

# THE GENUS *GERANIUM* L. (*GERANIACEAE*) IN NORTH AMERICA. I. ANNUAL SPECIES

by

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## Resumen

AEDO, C. (2000). El género *Geranium* L. (Geraniaceae) en Norteamérica. I. Especies anuales. *Anales Jard. Bot. Madrid* 58(1): 39-82 (en inglés).

Se revisan las especies anuales de *Geranium* de Norteamérica al norte de México. Se aceptan once especies de las cuales seis pertenecen al subg. *Geranium* y cinco al subg. *Robertium*. *Geranium bicknelli*, *G. carolinianum*, y *G. texanum* son las únicas especies autóctonas, mientras que *G. aequale*, *G. columbinum*, *G. dissectum*, *G. lucidum*, *G. molle*, *G. pusillum*, *G. robertianum* y *G. rotundifolium* fueron introducidas desde el Viejo Mundo. *Geranium sphaerospermum*, a veces aceptado en la literatura reciente, es considerado como sinónimo de *G. carolinianum*. Se revisa la nomenclatura de todas las especies y se designan ocho lectótipos. Se incluyen descripciones completas, una clave, mapas de distribución e ilustraciones.

Palabras clave: *Geranium*, *Geraniaceae*, taxonomía, tipificaciones, Norteamérica.

## Abstract

AEDO, C. (2000). The genus *Geranium* L. (Geraniaceae) in North America. I. Annual species. *Anales Jard. Bot. Madrid* 58(1): 39-82.

Annual species of *Geranium* from North America north of Mexico are revised. Eleven species are accepted, of which six belong in subg. *Geranium* and five belong in subg. *Robertium*. *Geranium bicknelli*, *G. carolinianum*, and *G. texanum* are the only native species, whereas *G. aequale*, *G. columbinum*, *G. dissectum*, *G. lucidum*, *G. molle*, *G. pusillum*, *G. robertianum*, and *G. rotundifolium* were introduced from the Old World. *Geranium sphaerospermum*, sometimes accepted in current literature, is considered to be a synonym of *G. carolinianum*. Nomenclature for all species is reviewed, and eight lectotypes are designated. Descriptions, key, distribution maps, and illustrations are included.

Key words: *Geranium*, *Geraniaceae*, taxonomy, typification, North America.

## INTRODUCTION

The genus *Geranium* L. (*Geraniaceae*) is distributed throughout most of the world. A brief history of generic delimitation and infrageneric classification, as well as a description of the genus, can be found in AEDO

(1996). *Geranium* comprises about 430 species and is divided, according to the currently accepted classification (YEO, 1984), into three subgenera: subg. *Geranium*, subg. *Erodioidea* (Picard) Yeo, and subg. *Robertium* (Picard) Rouy. Only subgenus *Erodioidea* has been monographed recently (AEDO, 1996). *Gera-*

*nium* subg. *Geranium* comprises over 380 species, grouped in at least 10 sections. Some of these sections have been revised (DAVIS, 1970; CARLQUIST & BISSING, 1976), but much more work is necessary to attain a satisfactory knowledge of subgenus *Geranium*. According to YEO's (1984) sectional classification, subgenus *Robertium* comprises eight sections and 30 species. Some of these sections have also been revised (YEO, 1973; YEO, 1992; AEDO & *al.*, 1998a). A world checklist of the genus (AEDO & *al.*, 1998b) summarises recent advances in classification, as well as provides an account of accepted species, and their distribution.

An early study of *Geranium* in North America was made by TRELEASE (1888), who recognised seven annual species and eight perennial ones. After that, many regional treatments of the genus were carried out. A comprehensive approach was published by HANKS & SMALL in 1907. In this revision 64 species of *Geranium* are recognised as North American Flora, including 13 annuals. It should be noted that these authors included Mexico in their account. FERNALD (1935) studied *G. carolinianum* and allies, some of them perennials. This author focused his account in *G. bicknellii* and *G. carolinianum*, and described two new taxa.

KARTESZ (1998) indicates the presence in Illinois of *G. divaricatum* Ehrh. as "possible but unconfirmed". I was not able to find any specimen of this species from America. *Geranium divaricatum* belongs to sect. *Divaricata*, which is characterised by its inoperative fruit-discharge mechanism and its cotyledons with incised margin. The most distinctive feature of this species is the transversely ribbed mericarp, which has thin walls and no longitudinal crest (fig. 18b; AEDO & *al.*, 1998a).

The area covered in this paper includes North America north of Mexico plus Greenland, since this study has been carried out for Flora of North America project, which includes the above mentioned area. The study of *Geranium* from North America has been divided in two parts for operative reasons. The first part, here presented, includes annual

and biennial species. A second paper in preparation will revise perennial species (ten native and ten introduced), most of them belonging to subg. *Geranium*: The aim of the whole study is to provide a comprehensive and modern taxonomic synthesis of *Geranium* for this area.

#### MATERIALS AND METHODS

This revision is based on more than 2500 herbarium specimens from the following herbaria: ALA, BM, BRIT, CAN, CAS, COI, CTES, DAO, DUKE, F, G, GA, GH, ILL, IND, K, KE, KY, MA, MICH, MIN, MO, MONTU, MOR, MSC, NA, NDG, NY, OKL, OSC, P, PH, QFA, RENO, S, TEX, VEN, VT, W, WIS, and WVA. Furthermore, microfiches, photographs, and other data have been examined from LINN, and NDG. Curators from ANSM, COLO, CS, DWC, FWVA, ILLS, KSC, MEXU, MONT, NCU, NEB, NMC, TEN, UAT, URV and UWL kindly answered our petition, but they did not find any of the requested specimens in their herbaria.

The three native species (*G. bicknellii*, *G. carolinianum* and *G. texanum*) have been more thoroughly studied in some aspects such as morphology, synonymy, and distribution.

In those native species a search of micro-morphological characters has been carried out by scanning electron microscopy (SEM). Samples were glued to aluminium stubs, coated with 40-50 nm gold, and examined with a JEOL-TSM T330A scanning electron microscope at 15 kV.

For introduced species only synonyms described from North America are indicated, while a comprehensive synonymy is provided for natives ones.

For the three native *Geranium* maps cover the total range of the each species including North America and other areas where they have been introduced. For the introduced species maps are restricted to its North American area.

## KEY TO THE SPECIES

1. Fertile stamens 5 ..... **9. G. pusillum**
1. Fertile stamens 10.
  2. Sepals with lengthwise keels and transverse flaps between these ..... **10. G. lucidum**
  2. Sepals smooth.
    3. Mericarps reticulate.
      4. Mericarps without collars at apex, transversely wrinkled ..... **8. G. molle**
      4. Mericarps with 1-2(3) collar-like rings round the apex, reticulate ..... **11. G. robertianum**
    3. Mericarps smooth.
      5. Mericarps with a basal prong, without callus ..... **6. G. dissectum**
      5. Mericarps without a basal prong, with callus.
        6. Mericarps glabrous on most of the surface, densely ciliate at the base ..... **7. G. aequale**
        6. Mericarps hairy on most of the surface.
          7. Fruit rostrum with a narrowed apex 2-6 mm long.
            8. Peduncles without glandular hairs .... **4. G. columbinum**
            8. Peduncles with glandular hairs.
              9. Leaves divided more than 0.85 of their length ..... **1. G. bicknellii**
              9. Leaves divided for 0.50-0.65 of their length ..... **5. G. rotundifolium**
          7. Fruit rostrum with a narrowed apex less than 2 mm long.
            10. Pedicels with patent, glandular and eglandular hairs, sometimes with retrorse, not appressed eglandular hairs; mericarps densely hairy, with hairs 0.5-1.8 mm long ..... **2. G. carolinianum**
            10. Pedicels with retrorse, appressed glandular hairs; mericarps sparsely hairy, with hairs 0.2-0.7 mm long ..... **3. G. texanum**

## TAXONOMY

I. *Geranium* subg. *Geranium*

Fruit of "seed-ejection-type" with seeds actively discharged by the explosive recoiling of the awn, which remains together with the mericarp attached to the columella; mericarps with basal callus or prong.

1. *Geranium bicknellii* Britton in Bull.

Torrey Bot. Club 24: 92 (1897)

*G. nemorale* var. *bicknellii* (Britton) Fernald in *Rhodora* 43: 35 (1941), nom. illeg.

*Ind. loc.*: "Nova Scotia (?) Maine to Western Ontario and southern New York"

*Typus.*: U.S.A. New York, Van Cortlandt Park, 23 June 1895, *Bicknell s.n.* (lectotype, here designated, NY!)

= *G. carolinianum* var. *longipes* S. Watson, *Botany* [fortieth parallel]: 50 (1871); *G. longipes* (S. Watson) Goodd. in *Bot. Gaz.* (Crawfordsville) 37: 56 (1904), nom. illeg., non DC. (1824); *G. bicknellii* var. *longipes* (S. Watson) Fernald in *Rhodora* 37: 297 (1935)

*Ind. loc.*: "This form also frequent in California and is 111 Parry from Colorado. (206)"

*Typus.*: U.S.A. Colorado, head-waters of Clear Creek and the alpine ridges lying east of Middle Park, 1861, *Parry III* (lectotype, here designated, MO!) [see also FERNALD, 1935: 297]

= *G. nemorale* Suksd. in *Deutsche Bot. Monatsschr.* 16: 222 (1898)

*Ind. loc.*: "Im westl. Teil von Klickitat-County, 10. Juni 1891 und früher (1880); in Spokane-County, 1889; in Skamania-County, 1894; und auch bei Milwaukee in Oregon, Juli 1893"

*Typus.*: U.S.A. Washington, Klickitat Co., 10 June 1891, *Suksdorf 2028* (lectotype, here designated, MO!; *isolectotype*, F!) [see also FERNALD, 1935: 297]

Herbs, annual, 15-50 cm tall. Stem erect or decumbent, usually branched from the base, pilose, with glandular and eglandular, patent hairs 0.1-0.85 mm long. Basal leaves in a ± deciduous rosette; lamina 2.5-6.4 × 3.2-

7.1 cm, polygonal in outline, palmatifid –divided for 0.85–0.95 of its length–, pilose, with eglandular, appressed hairs; segments 5(7), rhombic, 1–2(5) mm wide at the base, 5–11-lobed in distal half –ratio main-sinus length of the middle segment/middle-segment length = 0.29–0.42–; lower cauline leaves alternate, median and upper opposite; petioles to 9 cm long, with patent, eglandular and glandular hairs 0.2–0.85 mm long; stipules 5–9 × 1–2 mm, lanceolate, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Cymules (1)2(3)-flowered, not in dense aggregates at the top of each branch; peduncles (0)1–4(7) cm long, pilose, with glandular and eglandular, patent hairs 0.1–1 mm long; bracteoles 5–6 × 1 mm, lanceolate, pilose with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 1–2.5 cm long, pilose, with glandular and eglandular, patent hairs 0.1–1 mm long; pedicel and peduncle together often overtopping the subtending leaf. Sepals 4–6 × 2–2.5 mm –ratio pedicel length/sepal length = 0.37–0.53–, smooth, accrescent, 3-nerved, mucronate (with mucro 0.5–2 mm long), with scarious margins 0.1–0.2 mm wide, with glandular and eglandular hairs 0.2–0.6 mm long on the abaxial side (mainly on the nerves), glabrous on the adaxial side. Petals 4–6 × 2–3 mm, emarginate (with notch 0.5 mm deep), without claw, glabrous on the adaxial side, ciliate on the basal margin, pale purple. Stamens 10, both whorls bearing anthers; filaments 3–4 mm long, lanceolate, glabrous except for a some cilia on the proximal half; anthers 0.5–0.6 × 0.2 mm, dark bluish. Nectaries glabrous. Gynoecium ca. 5 mm long. Fruit 21–25 mm long; mericarps 3–3.5 × 2 mm, without a strand of fibres, smooth, without longitudinal rib, with a basal callus, covering the seed completely, with eglandular, antrorse hairs 0.4–0.9 mm long, blackish; rostrum 16–21 mm long, with a narrowed apex 3.5–4.5 mm long, with patent, eglandular hairs ca. 0.1 mm long, and patent, glandular hairs 0.2–0.3 mm long; stigmatic remains ca. 1 mm long, with 5 hairy lobes. Seeds 1.6–1.7 × 0.9–1 mm, pitted, reddish, the

hilum 1/6 as long as the perimeter. Cotyledons entire.  $2n = 52$ .

Flowering January–August. Open woods, clearings and disturbed areas; 800–2300 m. Canada and U.S.A.; introduced in Venezuela (Fig. 2).

*Illustrations.* Figs. 1, 3a, 3d, 4a, 4d; HOLMGREN (1998: 340 fig. 8).

This species may be separated from *G. carolinianum* and *G. texanum* by its long narrowed apex of the fruit rostrum. These three annuals, native of North America, share the accrescent calyx and the blackish mericarps. The first character suggests a relation with *G. columbinum*. This is also supported by the form of calyx, which is similar in the four species. However, chromosome numbers ( $2n = 18$  in the case of *G. columbinum* and  $2n = 52$  in *G. bicknellii* and *G. carolinianum*) do not support a close relationship among the European and the American species.

The blackish mericarps of *G. bicknellii* (and allies) are similar to *G. bohemicum* L., which could be a pyrophyte adaptation. MILBERG (1994) suggested that *G. bohemicum* can emerge from a bank of long-lived seeds after forest fires. ABRAMS & DICKMANN (1984) indicated a heat requirement for germination of buried seed of *G. bicknellii*. However, the different morphology of the fruit (in *G. bohemicum* there is no callus) suggests that it was acquired independently.

*Geranium bicknellii* shows a pollen grain with great variation in size supracteal elements, including gemmae. It is similar to many *Geranium* species according to BORTENSCHLAGER (1967), VERHOEVEN & VENTER (1992), and STAFFORD & BLACKMORE (1991).

KNUTH (1912: 54) recorded this species from Mexico: “bei San Luis Potosi (Schaffner, Fl. Mexic. N. 188! Herb. Schaffner n. 459!)”. Later, MOORE (1943) identified Schaffner’s collection as *G. kerberi* R. Knuth.

