangular bristles on the ribs and nodes, or glabrous; leaves principally in whorls of 5 or 6, narrowly elliptical infrequently oblanceolate, with rounded apices, and retrorse, triangular, flattened bristles on the midveins beneath and on the lower sides of the margins, the upper surfaces glabrous or with small, acicular, and apically facing marginal bristles; inflorescences of 3-flowered cymes (rarely 1-, 2-, or 4-flowered), the pedicels glabrous, straight, 5-10 mm. long, divaricate; corollas whitish, with 3 (rarely 4) obtuse lobes, the length and width of a lobe subequal. Fig. 17.

Galium tinctorium var. *tinctorium* is similar to *G. trifidum*, *G. brevipes*, and *G. tinctorium* var. *subbiflorum*. See under *G. trifidum* for a comparison of these taxa.

In addition to the typical variety of *G. tinctorium*, one other variety may be distinguished:

6a. *G. TINCTORIUM* L. var. *SUBBIFLORUM* (Wieg.) Fern.

Flowers on separate axillary peduncles or occasionally occurring in 2- or 3-flowered cymes; otherwise as in *G. tinctorium* var. *tinctorium*.

7. *GALIUM BREVIPES* Fern. & Wieg.

Perennial; stems matted and weak; ribs of the stem possessing retrorse, flattened, triangular bristles, or rarely glabrous; nodes of the stem almost always glabrous; leaves principally in whorls of 4, oblanceolate to narrowly elliptical, with obtuse apices and retrorse, triangular, flattened bristles on the midveins beneath and on the lower sides of the margins, the upper surfaces glabrous or with small, acicular, apically facing marginal bristles; flowers 1 on a peduncle or rarely in 2-flowered cymes, the ultimate stalks in either case .5-4 mm. long, glabrous; corollas with 3 (rarely 4) obtuse lobes, the length and width of a lobe subequal, whitish; fruits glabrous. Figs. 18-19.

This species is similar to *G. trifidum*, *G. tinctorium* var. *tinctorium* and var. *subbiflorum*. See the discussion following *G. trifidum* for a comparison of these species.

8. *GALIUM OBTUSUM* Bigel.

Perennial; stems branched from the base or diffusely branched upward, 2-8 dm. tall, the ribs glabrous or with

retorse, conical bristles; leaves principally in whorls of 5 or 6, narrowly elliptical, 1-8 mm. wide, with rounded tips, not reflexed with age, possessing triangular to acicular bristles in 1 or 2 rows on the midveins beneath and in 2 rows on each margin beneath, the margins tending to be involute, the upper leaf surfaces glabrous; inflorescences of cymules, terminal, once or twice branched, with 2-4 flowers, not overtopped by lateral branches; corollas white, with 4 acute lobes, each lobe longer than wide; fruits glabrous. Figs. 20-21.

G. obtusum and *G. labradoricum* are quite similar, both being characterized by ovaries and fruits without bristles, leaves not bristle-tipped, and corollas with four acute lobes. If the latter character cannot be ascertained, one may resort to a unique character of these two species. In both species, the margins of the leaves are usually rolled back and the marginal bristles, which are straight, face inwards toward each other. This character is found in no other Minnesota species of *Galium*.

The most noticeable difference between these two species concerns the bristles on the midveins of the under surfaces of the leaves; these being present in *G. obtusum* and absent in *G. labradoricum*. Also, leaf shape differences and leaf number per whorl, as is pointed out in the key, are reliable characteristics. The reflexing of the leaves, a characteristic found in most keys, is frequently misleading. The leaves of *G. obtusum* are never reflexed. On the other hand, many specimens of *G. labradoricum* are found to have either no reflexing of the leaves or merely a few reflexed leaves. However, a plant with strongly reflexed leaves is always *G. labradoricum*.

9. *GALIUM LABRADORICUM* Wieg.

Perennial; stems simple or branched above, small throughout, 8-30 cm. tall, the ribs glabrous or occasionally with thin, short, retrorse bristles, the nodes with downwardly directed acicular bristles; leaves principally in whorls of 4, linear-oblongate to spatulate, with rounded tips, 1-3 mm. wide, with 2 rows of acicular bristles on each inrolled margin, glabrous on the midveins beneath and on the upper surfaces; leaves usually soon reflexed, infrequently, however, not reflexed; cymules 3-flowered, soon overtopped; corollas white, with

4 acute lobes, each lobe longer than wide; fruits glabrous. Figs. 22-23.

This species is similar to *G. obtusum*. See under the latter species for a discussion of similarities and dissimilarities of the two.

10. *GALIUM CONCINNUM* T. & G.

Perennial; stems weak, much branched, the ribs smooth or irregularly armed with weak, retrorse, conical bristles; nodes matted with downwardly facing, acicular bristles; leaves principally in whorls of 6, linear to narrowly elliptic-lanceolate, bristle-tipped, with apically facing weak, conical bristles on the upper marginal surface (frequently there is a second row of retrorse marginal bristles); inflorescences of cymes, terminal or from the upper axils, twice or thrice branched, the ultimate branches usually ending in 2-flowered cymules; corollas white, 4-lobed; fruits glabrous. Figs. 24-25.

G. concinnum and *G. asprellum* are characterized by glabrous fruits and sharply acute or bristle-tipped leaves. They may be separated from each other by observing the bristles on the margins of the leaves. In *G. concinnum*, they face apically; in *G. asprellum*, they are retrorse. Infrequently, however, *G. concinnum* possesses irregularly placed, retrorse bristles in addition to the apically-facing bristles on the margins. It is, therefore, best to utilize the leaf shape as the more significant criterion.

11. *GALIUM ASPRELLUM* Michx.

Perennial; stems weak, much branched, with retrorse, conical bristles on the ribs, the nodes with downwardly facing, acicular bristles; leaves principally in whorls of 6, oblongate, to 6 mm. wide, sharply acute or bristle-tipped, with retrorse, conical bristles on the margins and midveins beneath, frequently with apically facing bristles on the upper surfaces; inflorescences terminal and axillary, once, twice or thrice branched, yielding a loose panicle of cymules; corollas 4-lobed, white; fruits glabrous. Figs. 26-27.

A comparison of this species and *G. concinnum*, with which it is sometimes confused, is provided under the latter species.