So far, the specimens supporting the following records of *G. bicknellii* have not

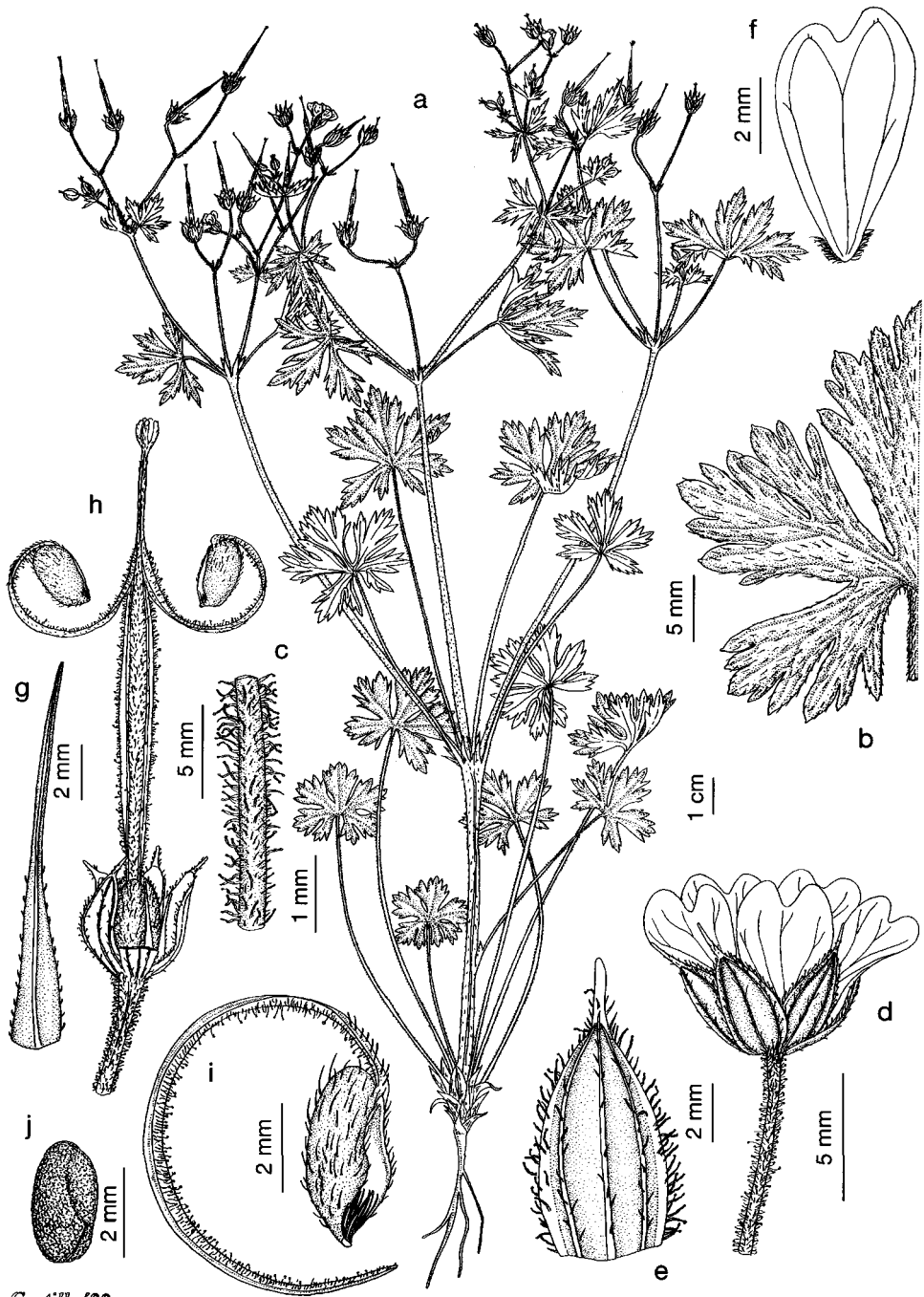


Fig. 1.—*Geranium bicknellii*: a, habit; b, leaf; c, peduncle; d, flower; e, sepal; f, petal; g, staminal filament; h, fruit; i, mericarp; j, seed. a-g, Gorman 6129 (NY); h-j, Christ & Smith 15221 (NY).

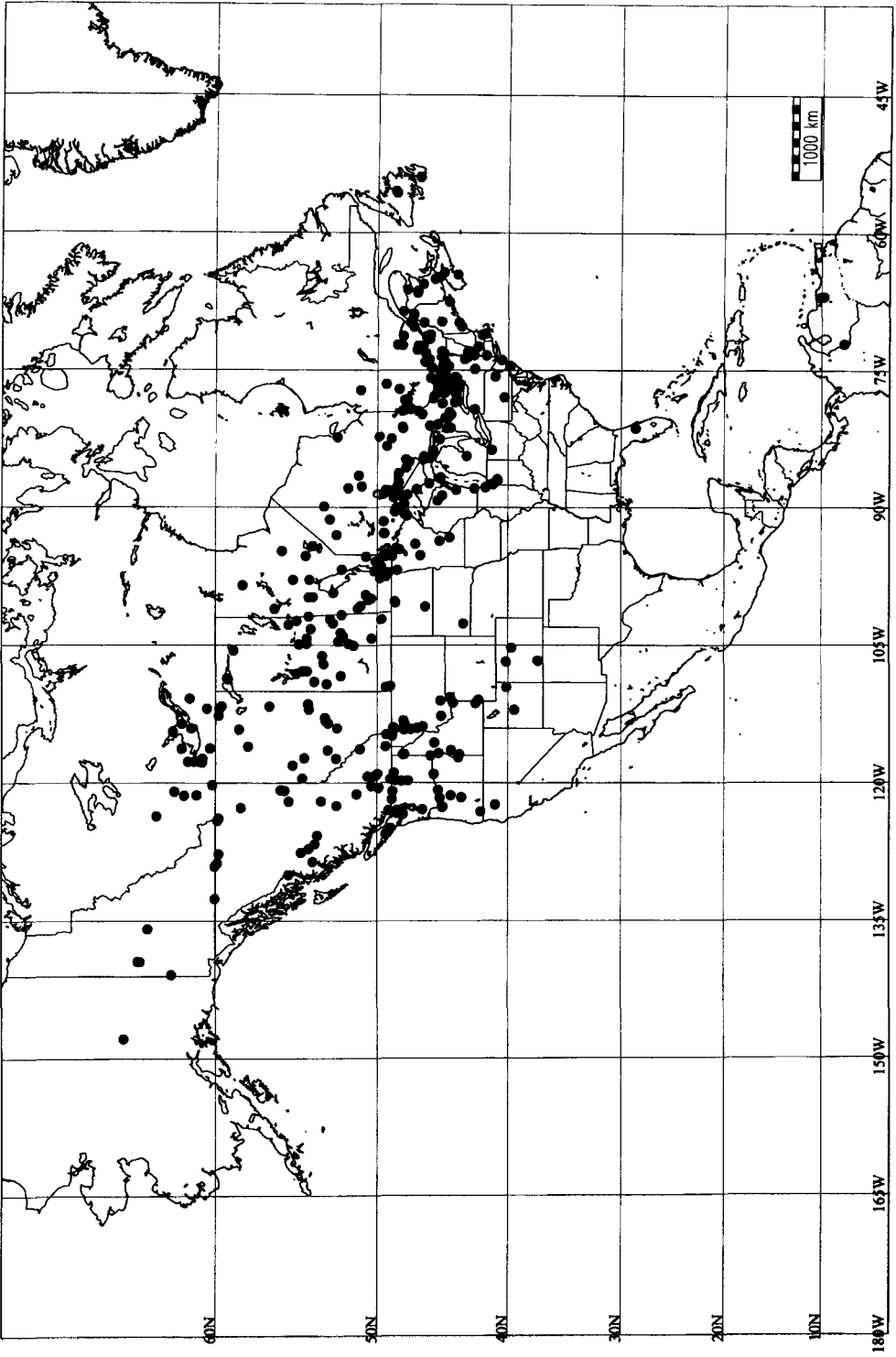


Fig. 2.—Distribution of *Geranium bicknellii*.

been studied: Connecticut (SEYMOUR, 1969: 367), Iowa (EILERS & ROOSA, 1994: 98), Missouri (KARTESZ, 1998), Tennessee (WOFFORD & KRAL, 1993: 45), Virginia (KARTESZ, 1998), and West Virginia (STRAUSBAUGH & CORE, 1978: 586).

### Representative specimens examined

CANADA. ALBERTA: Beaverlodge, 55°11'N, 119°29'W, 18-VI-1971, *Henn 88* (DAO); Brazeau National Forest, forest road between Cadomin and Hinton, 53°2'N, 117°20'W, 29-VIII-1957, *Porsild 20852* (CAN); Bruderheim, 53°45'N, 112°51'W, 18-VIII-1952, *Boivin & al. 10190* (DAO); Cameron Lake, 49°1'N, 114°4'W, 17-VII-1953, *Breitung 16135* (F); Crow's Nest Forest reserve, 49°38'N, 114°42'W, 10-VIII-1915, *Malte 216* (CAN); Eastern edge of Caribou Mountain plateau, 58°54'N, 114°9'W, 23-VII-1930, *Raup 2811* (CAN). BRITISH COLUMBIA: Lumby, 50°15'N, 118°58'W, 14-VI-1955, *Lindsay & Woodbury 1071* (DAO); 10 mi NW of Houston along road to Smithers, 54°24'N, 126°40'W, 12-VII-1954, *Calder & al. 12864* (DAO); 5 mi NNE of Gateway, 51°40'N, 121°13'W, 15-VI-1953, *Calder & Savile 9228* (DAO); 5 mi SSE of town of Burns Lake, 54°14'N, 125°45'W, 23-VII-1954, *Calder & al. 13463* (DAO); Agassiz, 49°14'N, 121°46'W, 2-VI-1931, *Groh s.n.* (DAO); Armstrong, 50°27'N, 119°14'W, 20-VI-1910, *Davidson s.n.* (DAO); Cathedral Park, Ashnola Road, mi 33, 49°28'N, 122°58'W, 21-VII-1976, *Hainault 7929* (DAO). MANITOBA: Brokenhead, 50°4'N, 95°29'W, 21-VI-1952, *Mosquin 194* (DAO); Churchill, Gillam, 56°25'N, 94°45'W, 29-VII-1950, *Schofield 1285* (DAO); Churchill, The Pas, Indian Reserve, 58°42'N, 98°28'W, 27-VII-1955, *Krivida 1594* (DAO); Cross Lake, Whitemud Falls, 54°44'N, 97°52'W, 7-VII-1948, *Scoggan 3512* (CAN); Duck Mountain prov. Park by Hwy 366, 5 mi S of Baldy Mtn, 51°35'N, 101°0'W, 12-VII-1971, *Longton 3206* (DAO); Duck Mountain, Swan river, 51°35'N, 101°0'W, 28-VIII-1967, *Baldwin 11577* (QFA); Grand Rapids, Lake Winnipeg, 53°12'N, 99°18'W, 5-VIII-1948, *Scoggan 4358* (CAN); Herb Lake, between Laguna and Ferro Mines, 54°46'N, 99°46'W, 7-VIII-1949, *Scoggan 6500* (QFA). NEW BRUNSWICK: Albert, 45°45'N, 64°47'W, (DAO); North Co., 5 mi E of Pople Depot, 47°24'N, 66°20'W, 13-VII-1960, *Cater s.n.* (DAO); Northumberland Co., 15 mi S of Newcastle, 47°0'N, 65°34'W, 22-VIII-1956, *Scoggan 13515* (CAN); Westmoreland Co., 24 mi W of Berry Mills, 46°7'N, 65°0'W, 30-VII-1953, *Bassett & G.A. Mulligan 2947* (DAO). NEWFOUNDLAND I: 15 mille N of Placentia Junction, 47°14'N, 53°58'W, 10-VIII-1894, *Robinson & Schrenk s.n.* (MO); Exploits River, Bishop's Falls, 49°1'N, 55°29'W, 23-VII-1988, *Bouchard & al. 88197* (CAN); Grand Falls, near Paragon hotel, 48°56'N, 55°41'W, 26-VI-1958, *Rouleau 4465* (CAN). NORTH-WEST TERRITORIES: Entrance Mackenzie river Highway, pr. Kakisa lake, 60°56'N, 117°43'W, 10-VII-1959, *Thieret & Reich 5097* (CAN); Great Slave Lake, 61°30'N, 114°0'W, 3-VIII-1961, *Thieret & Reich 8385* (F); 5 mi SE of Trainor Lake, 60°23'N, 120°12'W,

12-VIII-1973, *Reid 770* (CAN); Mackenzie, 1 mi NE of MacKenzie River opposite Fort Simpson, 61°52'N, 121°22'W, 26-VI-1961, *Cody & Spicer 11327* (DAO); along the Mackenzie river-Yellowknife Hwy, mile 98.5, 62°0'N, 116°15'W, 26-VII-1961, *Thieret & Reich 8159* (DAO). NOVA SCOTIA: Cumberland Co., New Prospect, 45°26'N, 64°16'W, 26-VI-1953, *Schofield 3134* (DAO); Lunenburg Co., Bridgewater, 44°23'N, 64°31'W, 18-VIII-1921, *Ferland & B. Long 24083* (CAN). ONTARIO: Albany River, Martin Falls, 51°32'N, 86°30'W, 18-VIII-1952, *Dutilly & al. 30501* (QFA); Algoma, Gros Cap, 46°32'N, 84°36'W, 29-VI-1976, *Riley & Hoy 3039* (DAO); Algoma, Mamainse Pt., 47°0'N, 84°45'W, 13-VII-1935, *Taylor & al. 1321* (CAN); vicinity of Michipicoten Harbour, 48°0'N, 85°0'W, 25-VI-1938, *Hosie & al. 1326* (MO); Algoma, St Joseph Island, 46°15'N, 83°46'W, 2-VIII-1954, *Jenkins & Nott 4959* (DAO); Algonquin Park, 1 mi S of Petawawa River, 45°55'N, 77°15'W, 11-VI-1970, *Brunton 312* (DAO); Arnprior, 45°26'N, 76°21'W, 3-VI-1949, *Lindsay & Thompson 42* (DAO); Big Trout Lake, 53°49'N, 89°53'W, 2-VIII-1956, *Hustich 1694* (CAN); Bruce Co., creek out of Gillies Lake, 45°12'N, 81°20'W, 16-VI-1979, *Darbyshire 759* (DAO); Bruce Peninsula, 44°55'N, 81°15'W, 1956, *Launden s.n.* (DAO); Carleton Co., 1 mile N of Harwood Plains, 45°20'N, 75°35'W, 3-VII-1947, *Dore & Calder 47-246* (MO). QUEBEC: 35 mi N de Senneterre, 48°44'N, 77°3'W, 28-VII-1957, *Dutilly & Lepage 35068* (QFA); Abitibi Co., Hébécourt, 48°30'N, 79°25'W, 29-VII-1980, *Gauvin & al. 80-307* (CAN); Abitibi, lac Malartic, 48°9'N, 78°9'W, 12-VII-1927, *Fortier & Chauret 239* (DAO); Bonaventure Co., Carleton, 48°8'N, 66°10'W, 23-VII-1904, *Collins & al. 4377* (F); Cap aux Corbeaux, 47°58'N, 69°46'W, 19-VII-1936, *Gosselin 36232* (QFA); Cascades, 45°35'N, 75°52'W, 31-IX-1930, *Rolland 16053* (F); Charlevoix Co., Saint-Pamphile, 46°58'N, 69°47'W, 21-VII-1937, *Boivin 1430* (DAO); Châteauguay Co., Cairnside, 46°43'N, 71°15'W, 3-VI-1961, *Cinq-Mars s.n.* (QFA); Chelsea, 45°30'N, 75°47'W, 6-VI-1901, *Fletcher s.n.* (DAO); Chicoutimi Co., Chicoutimi, 46°28'N, 71°6'W, 27-VI-1933, *Anselme 1057* (DAO); Chicoutimi Co., St-Ambroise, 48°28'N, 71°16'W, 18-VI-1970, *Bouchard 70-551* (DAO); Deux-Montagnes Co., La Trappe, 46°52'N, 74°4'W, 4-VII-1943, *Louis-Marie s.n.* (MA); Deux-Montagnes Co., Papineauville, 45°37'N, 75°2'W, VI-1937, *Desile s.n.* (QFA). SASKATCHEWAN: 10 mi W of Saint Walburg, 53°39'N, 109°12'W, 8-VIII-1972, *Looman 17904* (QFA); 3 mi W of McKague, 52°37'N, 103°56'W, *Breitung 1233* (DAO); 45 mi N of Green Lake, 54°54'N, 107°49'W, 10-VI-1972, *Harms 18723* (DAO); Battleford, 52°44'N, 108°19'W, 4-VII-1911, *Robbins s.n.* (DAO); Big River, 53°50'N, 107°1'W, 1-X-1939, *Groh 1171* (DAO); Bjorkdale, 52°43'N, 103°39'W, 1942, *Hart s.n.* (DAO); Cypress Hills Park, 49°40'N, 109°31'W, 8-VII-1947, *Breitung 4470* (MO); Sulphide Lake, 55°22'N, 104°54'W, 3-X-1941, *Hart 3-15* (DAO); Uranium City, 59°35'N, 108°35'W, 13-VIII-1966, *Cody 16193* (DAO); Wallwort, 52°33'N, 104°3'W, 4-VII-1936, *Breitung s.n.* (NA); Wapawekka Hills, 54°53'N, 104°16'W, 28-VII-1980, *Harms 28979* (DAO). YUKON: 13 km NW of Beaver Creek, 62°30'N, 140°51'W,

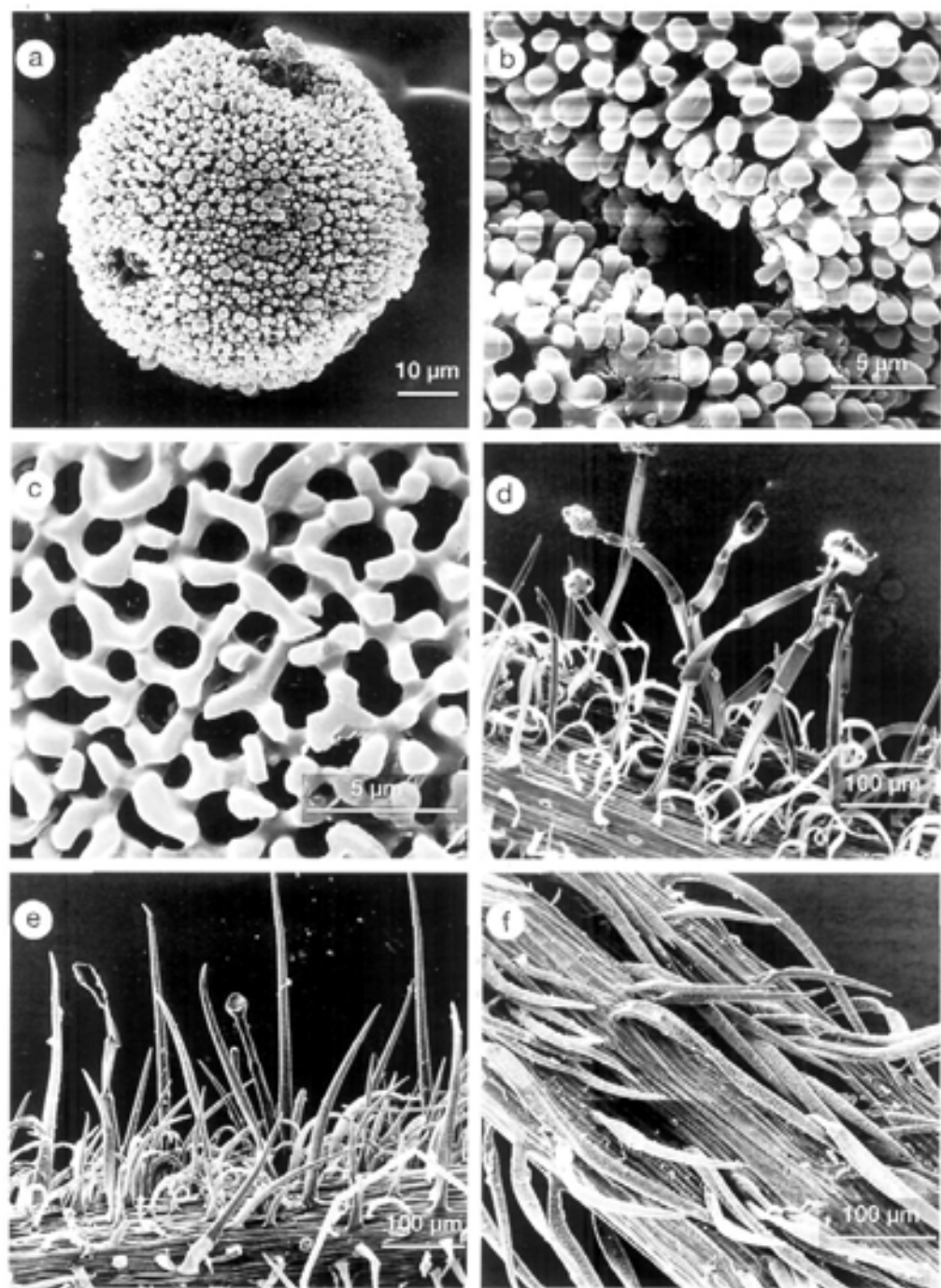


Fig. 3.—Pollen SEM photomicrographs of: a, *Geranium bicknellii* [Lepage 36046 (QFA)]; b, *G. carolinianum* [McCoy 1662 (NY)]; c, *G. texanum* [Cory 487 (GH)]. Pedicels SEM photomicrographs of: d, *G. bicknellii* [Cousineau 43581 (QFA)]; e, *G. carolinianum* [Nelson 8203 (NY)]; f, *G. texanum* [Carr 11692 (TEX)].



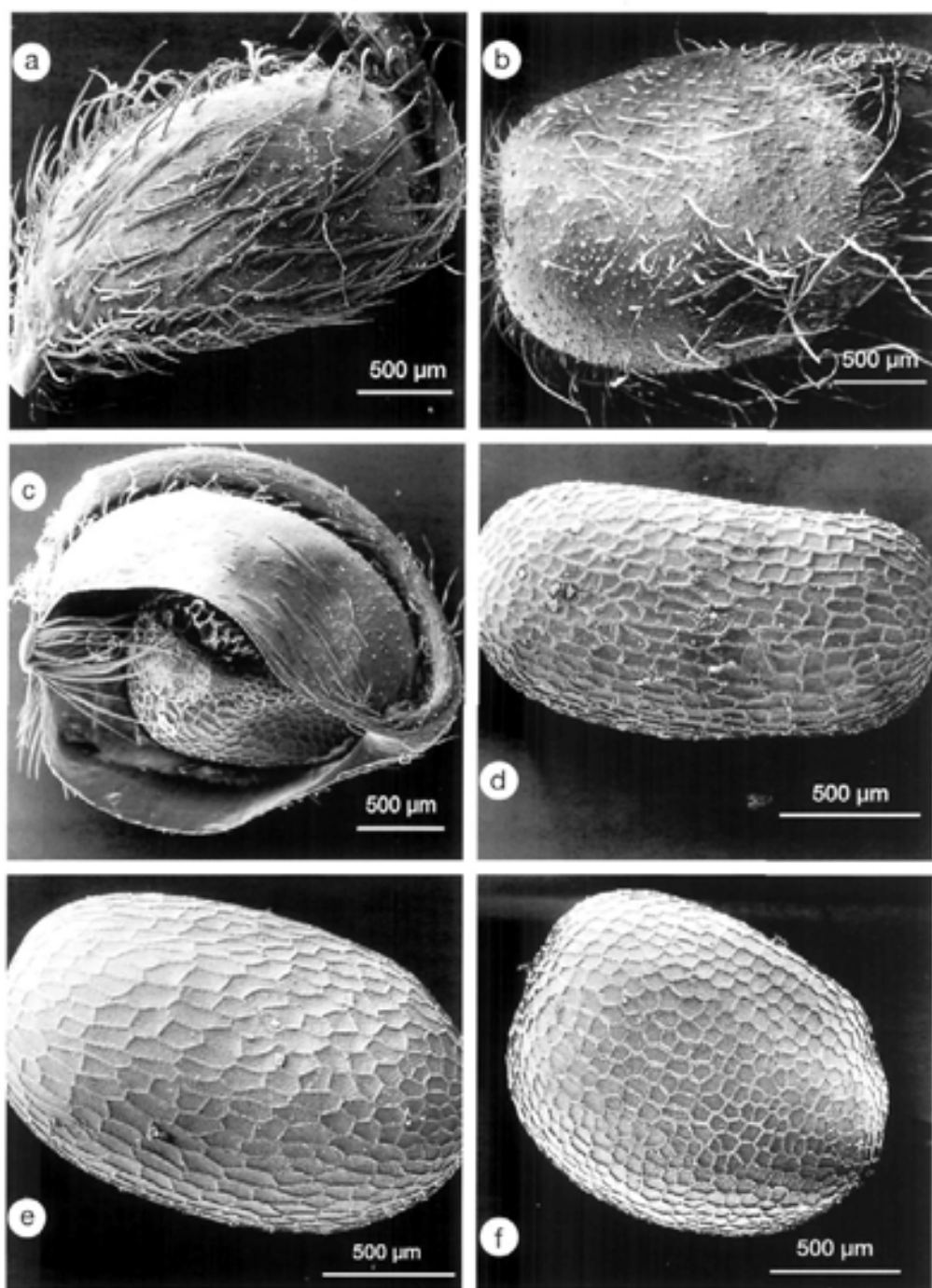


Fig. 4.—Mericarps SEM photomicrographs of: a, *Geranium bicknellii* [Cousineau 43581 (QFA)]; b, *G. carolinianum* [Nelson 8903 (NY)]; c, *G. texanum* [Thieret 33007 (GH)]. Seeds SEM photomicrographs of: d, *G. bicknellii* [Dickson 11577 (QFA)]; e, *G. carolinianum* [Nelson 8903 (NY)]; f, *G. texanum* [Thieret 33007 (GH)].

6-VI-196, *Bennett 97-30* (DAO); 2 mi S of West Dawson on road to Sunnydale, 64°3'N, 139°25'W, 30-VI-1949, *Calder & Billard 3400* (DAO); Columbia Gas Plant, Site E-37, 60°6'N, 124°7'W, 26-VIII-1980, *Smith 9* (DAO); contact Creek Esso Station, Alaska Hwy km 949, 60°1'N, 127°44'W, 9-VII-1983, *Cody 32477* (DAO); Dawson, S slope of Moosehide Mountain, 64°10'N, 139°23'W, 19-VII-1949, *Calder & Billard 3783* (DAO); La Biche River, 60°1'N, 123°54'W, 15-VI-1995, *Bennett 95230* (DAO).

U.S.A. ALASKA: College, 64°51'N, 147°48'W, 27-VII-1931, *Anderson 1270* (NA). CALIFORNIA: Siskiyou Co., Deetz Station near Black Butte, 41°21'N, 122°22'W, 26-VIII-1914, *Heller 11715* (MO). COLORADO: Headwaters of Clear Creek and the alpine ridges lying east of Middle Park, 37°48'N, 106°40'W, 1861, *Parry III* (MO); Juleh, Boulder, 40°0'N, 105°16'W, 24-VII-1906, *Daniels s.n.* (MO); Routt Co., Fish Creek Falls, 40°28'N, 106°46'W, 21-VII-1903, *Gooding 1646* (NY). FLORIDA: Volusia Co., De Land, 29°1'N, 81°18'W, *Harkness s.n.* (MO). IDAHO: Adams Co., Starkey, 44°51'N, 116°26'W, 24-VIII-1941, *Christ 12944* (NY); Bonner Co., Coolin, 48°28'N, 116°50'W, 6-VII-1946, *Christ & Smith 15221* (NY); Caribou Co., Williamsburg, 42°56'N, 111°15'W, 3-VII-1978, *Shultz & Shultz 2710* (NY); Idaho Co., Selway River, 46°8'N, 115°35'W, 2-VII-1941, *Davis 3759* (NY); Lewiston, 46°25'N, 117°1'W, 31-V-1892, *Sandberg & al. 279* (NY). ILLINOIS: Cook Co., Braeside, 42°9'N, 87°46'W, 9-VIII-1925, *Benke 4120* (F); Cook Co., Glencoe, 42°8'N, 87°45'W, 20-VIII-1912, *Sherff 1734* (MO). INDIANA: Clarke, 41°37'N, 87°24'W, 20-VI-1895, *Beb 85* (F); Lake Co., 1 mi S of Griffith, 41°31'N, 87°25'W, 12-VII-1920, *Deam 31631* (IND); Pulaski Co., 3 mi SW of San Pierre, 41°12'N, 86°53'W, 26-VI-1930, *Deam 48970* (IND); Starke Co., 3 mi N of Ora, 41°10'N, 86°63'W, 14-VII-1920, *Deam 31855* (IND). OHIO: Lucas Co., Todd, 41°39'N, 83°40'W, 28-VI-1984, *Hardin s.n.* (KE). MAINE: Androscoggin Co., Auburn, 44°5'N, 70°13'W, VIII-1898, *Merrill s.n.* (NY); Augusta, 44°18'N, 69°46'W, *Robbins s.n.* (NY); Lake Mosehead, 45°38'N, 69°40'W, 28-VIII-1871, *Portier s.n.* (NY); Washington Co., 45°0'N, 67°30'W, 9-VII-1909, *Wiegand 403* (NY). MASSACHUSETTS: Berkshire Co., Bartholomew's Cobble, near Sheffield, 42°6'N, 73°21'W, 23-VI-1924, *Freeman s.n.* (NA); Blue Hills, W Quincy, 42°15'N, 71°0'W, 17-VI-1891, *Churchill s.n.* (MO); Stoneham, 42°28'N, 71°6'W, 1879, *Churchill s.n.* (MO). MICHIGAN: Delta Co., Burnt Bluff, 45°41'N, 86°42'W, 10-VIII-1934, *Hermann 6314* (NA); Keweenaw Co., Lake Glazon, 47°28'N, 88°0'W, 28-VI-1936, *Hermann 7747* (MO); Marquette Co., Marquette, 46°32'N, 87°23'W, 2-VII-1916, *Dodge 167* (NY); Midland Co., Sanford, 43°40'N, 84°22'W, 23-VI-1928, *Dreibach 5850* (NY). MINNESOTA: Clearwater Co., Itasca Park, 47°11'N, 95°12'W, 1-VIII-1929, *Grant 2981* (MO); Crow Co., Gull Lake, 48°9'N, 90°53'W, 19-VII-1946, *Chandler 2881* (MO); Itasca Co., roadside at McDonald's, N of Inger, 47°33'N, 93°59'W, 29-VII-1927, *Johnson 2272* (MO); Lancaster city, Penna, 48°51'N, 96°48'W, VI-1896, *Eby s.n.* (MO); Mille Lacs Co., Milaca, 45°45'N, 93°39'W, VII-1892, *Sheldon s.n.* (MO). MONTANA: Flathead Co., 1 mille S of Columbia Falls, 48°22'N, 114°10'W, 9-VII-1942, *Rogers & Rogers*

1034 (MO); Flathead Lake, Big Fork, 47°53'N, 114°7'W, 17-VII-1908, *Clemens s.n.* (F); Gallatin Co., near Bozeman, 45°41'N, 111°1'W, 23-V-1900, *Chesnut & Jones 154* (NA); Glacier Co., Midvale, 48°25'N, 113°10'W, 26-VI-1903, *Umbach 165* (F); Glacier National Park, Park Creek, 48°21'N, 113°29'W, 3-VII-1934, *Piranian 15808* (MO). NEW HAMPSHIRE: Winchester, Forest Lake, 42°46'N, 72°23'W, 13-VII-1940, *Manning s.n.* (MO). NEW JERSEY: New Jersey, 40°10'N, 74°30'W, *Knieskern s.n.* (MO). NEW YORK: Bronx Co., Bronx, Van Cortland Park, 40°51'N, 73°52'W, 23-VI-1895, *Bicknell s.n.* (NY); Essex Co., Schroon lake, 43°51'N, 73°47'W, 15-VIII-1927, *House 15422* (MO); Herkimer Co., Little Falls, 43°2'N, 74°51'W, 4-X-1903, *Haberer 1372* (F); Shushan, 43°5'N, 73°20'W, 22-VI-1924, *Potter s.n.* (MO); Washington Co., E side Lake George, W base of Pilot Knob, 43°37'N, 73°34'W, 3-VII-1943, *House 28595* (MO); NORTH DAKOTA: Bottineau Co., Lake Metighose, 48°59'N, 100°21'W, 19-VIII-1891, *Wright s.n.* (NY). OREGON: Crook Co., Farewell, 44°3'N, 121°34'W, 18-VII-1894, *Leiberg 474* (NY); Jackson Co., Wimer, 42°32'N, 123°8'W, 25-VI-1892, *Hammond 63* (NY); Mt. Tabor, 45°30'N, 122°35'W, V-1889, *Drake & Dickson s.n.* (F); Multnomah Co., Portland, 45°31'N, 122°40'W, VI-1896, *Drake & Dickson s.n.* (F); near Snake River, 46°11'N, 119°1'W, 28-V-1901, *Cusick 2529* (MO). PENNSYLVANIA: Huntingdon Co., Stone Valley, 40°39'N, 77°55'W, 12-VI-1920, *Gref[?]chwog[?] s.n.* (NY); Lackawanna Co., Scranton, 41°24'N, 75°39'W, 19-VI-1937, *Glowneke 448* (PH). SOUTH DAKOTA: Custer, 46°48'N, 100°47'W, 30-VII-1942, *Degener 16302* (NY); Rapid Canyon, 43°54'N, 102°37'W, 27-VII-[????], *Visher 1576* (F). UTAH: Uinta Co., Vernal, 40°27'N, 109°31'W, 17-VII-1991, *Goodrich 23417* (NY); Young Spring's Dugway, Uintah mts., 39°48'N, 112°0'W, 16-VII-1902, *Gooding 1395* (MO). VERMONT: Clarendon, 43°30'N, 72°58'W, 26-VI-1899, *Eggleston 1089* (MO); Fair Haven, 43°35'N, 73°15'W, 28-V-1916, *Knowlton s.n.* (MO); Twin Mountains, West Rutland, 43°36'N, 72°58'W, VII-1902, *Eggleston 2902* (MO). WASHINGTON: Klickitat Co., 45°52'N, 120°46'W, 10-VI-1891, *Suksdorf 2028* (F); Okanogan Co., along the Okanogan river, 48°5'N, 119°43'W, VIII-1897, *Elmer 527* (MO); San Juan Islands, Friday Harbor, 48°32'N, 123°0'W, 1-VIII-1917, *Zeller 813* (MO); Skamania Co., Little White Salmon River, 45°43'N, 121°38'W, 13-V-1923, *Gorman 6129* (NY); W of Olympia, Grangers Prairie, 47°2'N, 122°53'W, 6-VI-1905, *Townsend s.n.* (MO). WISCONSIN: Brown Co., Ashwaubenon, 44°28'N, 88°4'W, VII-1889, *Schuette s.n.* (NY); Florence Co., Nicolet Forest, 45°33'N, 88°40'W, 6-VI-1938, *Anderson & Lovin 173* (NA); Milwaukee, 43°2'N, 87°54'W, *Lapham s.n.* (MO); Vilas Co., Eagle River, 45°55'N, 89°14'W, VII-1926, *Edmonds s.n.* (MO). WYOMING: Lincoln Co., hills E of Afton, 42°43'N, 110°55'W, 5-VII-1923, *Payson & Armstrong 3371* (MO); Yellowstone National Park, Undine Falls, 44°56'N, 110°38'W, 6-VII-1899, *Nelson & Nelson 5672* (MO).

VENEZUELA: En la Selva Virgen del Ávila, DF, 10°30'N, 66°55'W, 23-VIII-1937, *Vogl s.n.* (VEN); prope coloniam Tovar, 10°9'N, 66°52', V-1854, *Fendler 142* (MO); Sabana de El Junquito, carretera a Colonia Tovar,

cabeceras de Macaras DF, 10°9'N, 66°52'W, 4-XII-1936, *Pittier 13776* (VEN); Táchira, Jáuregui, pr. El Cobre, 8°2'N, 72°3'W, 18-VIII-1988, *Badillo & al. 7935* (F).

**2. *Geranium carolinianum* L., Sp. Pl.: 682 (1753)**

*G. carolinum* Burm. f., Spec. Bot. Geran.: 27 (1759), orthographic variant

*G. atrum* Moench, Methodus: 285 (1794), nom. illeg.

*G. dissectum* var. *carolinianum* (L.) Hook. f., Handb. N. Zeal. Fl.: 36 (1864)

*G. carolinum* Crantz, Inst. Rei Herb. 2: 156 (1766), orthographic variant

*Ind. loc.*: "Habitat in Carolina, Virginia"

*Typus*: U.S.A. Virginia, Clayton 372 (BM, photo!) [lectotype, designated by FAWCETT & RENDLE, 1920: 154]

= *G. lanuginosum* Jacq., Pl. Hort. Schoenbr. 2: 8, pl. 140 (1797), nom. illeg., non Lam. (1788)

*Typus*: locality and collector unknown, specimen annotated as *Hb. Jacq.* (lectotype, here designated, W!)

=? *G. lenticulum* Raf., New Fl. 2: 34 (1837)

*Ind. loc.*: "West Tennessee and Kentucky"  
*Typus*: no original material found

= *G. langloisii* Greene in Pittonia 3: 171 (1897)

*Ind. loc.*: "A common weed in gardens and waste lands at St. Martinsville, Louisiana, where it is collected by Rev. Father Langlois, and has been distributed by him as *G. carolinianum*..."

*Typus*: U.S.A. Louisiana, Saint Martin Co., Saint Martinville, 4 Apr. 1892, *Langlois s.n.* (lectotype, here designated, NDG-27963!)

= *G. thermale* Rydb. in Mem. New York Bot. Gard. 1: 478 (1900)

*Ind. loc.*: "Montana: Lo-Lo Hot Springs, 1898, Williams & Griffith"

*Typus*: U.S.A. Montana, Lo-Lo Hot Springs, 1898, *Williams & Griffith s.n.* (lectotype, here designated, NY!)

= *G. sphaerospermum* Fernald in Rhodora 37: 298, tab. 372, figs. 1-5 (1935); *G. carolinianum* var. *sphaerospermum* (Fernald) Breitw. in Amer. Midl. Naturalist 58: 43 (1957)

*Ind. loc.*: "savannahs, swales and peaty depressions in the limestone pavement,

Great Cloche Island, June 29, 1934, Ferland & Pease, no. 3405 (type in Gray Herb.)..."

*Typus*: Canada. Ontario, Great Cloche Island, 29 June 1934, *Ferland & Pease 3405* (holotype, GH; isotype, K!)

= *G. carolinianum* var. *confertiflorum* Fernald in Rhodora 37: 300, tab. 374 figs. 1-6 (1935)

*Ind. loc.*: "Dry rocky or sandy soil, southern Maine to Wisconsin, south to Delaware, uplands of North Carolina and Tennessee, and Missouri. Type: open field, North Amherst, Lorain Co., Ohio, June 22, 1924, R. J. Webb, no. 5263 in Gray Herb."

*Typus*: U.S.A. Ohio, Lorain Co., North Amherst, 22 June 1924, *Webb 5263* (holotype, GH!)

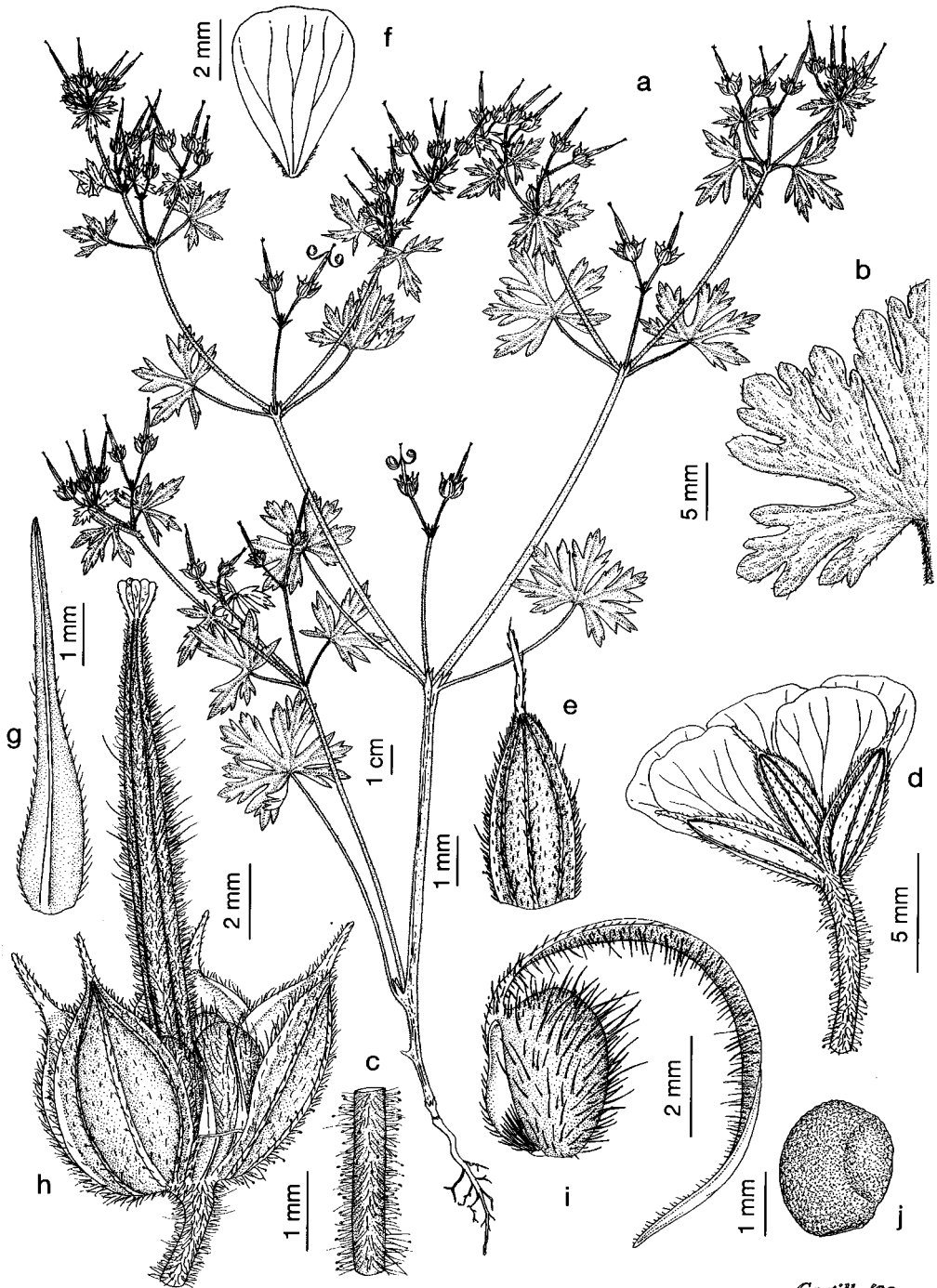
= *G. carolinianum* f. *albiflorum* B. Boivin in Naturaliste Canad. 93: 1060 (1967).

*Ind. loc.*: "W.J. Dore 20292, Hasting Co., E. of Belleville, Point Anne, 15 June 1963 (DAO), type"

*Typus*: Canada. Ontario, Hastings Co., Point Anne, 15 June 1963, *Dore 20292* (holotype, DAO!)

*G. mobile* Gewez?, nom. nud., in sched. (P!)

Herbs, annual, 10-65 cm tall. Stem erect, usually branched from the base, pilose, with scattered glandular and abundant eglandular, patent -sometimes retrorse, appressed-hairs 0.2-1.1 mm long. Basal leaves in a ± deciduous rosette; lamina 2.2-6.5 × 2.5-8.5 cm, polygonal in outline, palmatifid -divided for 0.7-0.9 of its length-, pilose, with eglandular, appressed hairs; segments 5(7), rhombic, 2-5 mm wide at the base, 5-12-lobed in distal half -ratio main-sinus length of the middle segment/middle-segment length = 0.27-0.31-; lower cauline leaves alternate, median and upper opposite; petioles to 16 cm long, with usually patent, eglandular hairs 0.2-1.1 mm long, and scattered glandular hairs; stipules 5-11 × 1.5-2 mm, lanceolate to subulate, sometimes lobed, pilose with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Cymules 2(3)-flowered, in dense aggregates at the top of each branch or solitary in the forks; peduncles 0-2.5(6) cm long, pilose, with glandular and



Castillo '99

Fig. 5.—*Geranium carolinianum*: a, habit; b, leaf; c, peduncle; d, flower; e, sepal; f, petal; g, staminal filament; h, fruit; i, mericarp; j, seed. a-c, h, *Nelson 8903* (NY); d-g, *McCoy 1662* (NY); i-j, *Heller 5808* (MO).

eglandular, patent –sometimes  $\pm$  retrorse– hairs 0.1–0.6 mm long; bracteoles 3–5  $\times$  1 mm, lanceolate, pilose with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 0.3–1.1 cm long, pilose, with glandular and eglandular, patent –sometimes retrorse, not appressed– hairs 0.2–0.7 mm long; pedicel and peduncle together not overtopping the subtending leaf. Sepals 5–6.5  $\times$  3–3.5 mm –ratio pedicel length/sepals length = 0.63–1.15, considering cymules at the top of each branch–, smooth, accrescent, 3–5-nerved, mucronate (with mucro 1.5–2 mm long), with scarios margins 0.1–0.2 mm wide, with glandular and eglandular hairs 0.1–0.6 mm long on the abaxial side, glabrous on the adaxial side. Petals 5.5–6  $\times$  2 mm, entire, without claw, glabrous on the adaxial side, ciliate on the basal margin, pale purple. Stamens 10, both whorls bearing anthers; filaments 3–4 mm long, lanceolate to subulate, glabrous except for a some cilia on the proximal half; anthers 0.4–0.6  $\times$  0.4–0.6 mm. Nectaries glabrous. Gynoecium ca. 4 mm long. Fruit 19–25 mm long; mericarps 3–4.5  $\times$  2–2.4 mm, without a strand of fibres, smooth, without longitudinal rib, with a basal callus, covering the seed completely, densely hairy, with eglandular –and sometimes glandular–, antrorse hairs 0.5–1.8 mm long, blackish; rostrum 15–19 mm long, with a narrowed apex 1–2 mm long, with patent, glandular and eglandular hairs 0.1–0.8 mm long; stigmatic remains 0.7–1.4 mm long, with 5 hairy lobes. Seeds 2–2.2  $\times$  1.7 mm, smooth to reticulate, brownish, the hilum 1/6 as long as the perimeter. Cotyledons entire.  $2n = 52$ .

Flowering February–August. Open woods, prairies, clearings and disturbed areas; 0–2850 m. Canada, U.S.A., and New Mexico; introduced in Asia (China, probably India, Japan), South America (Argentina, Brazil, Paraguay, probably Peru), Reunion Is., and, in some Caribbean island (Bahamas, probably Bermuda, Jamaica). Figs. 6, 7.

*Illustrations.* Fig. 3b, 3e, 4b, 4e, 5; CAVANILLES (1787, tab. 84 fig. 1); HOLMGREN (1998: 339 fig. 4).

A number of minor morphological variants of *G. carolinianum* have been recognised in the literature, of which the most notable seems to be *G. sphaerospermum*. According to FERNALD (1935), *G. sphaerospermum* is characterized by its 5-nerved eglandular sepals, and its subspherical seeds. However, in some cases the number of nerves per sepal varies between 3 and 5 in the same inflorescence. Additionally, glandular hairs can be restricted to the pedicels or widespread through inflorescence and stem. Finally, the seeds can be subspherical to elongated, with many intermediate forms. Considering that all these characters vary considerably but independently, *G. sphaerospermum* is here not accorded taxonomic recognition. A similar view was pointed out by MCGREGOR (1986: 581).

Pollen morphology in *Geranium carolinianum* is much like that in *G. bicknellii* with great variation in size supracteal elements. It is similar to many *Geranium* species according to BORTENSCHLAGER (1967), STAFFORD & BLACKMORE (1991), and VERHOEVEN & VENTER (1992).

According to MOORE (1943: 102–103), collections from San Luis Potosí, referred to *G. carolinianum* by WATSON (1882: 334), are perennial and seem to be *G. tenue* Hanks.

So far, the specimens supporting the following records of *G. carolinianum* have not been studied: Alaska (ANDERSON, 1959: 342), New Hampshire (SEYMOUR, 1969: 368), and Utah (WELSH & *al.*, 1993: 352).

#### *Representative specimens examined*

ARGENTINA: Buenos Aires, Avellaneda, Dársena de Inflamables, Dock Sud, 34°39'S, 58°23'W, 24-XI-1945, *Krapovic*s 2688 (MO); Chaco, Colonia Benítez, 27°20'S, 58°56'W, X-1967, *Schulz* 16214 (CTES); Corrientes, Empedrado, Ruta 12 y acceso a Empedrado, 27°57'S, 58°48'W, 18-XI-1986, *Tressens & al.* 3230 (CTES); Corrientes, Mercedes, Río Corrientes y ruta 123, 29°12'S, 58°5'W, 4-XI-1995, *Schimini* 30385 (CTES); Delta, río Carabelas, frente recreo Tiburón, 34°3'S, 60°52'W, XI-1925, *Scala s.n.* (NY); Entre Ríos, Colón, ruta 14, desvío a Colón, 33°53'S, 61°6'W, 13-XI-1979, *Troncoso & al.* 2644 (CTES); Formosa, El Colorado, 24°48'S, 61°32'W, X-1971, *Insrán* 932 (CTES); Misiones, San Martín, Ruiz de Montoya, 26°59'S, 55°3'W, 11-X-1995, *Torri* 256 (CTES); Tucumán,

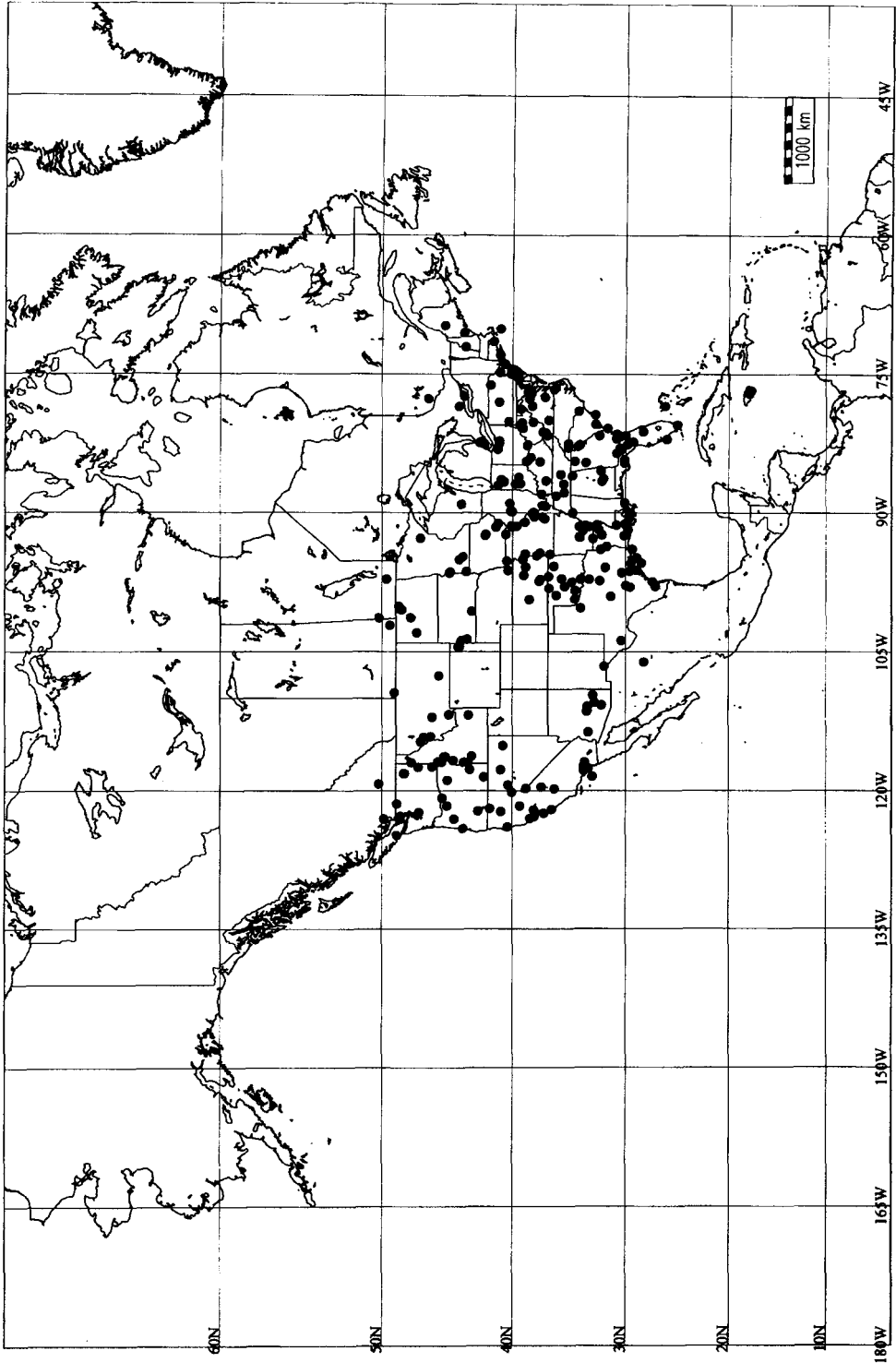


Fig. 6.—Distribution of *Geranium carolinianum* in North America.

Famailla, San Javier, Villa Nougues, 29°57'S, 63°5'W, 15-XI-1946, *Sparre 690* (S).

BAHAMAS: Grand Bahama, N side of Queen's Highway, E of Freeport Airport roundabout, 26°38'N, 78°25'W, 5-IV-1980, *Correll & Popenoe 51235* (F).

BRAZIL: Parana, Serra do Mar, Casa Ypiranga, 25°1'S, 50°35'W, 18-XII-1914, *Dusén 16133* (F); Paraná, Serra do Mar, Ypiranga, 25°1'S, 50°35'W, 18-XII-1914, *Dusén 16133* (MO); São Paulo, São Roque Linha Sorocabana, 26°25'S, 50°47'W, 28-XI-1981, *Kerichi 1725* (MO).

CANADA. BRITISH COLUMBIA: Armstrong, 50°27'N, 119°14'W, VII-1909, *Wilson s.n.* (DAO); Chilliwack Valley, 49°10'N, 121°25'W, 27-V-1901, *Spreadborough 34104* (NY); Sproat, 50°5'N, 123°2'W, 30-VI-1890, *Macoun 2878a* (NY); Vancouver Is., Alberni canal, 49°12'N, 124°51'W, 26-VI-1907, *Rosendahl 1961* (MO). MANITOBA: Adam Lake, Turtle Mountain Provincial Park, 49°2'N, 100°4'W, 25-VII-178, *Keleher 470* (DAO); Saint Lazare, W of Birtle, 50°27'N, 101°19'W, 7-VIII-1951, *Scoggan 10235* (MIN); Saint-Boniface, Saint-Vital, 49°54'N, 97°7'W, 14-VII-1949, *Boivin 6480* (NY). ONTARIO: Essex Co., Pointe Pelee, 42°48'N, 82°17'W, 5-VII-1936, *Marie-Victorin & al. 45979* (F); Hastings Co., Point Anne, E of Belleville, 44°10'N, 77°23'W, 15-VI-1963, *Dore 20292* (DAO); Peterborough Co., Harvey Twp., 1 mi E of Nogies Creek, 44°36'N, 78°29'W, 11-VII-1974, *Hoy & al. 3924* (DAO). QUEBEC: Lac Constance, 46°55'N, 77°38'W, 4-VII-1922, *Victorin 15912* (NY). SASKATCHEWAN: Cypress Hills Park, 49°21'N, 109°25'W, 11-VII-1947, *Breitung 4654* (MO); Moose Mountain Provincial Park, Kenosee Lake, 49°42'N, 102°7'W, 21-VI-1986, *Harms 35751* (DAO).

CHINA: Anhui, Qi-men, Cha-wan, 31°25'N, 118°31'E, V-1987, *Yao 10208* (MO); Fujian, Nanping city, 26°38'N, 118°10'E, 12-V-1993, *Guosheng 5138* (MO); Guangxi, Gui-lin city, Yanshan mt., 25°0'N, 110°16'E, 8-IV-1994, *Guangzhao 13860* (MO); Guangxi, Lin-gui Co., 21°37'N, 108°46'E, 27-X-1994, *Guangzhao 14428* (MO); Jiangsu, Bao-Ying Co., 33°13'N, 119°18'E, 27-V-1961, *Shulu & al. 290* (MO); Jiangsu, Nanking, 32°3'N, 118°46'E, 12-V-1922, *Steward 1891* (MO); Jiangxi, Jiu-jiang Co., 29°37'N, 115°53'E, 9-VI-1993, *Ceming 93303* (MO); Jiangxi, Wu-ning Co., Jiuling shan mt., 28°55'N, 114°50'E, 21-IV-1994, *Cun-Su 130* (MO); Nanking, 32°3'N, 118°46'E, 31-V-1931, *Luh & Teng 9818* (W).

JAMAICA: Below New Castle, 18°17'N, 77°5'W, 4-II-1915, *Harris 11939* (F); St. Helens Gap, St. Andrew, 18°4'N, 76°45'W, 4-III-1920, *Maxon & Killip 570* (F).

JAPAN: Honshu, Hyogo, near Higashi-kakogawa station, Kakogawa-shi, 34°45'N, 134°50'E, 4-VI-1969, *Kurosaki s.n.* (MO); Honshu, Kyoto-fu, near Hozu-bashi, Hozu-cho, Kameoka-shi, 35°23'N, 136°42'E, 27-V-1991, *Tsugaru & M. Sawada 14433* (MO).

MEXICO: Chihuahua, 28°38'N, 106°05'W, 1852, *Wright s.n.* (GH).

PARAGUAY: Asunción, 25°16'S, 57°40'W, X-1986, *Schinini 25269* (CTES); in arvis Caraguatay, 25°14'S, 56°49'W, *Hassler 3402* (P); Misiones, Santiago, estancia La Soledad, 27°9'S, 56°47'W, 22-X-1959, *Pedersen 5186* (P).

REUNION: Plaine de Palmistes, 21°7'S, 55°38'E, VI-1957, *Bosser 11492* (P).

TAIWAN: Nantou, Chian-chin, 23°55'N, 120°41'E, 18-VI-1982, *Kao 9767* (MO).

U.S.A. ALABAMA: Elmore Co., W of Booth on US 82 at jct. of Whitewater Ck., 32°30'N, 86°34'W, 27-IV-1979, *Whetstone & al. 9636* (MO); Lee Co., Auburn, 32°36'N, 85°28'W, 6-V-1898, *Earle & Baker 1613* (NY). ARIZONA: Gila Co., Sierra Ancha Mountains, 33°49'N, 110°52'W, 5-VI-1946, *Gould 3587* (NY); Graham Co., Graham Mountains, below Pine Crest, 33°20'N, 109°38'W, 19-V-1935, *Maguire 11462* (NY). ARKANSAS: Arkansas Co., Arkansas Post, 34°1'N, 91°20'W, 12-V-1940, *Demaree 21064* (MO); Benton Co., 34°33'N, 92°35'W, 1899, *Plank s.n.* (NY). CALIFORNIA: Butte Co., Berry Canon, near Clear Creek, 39°40'N, 121°39'W, 8-V-1902, *Heller s.n.* (MO); Fresno Co., Fresno, 36°44'N, 119°46'W, 25-V-1953, *Quibell 2034* (NY); Humboldt Co., 40°40'N, 123°55'W, 11-X-1914, *Tracy 4633* (NY); Lassen Co., Amedee, 40°20'N, 120°8'W, 23-VI-1897, *Jones s.n.* (CAS) (MO). CONNECTICUT: New Haven, 41°18'N, 72°55'W, VIII-1836, *Bucklen s.n.* (MO). DELAWARE: Wilmington, Brandywine river, 39°44'N, 75°32'W, 14-V-1846, *Leeds s.n.* (F). DISTRICT OF COLUMBIA: Washington, 38°55'N, 77°0'W, 20-V-1889, *Churchill s.n.* (MO). FLORIDA: Alachua Co., 2 mi E of Gainesville, 29°39'N, 82°19'W, 6-IV-1968, *D'Arcy 2397* (MO); Dade Co., along Tennessee Road, near Florida City, 25°26'N, 80°28'W, 27-II-1977, *Correll & al. 48106* (MO). GEORGIA: Brantley Co., W of Nahunta, 31°12'N, 81°58'W, 1-V-1971, *Robinson s.n.* (MO); Camden Co., St. Mary's R. swamp just S of Kingsland, 30°47'N, 81°41'W, 5-IV-1941, *Duncan 3138* (MO). IDAHO: Boise, 43°36'N, 116°12'W, 17-VI-1911, *Clark 57* (MO); Canyon Co., Falk's Store, 43°52'N, 116°57'W, 7-VI-1910, *Macbride 193* (MO). ILLINOIS: Adams Co., Quincy, 39°56'N, 91°24'W, 20-V-1943, *Jones 15847* (MO); Jackson Co., Carbondale, 37°43'N, 89°13'W, 21-IV-1947, *Bailey 46* (MIN); Lincoln Co., 3 miles SE of Crab Orchard, 37°47'N, 89°12'W, 10-V-1938, *Wharton 2098* (MO); Mason Co., Bishop, 40°20'N, 89°52'W, 4-VI-1949, *Chase 10390* (NY); McLean Co., Bloomington, 40°29'N, 88°59'W, 5-VI-1975, *Solomon 1360* (MO). INDIANA: Lake Maxinkuckee, 41°12'N, 86°24'W, 1900, *Scovell & Clark 779* (MO); Marion Co., 39°46'N, 86°9'W, 6-X-1944, *Friesner 18149* (NY); Montgomery Co., Crawfordsville, 40°2'N, 86°52'W, 1-VI-1933, *Bechtel 13590* (NY); Porter Co., Baileytown, 41°28'N, 87°3'W, 3-VI-1956, *Bennett s.n.* (MIN). IOWA: Black Hawk Co., Island Camp, Cedar Falls, 42°31'N, 92°26'W, 12-VII-1926, *Pammel & al. 282* (MIN); Davis Co., Floris, 40°51'N, 92°19'W, 26-VI-1939, *Hayden 9611* (NY). KANSAS: Atchinson Co., 1 mi W Oak Mills, 39°26'N, 95°0'W, 26-V-1976, *Stephens 89049* (MO); Butler Co., Whitewater, 37°57'N, 97°8'W, 4-VI-1961, *Harms 1659* (NY); Cowley Co., 37°14'N, 96°50'W, V-1898, *White s.n.* (MO). KENTUCKY: Bracken Co., Augusta, 38°46'N, 84°0'W, 15-V-1983, *Buddell 1057* (NY); Calloway Co., Junction Hwy 121 and 280, 3 mi N on 280, 2 mi on dirt road, 36°34'N, 88°9'W, 5-V-1974, *Funk 498* (MO). LOUISIANA: Baton Rouge, Louisiana State University Campus, 30°24'N, 91°10'W, 8-I-1992, *Thomas & Allen 127030* (MO); Caddo Co., Fort Humbug, 32°38'N, 93°54'W, 19-IV-1940, *Demaree*

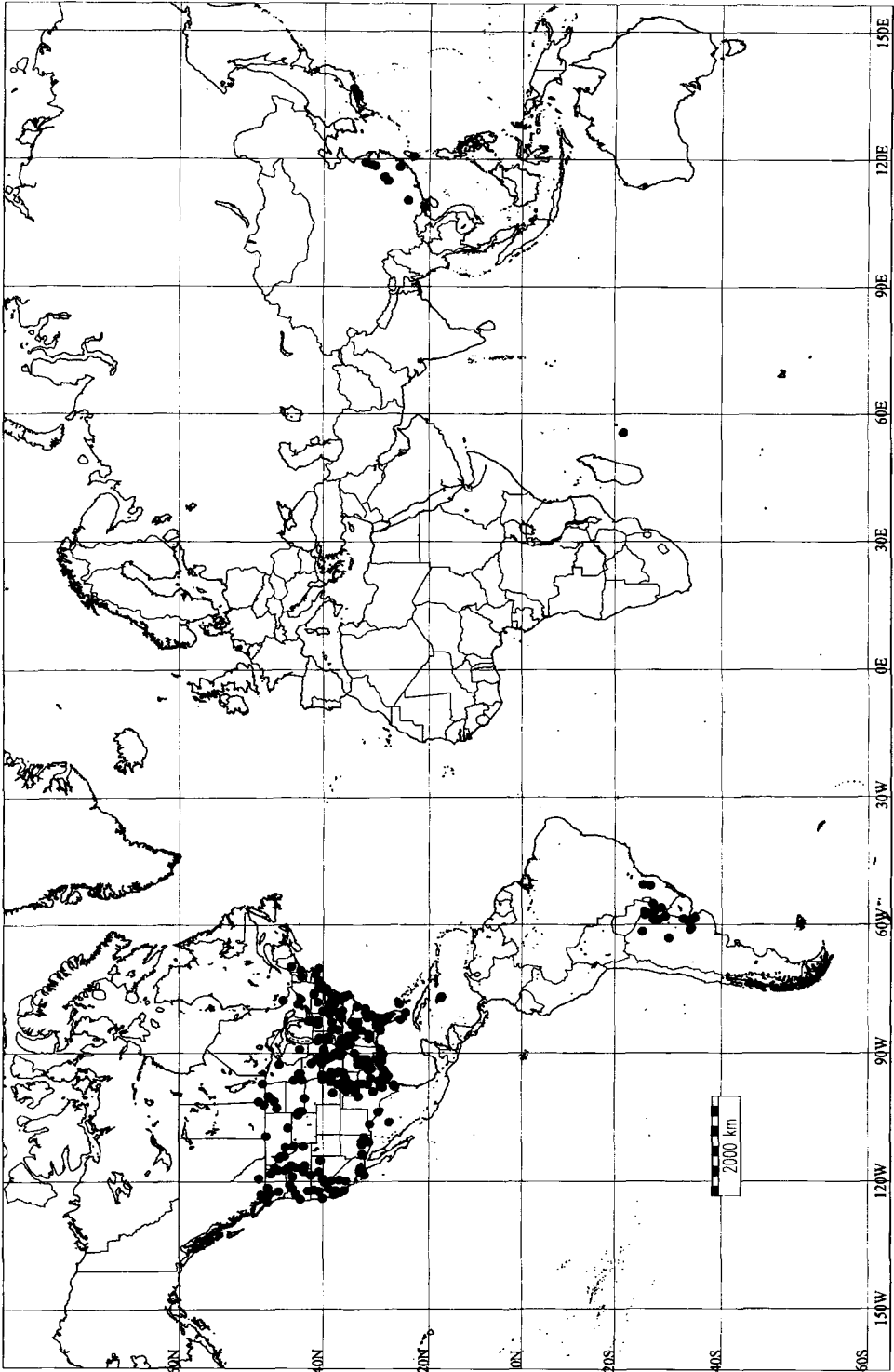


Fig. 7.—World distribution of *Geranium carolinianum*.



20798 (MO). MAINE: mt. Kineo, 45°41'N, 69°44'W, (PH); Norway, 44°12'N, 70°32'W, 8-VIII-1864, *Smith s.n.* (NY). MARYLAND: College Park, 38°58'N, 76°56'W, 15-V-1901, *Stewart s.n.* (MO); Prince Georges Co., 0.25 mi E of Potomac River, near Charles Co. line, 38°40'N, 77°1'W, 10-V-1984, *Hill 13625* (MO). MASSACHUSETTS: Nantucket, 41°17'N, 70°6'W, 6-VII-1886, *Churchill s.n.* (MO). MICHIGAN: Port Huron, 42°58'N, 82°25'W, 14-VII-1904, *Dodgr 47* (NY); Saint Clair Co., Algonac, 42°37'N, 82°31'W, 29-VI-1901, *Cooper s.n.* (MIN). MINNESOTA: Big Stone Co., 2 mi W of Odessa, 45°15'N, 96°19'W, 18-VII-1981, *Smith 5094* (MIN); Itasca Co., 44 mi NE of Grand Rapids, 47°30'N, 92°43'W, 7-VII-1977, *Wheeler & Glaser 1901* (MIN). MISSISSIPPI: Biloxi, 30°23'N, 88°53'W, 4-VII-1900, *Tracy 6869* (MO); Harrison Co., near Hilton Hotel, Biloxi, 30°23'N, 88°53'W, 15-IV-1988, *Hill 19114* (MO). MISSOURI: Bates Co., Amoret, 38°15'N, 94°35'W, 27-V-1933, *Bush 12594* (MIN); Clark Co., Rose Pond area, near 2W trap, 40°20'N, 91°30'W, 4-VII-1983, *Walker 489* (MO); Clay Co., 1 mi N of Liberty, 39°14'N, 94°25'W, 28-V-1965, *Henderson 65-184* (MO). MONTANA: Lewis and Clark Co., Helena, 46°36'N, 112°0'W, 12-VII-1895, *Shear 3185* (NY); Lo-Lo, Hot Spring, 46°45'N, 114°6'W, 1898, *Williams & Griffith s.n.* (NY). NEBRASKA: Otoe Co., near Syracuse, 40°39'N, 96°11'W, 28-V-1936, *Osborn 828R* (MO). NEVADA: Carson City, 39°10'N, 119°43'W, 1864, *Anderson 176* (P); Elko Co., Clover Creek, 41°5'N, 115°5'W, 23-VII-1941, *Robertson s.n.* (RENO); Humboldt Co., Paradise valley, 41°16'N, 117°41'W, 24-VI-1967, *Gentry & Davide 1629* (MIN). NEW JERSEY: Burlington Co., Lumberton, 39°57'N, 74°48'W, 23-V-1923, *Meredith s.n.* (MO); Hunterdon Co., Stockton, 40°24'N, 74°58'W, 3-VI-1897, *Fisher s.n.* (MO); Rock Hill, near Philadelphia, 40°23', 74°38', 15-VI-1870, *Redfield 972* (MO). NEW MEXICO: Organ mts., 32°19'N, 106°33'W, 20-V-1893, *Norton 355* (MO). NEW YORK: Tioga Co., Apalachin, 42°4'N, 76°9'W, V-1898, 76 (NY); Westchester Co., Yonkers, 40°55'N, 73°53'W, 26-V-1883, *Schrenk s.n.* (MO). NORTH CAROLINA: Buncombe Co., Biltmore, 35°33'N, 82°32'W, 2-VI-1897 (MO); Haywood Co., Fincher Mt., 35°32'N, 82°58'W, 12-VI-1935, *Price 187* (NY); New Hanover Co., Carolina Beach, 35°32'N, 82°58'W, 18-IV-1938, *Friend 10444* (NY). NORTH DAKOTA: Kummer, 47°47'N, 102°54'W, 6-VIII-1912, *Bergman 2738* (MIN); Metigoshe State Park, T. Mts., 48°59'N, 100°21'W, 15-VI-1951, *Stevens 1245* (MIN); Turtle mts., Bottineau, 48°49'N, 100°26'W, 1-VIII-1941, *Stevens 585* (MO). OHIO: Erie Co., Old Woman Creek, 41°23'N, 82°30'W, 30-VI-1977, *Shane 77-4* (MIN); Hamilton Co., Cincinnati, 39°9'N, 84°27'W, 23-V-1887, *Lloyd s.n.* (MO); Jackson Co., Liberty, 39°4'N, 82°43'W, 31-V-1936, *Bartley 231* (NY). OKLAHOMA: Cleveland Co., Norman, 35°13'N, 97°26'W, 18-V-1969, *Crook 924* (MIN); Fort Sill, 34°55'N, 98°21'W, 22-V-1916, *Clemens 11651* (MO); Kingfisher Co., Huntville, 35°51'N, 97°55'W, 6-V-1896, *Blankinship s.n.* (MO). OREGON: Harney Co., Alvord Ranch, 42°37'N, 118°29'W, 5-VII-1930, *Jones 25354* (MO); Hood River Co., 45°30'N, 121°38'W, 10-V-1924, *Henderson 468* (MO); Klamath Co., Keno, 42°7'N, 121°55'W, 6-VII-1920, *Peck 9321*

(MO). PENNSYLVANIA: Allegheny Co., Warlington's Hallow, 40°37'N, 80°7'W, 8-VI-1901, *Shafer 121* (NY); Cameron Co., Lushbaugh, 41°25'N, 78°1'W, 4-VI-1995, *Cusick 32469* (NY); Milford, 41°19'N, 74°48'W, 1-VI-1905, *Nell s.n.* (MO). RHODE ISLAND: Providence, Elmwood, 41°50'N, 71°28'W, 14-VI-1890, *Collins s.n.* (MO). SOUTH CAROLINA: Anderson Co., Anderson, Burriss Place, 34°30'N, 82°39'W, 10-V-1920, *Davis s.n.* (MO); Charleston Co., Washo Reserve, 33°8'N, 79°23'W, 17-IV-1993, *Hill 24944* (NY); Dorchester Co., 33°6'N, 80°23'W, 29-III-1935, *Correll 273* (NY). SOUTH DAKOTA: Black Hills National Forest, [?]air Ground Pilart, 43°57'N, 103°36'W, 1-VII-1909, *Murdoch 3532* (F); Deadwood, 44°24'N, 103°42'W, 19-VII-1913, *Carr 67* (MO). TENNESSEE: Franklin Co., Cumberland mt. at Cowan, 35°10'N, 86°1'W, 5-V-1898, *Eggert s.n.* (MO); Humphries Co., 7.5 mi W Buffalo, 35°53'N, 87°48'W, 24-IV-1972, *Kral 45745* (MO). TEXAS: Austin Co., Bellville, 29°57'N, 96°15'W, 20-IV-1973, *Grawunder 33* (MIN); Brazos Co., Bryan, along Industrial Blvd., between Independence Ave. and Stone City Dr., 30°41'N, 96°24'W, 20-IV-1976, *Cullum 62* (MO); Brown Co., Brownwood, 31°42'N, 98°59'W, 31-III-1917, *Palmer 11425* (MO). VERMONT: Orange Co., Newbury, mt. Pulaski, 44°4'N, 72°4'W, *Wood 196* (NY). VIRGINIA: Arlington, 38°54'N, 77°6'W, 11-VI-1891, *Blandchard s.n.* (MO); Fauquier Co., W slope of Bull Run Mountains, 38°54'N, 77°40'W, 30-V-1940, *Allard 3691* (MO); Nansemond Co., about Suffolk, 36°44'N, 76°37'W, 8-VI-1893, *Heller 907* (MO). WASHINGTON: Ferry Co., Kettle Falls, 48°42'N, 118°7'W, 17-VI-1939, *Boner & Weldert 155* (NY); Klickitat Co., 45°52'N, 120°46'W, 10-VI-1891, *Suksdorf 2027* (MO). WEST VIRGINIA: Marion Co., Hutton's branch, 39°31'N, 80°15'W, 6-VI-1892, *Small s.n.* (MO); McDowell Co., Panther State Park, 37°22'N, 81°39'W, 30-VI-1986, *Hutton s.n.* (WVA). WISCONSIN: Waupaca, 44°23'N, 89°4'W, 1907, *Garische s.n.* (MO). WYOMING: Crooc Co., Black Hills, Bear Lodge mtns., 44°33'N, 104°28'W, 9-VII-1982, *Nelson 8903* (NY); Crook Co., Bear Lodge Range, between Alva and Aladdin, 44°40'N, 104°25'W, 24-VI-1959, *Porter & Porter 7818* (MIN).

### 3. *Geranium texanum* (Trel.) A. Heller in Bull. Torrey Bot. Club 25: 198 (1898)

*G. carolinianum* var. *texanum* Trel. in Mem. Boston Soc. Nat. Hist. 4: 76, pl. 12 fig. 8 (1888)

*Ind. loc.*: "collected near New Braunfels, Texas, by Lindheimer, in 1848..."

*Typus*: U.S.A. Texas, Comal Co., New Braunfels, 1848, *Lindheimer s.n.* (lectotype, here designated, MO!)

= *G. texanum* f. *albiflorum* A.M. Davis in Nat. Leaflet 2: [2] (1945)

*Ind. loc.*: "The type of this form was collected by the author at Southmost, Cameron County, Texas in March, 1942

and is deposited in the herbarium of the University of Texas"

*Typus*: U.S.A. Texas, Cameron Co., Mar. 1942, Davis s.n. (*holotype*, TEX; *isotypes*, GH!, MO!)

Herbs, annual, 10-45 cm tall. Stem erect or decumbent, usually branched from the base, pilose, with retrorse, appressed, eglandular hairs 0.1-0.3 mm long. Basal leaves in a  $\pm$  deciduous rosette; lamina 1.7-4.7  $\times$  2.2-6 cm, polygonal in outline, palmatifid -divided for 0.75-0.9 of its length-, pilose, with appressed, eglandular hairs; segments 5(7), rhombic, 3-4 mm wide at the base, 5-9-lobed in distal half -ratio main-sinus length of the middle segment/middle-segment length = 0.25-0.35-; lower cauline leaves alternate, median and upper opposite; petioles to 15 cm long, with retrorse, appressed, eglandular hairs 0.1-0.4 mm long; stipules 5-7  $\times$  1.5-2 mm, lanceolate to subulate, pilose with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Cymules 2-flowered, usually solitary, sometimes in scattered aggregates at the top of each branch; peduncles (0)1-1.8(5) cm long, pilose, with retrorse, appressed, eglandular hairs 0.1-0.4 mm long; bracteoles 3-4  $\times$  1 mm, lanceolate, pilose, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 0.4-0.9 cm long, pilose, with retrorse, appressed, eglandular hairs 0.1-0.4 mm long; pedicel and peduncle together not overtopping the subtending leaf. Sepals 3.5-4.5  $\times$  3-3.5 mm -ratio pedicel length/ sepal length = 0.5-1.1-, smooth, accrescent, 3-nerved, mucronate (with mucro 1-1.4 mm long), with scarious margins 0.1-0.2 mm wide, with eglandular hairs 0.1-0.6 mm long on the abaxial side (mainly on the nerves), glabrous on the adaxial side. Petals 4-5  $\times$  1.5-2 mm, entire, without claw, glabrous on the adaxial side, ciliate on the basal margin, pale purple, sometimes white. Stamens 10, both whorls bearing anthers; filaments 3-4 mm long, lanceolate to subulate, glabrous except for some cilia on the proximal half; anthers 0.4-0.5  $\times$  0.3 mm. Nectaries glabrous. Gynoecium ca. 3 mm long. Fruit 14-16 mm

long; mericarps 3-3.5  $\times$  2 mm, without a strand of fibres, smooth, without longitudinal rib, with a basal callus, covering the seed completely, sparsely hairy, with eglandular, antrorse hairs 0.2-0.7 mm long,  $\pm$  blackish; rostrum 11-12 mm long, with a narrowed apex 0.5 mm long, with antrorse,  $\pm$  appressed, eglandular hairs 0.1-0.3 mm long; stigmatic remains 0.5 mm long, with 5 hairy lobes. Seeds 1.9-2.2  $\times$  1.6-1.8 mm,  $\pm$  reticulate, brownish, the hilum 1/6 as long as the perimeter. Cotyledons entire.

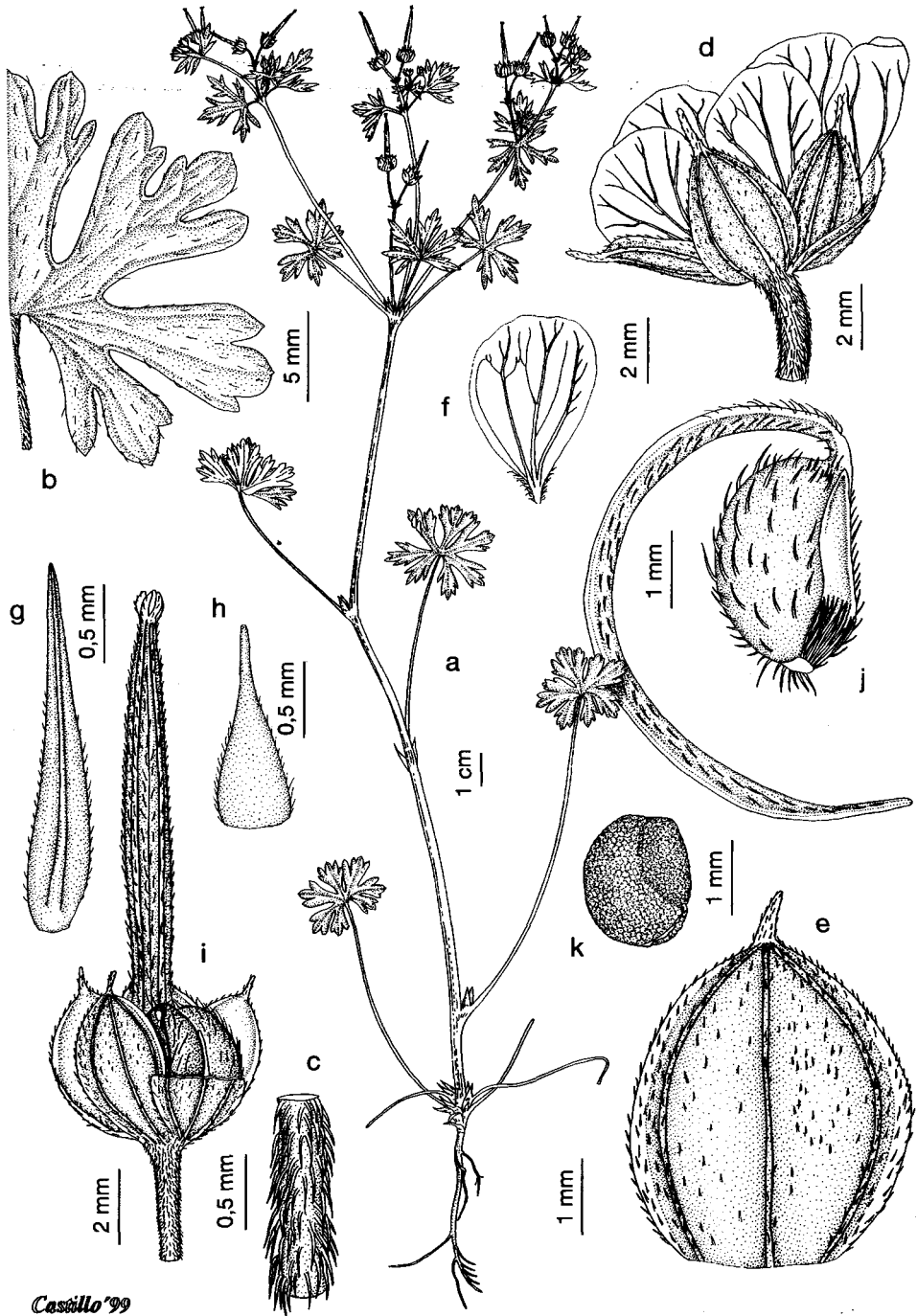
Flowering March-April. Open woods, clearings and disturbed areas; 0-700 m. South U.S.A. and probably north Mexico; probably introduced in Azores. Fig. 9.

*Illustrations*. Figs. 3c, 3f, 4c, 4f, 8.

This species is clearly related to *G. carolinianum*, from which can be distinguished by the type of indumentum on inflorescence and fruit. In *G. texanum* pedicels have retrorse, appressed, eglandular hairs, while *G. carolinianum* usually has patent, glandular and eglandular hairs. However, in some forms of *G. carolinianum* the glandular hairs are scattered or even lacking; in these forms hairs can be retrorse but never appressed. *Geranium texanum* fruits show scattered, short hairs while in *G. carolinianum* fruits are densely covered by long hairs. Sepals, petals and fruits are longer in *G. carolinianum* than in *G. texanum*. On the contrary, two characters support the close relationship between *G. texanum* and *G. carolinianum*: the short narrowed apex of the fruit rostrum, and the short pedicels.

Pollen grains of *Geranium texanum* are different from those of *G. bicknellii* and *G. carolinianum* in showing fusion of supracteal elements. According to VERHOEVEN & VENTER (1992), a similar pollen has been found in the South African *G. magniflorum* R. Knuth.

Since *G. texanum* reaches Mexican border in Cameron Co., it is probably present in Mexico. However, I could not examine any specimen of this species from Mexico. According to F. Chiang (*in litt.*) there is no



Casillo'99

Fig. 8.—*Geranium texanum*: a, habit; b, leaf; c, peduncle; d, flower; e, sepal; f, petal; g-h, staminal filaments; i, fruit; j, mericarp; k, seed. a-d, f-i, Correll & Correll 37050 (GH); e, Howell s.n., 7-VI-1936 (NY); f, k, Thieret 33007 (GH).

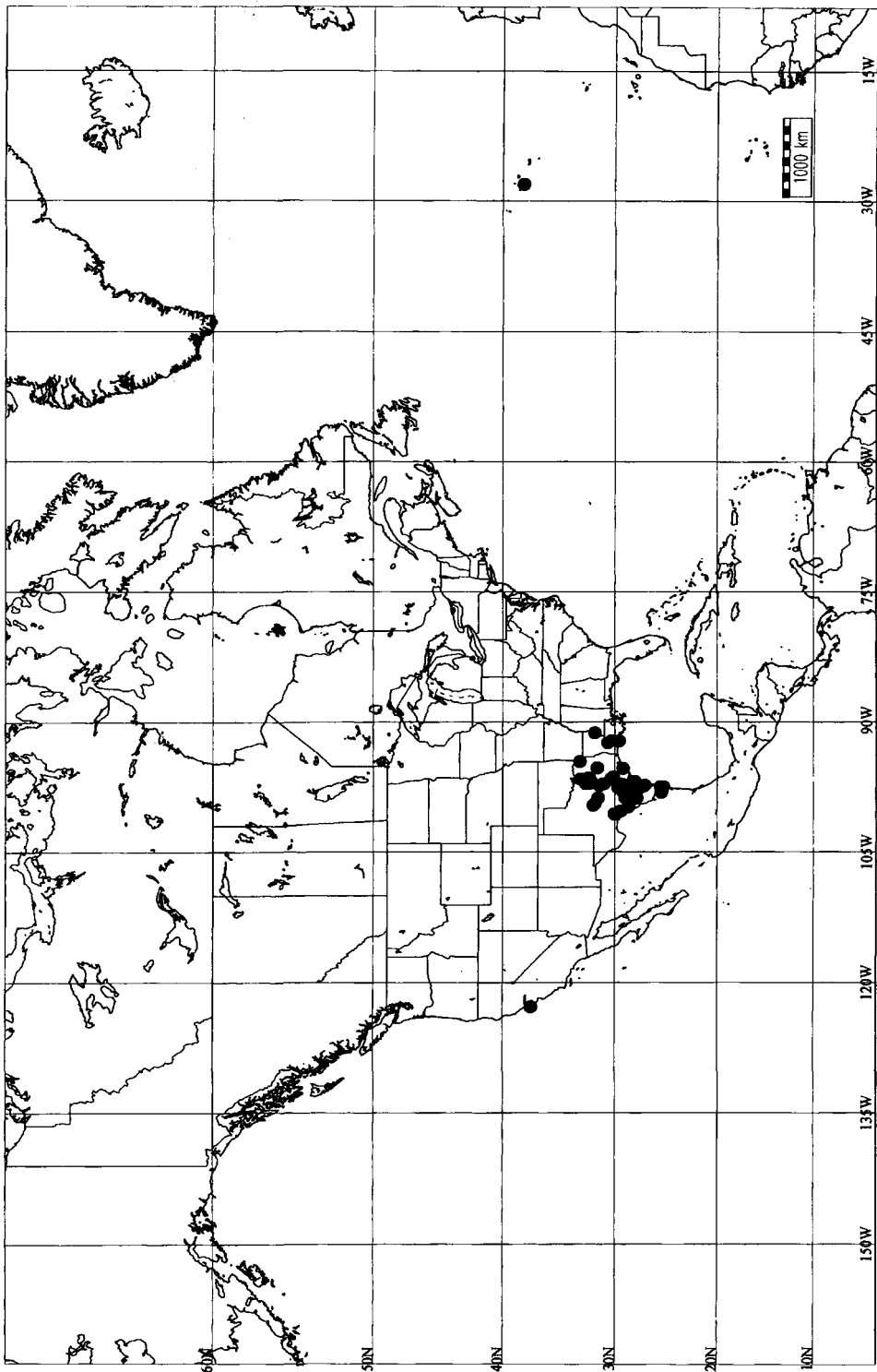


Fig. 9. -Distribution of *Geranium texanum*.

Mexican specimen of *G. texanum* at MEXU. Additionally, I also tried to find this species in ANSM and UAT herbaria without success. MOORE (1943: 102) recorded a single sheet of *G. texanum* in the Gray Herbarium, collected by Wright in 1852, from Chihuahua, which is *G. carolinianum*.

So far, the specimens supporting the following record of *G. texanum* has not been studied: Arkansas (SMITH, 1994: 154). Its presence in California (not previously reported) probably constitutes a occasional introduction, as well as its presence in Azores.

#### *Representative specimens examined*

PORTUGAL. AZORES: Ilha de São Jorge, 38°40'N, 28°3'W, VI-1903, *Carreiro 960* (COI).

U.S.A. CALIFORNIA: Marin Co., Olema, 38°2'N, 122°47'W, 7-VI-1936, *Howell s.n.* (NY). LOUISIANA: Avoyelles Co., 7.5 miles S of Bunkie along road to Whiteville, 30°7'N, 92°11'W, 30-IV-1971, *Thieret 33007* (GH); Madison, along Tensas River at Sharkey Plantation, W of Quimby, 32°22'N, 91°15'W, 16-IV-1948, *Ewan 17559* (MO); Rapides Co., Chambers, 31°10'N, 92°24'W, *Thieret 33064* (GH); St. Landry Co., 3.5 miles NW of Whiteville along road to Bunkie, 30°47'N, 92°8'W, 30-IV-1971, *Thieret 32999* (GH). OKLAHOMA: Barney Ward Lake, 1.5 mi SW of Tom, 33°44'N, 94°34'W, 29-IV-1975, *Taylor 18413* (NY). TEXAS: At Camp Berkeley, 13-IV-1943, *Tolstead 6986* (MO); Bexar Co., Austin Chalk, Government Canyon State Park, 29°33'N, 98°44'W, 3-V-1995, *Carr 14568* (TEX); Bexar Co., Columbia, 29°22'N, 98°31'W, 4-IV-1902, *Bush 1309* (MO); Bexar Co., San Antonio, 29°25'N, 98°29'W, *Jermy 166* (GH); Brazos Co., on the Texas A. & M campus, west of Wellborn road, 30°40'N, 96°22'W, 27-III-1996, *Skinner 117* (MO); Callahan Co., 4 miles west of Clyde, 32°24'N, 99°29'W, 23-IV-1963, *Henderson 63-477* (TEX); Cameron Co., Brownsville, 25°54'N, 97°29'W, 10-III-1924, *Runyon 634* (TEX); Comal Co., New Braunfels, 29°42'N, 98°7'W, 1848, *Lindheimer s.n.* (MO); Dallas Co., inwood road between Valley View Lane and Belt Line Road, 32°47'N, 96°48'W, 25-IV-1959, *Hamric & Thompson 16* (TEX); Dallas Co., Stultus Prairie, SW corner of Coit Road and Belt Line Road, 32°47'N, 96°48'W, 28-V-1959, *Correll & Johnston 22444* (GH); Dallas, 32°47'N, 96°48'W, 25-IV-1959, *Hamric & Thompson 16* (NY); Denton Co., Denton, 33°12'N, 97°7'W, 17-IV-1939, *Mccart 1586* (NY); Edwards Co., Moody's, 29°58'N, 100°18'W, 6-IV-1929, *Cory 487* (GH); Edwards Co., Pasture D, Substation no. 14, 29°58'N, 100°18'W, 30-IV-1941, *Cory 37056* (GH); Fayette Co., on state road 95, 2.1 mi N of I-10 bridge, 0.5 mi N of junction FR154 at small power line crossing road, 29°48'N, 97°13'W, 18-IV-1992, *Mayfield 1204* (TEX); Gonzales Co., Ottine, 29°35'N, 97°35'W, 12-IV-1940, *Warnock 20660* (MO); Gonzales Co., Ottine, 29°35'N, 97°35'W, 12-IV-1940, *Warnock 20660*

(TEX); Grayson Co., Sherman, 33°38'N, 96°36'W, 7-V-1983, *Nee & Diggs 27181* (F); Harris Co., Houston, near the Union Depot, 29°45'N, 95°21'W, 16-VI-1903, *Reverchon 3773* (MO); Hays Co., 12.3 miles E of San Marcos on highway 80, 29°52'N, 97°50'W, 2-IV-1939, *Reese s.n.* (TEX); Hidalgo Co., near Santa Ana National Wildlife Refuge, 26°4'N, 98°8'W, 29-III-1960, *Fleetwood 3205* (TEX); Hill Co., 4 miles N of Whitney, 31°57'N, 97°19'W, 28-IV-1960, *Gould 9055* (TEX).

#### 4. *Geranium columbinum* L., Sp. Pl.: 682 (1753)

*Ind. loc.*: "Habitat in Gallia, Helvetia, Germania"

*Typus*: LINN 858/79 left specimen (color slide!) [lectotype, designated by GHAFOR, 1978: 47]

Herbs, annual, 9-60 cm tall. Stem erect, usually branched from the base, pilose, with retrorse, appressed, eglandular hairs 0.3-0.6 mm long. Basal leaves in a  $\pm$  persistent rosette; lamina 3.5-5.5  $\times$  3-5 cm, polygonal in outline, palmatisect, pilose, with appressed, eglandular hairs; segments 5-7, rhombic, 2-3 mm wide at the base, 6-12-lobed in distal half -ratio main-sinus length of the middle segment/middle-segment length = 0.33-0.48-; cauline leaves opposite; petioles to 15 cm long, with retrorse, appressed, eglandular hairs 0.3-0.6 mm long; stipules 7-8  $\times$  0.8-1.2 mm, lanceolate, sometimes lobed, pilose with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Cymes 2-flowered, solitary; peduncles 3-10 cm long, pilose, with retrorse, appressed, eglandular hairs 0.3-0.5 mm long; bracteoles 3-5  $\times$  0.5 mm, lanceolate, pilose, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 2-6 cm long, pilose, with retrorse, appressed, eglandular hairs 0.3-0.5 mm long; pedicel and peduncle together overtopping the subtending leaf. Sepals 6-10(11)  $\times$  2-4.5(5.5) mm -ratio pedicel length/sepals length = 3.3-8.2-, smooth, accrescent, 3-nerved, mucronate (with mucro 1.2-2 mm long), with scarious margins 0.4-0.5 mm wide, with eglandular, antrorse, appressed, hairs 0.3-0.5 mm long on the abaxial side (mainly on the nerves), glabrous on the adaxial side. Petals 8-10  $\times$  4-5 mm, entire or emarginate (with notch

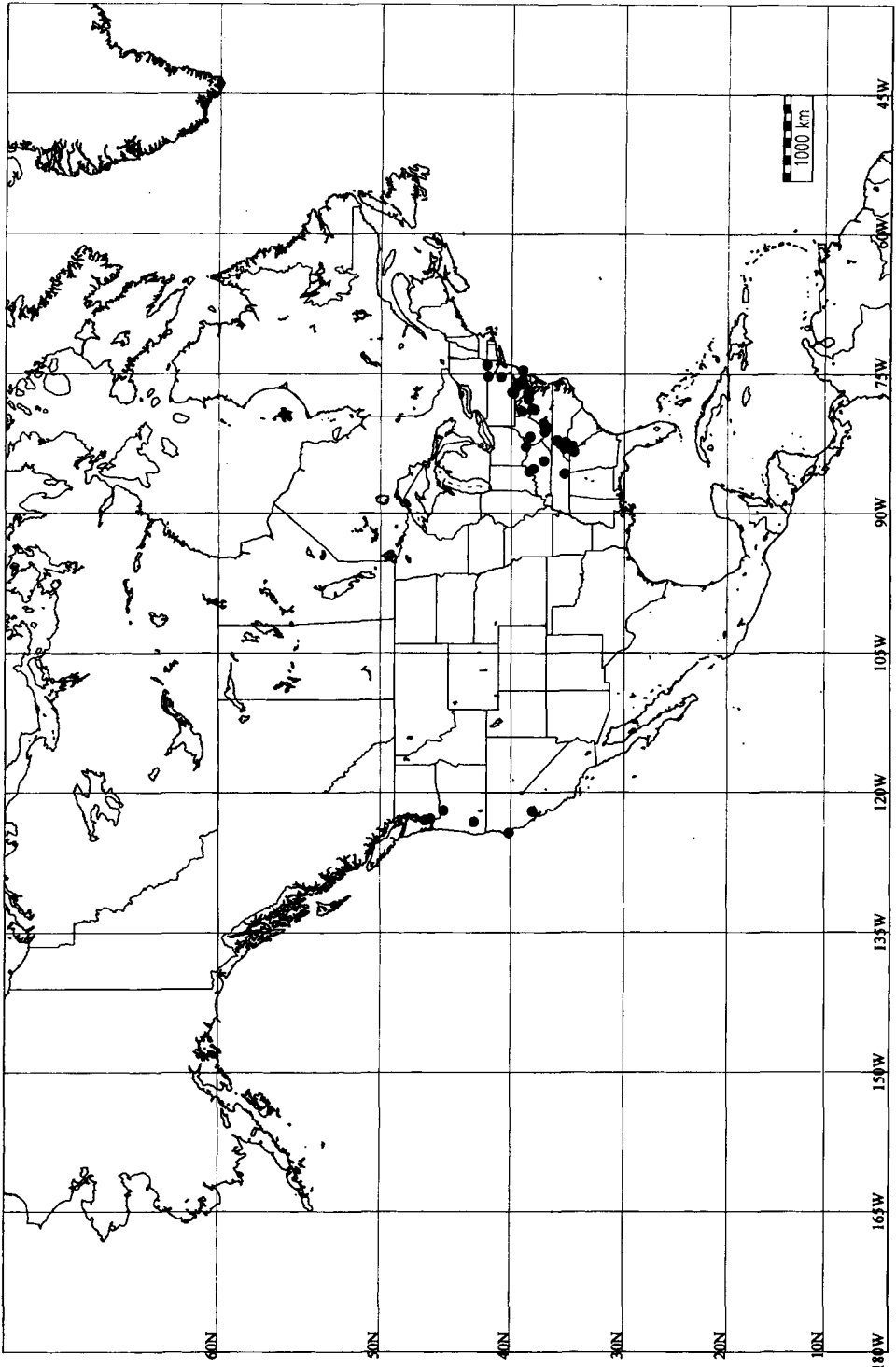


Fig. 10.—Distribution of *Geranium columbinum* in North America.

0.5 mm deep), without claw, glabrous on the adaxial side, ciliate on the basal margin, purple. Stamens 10, both whorls bearing anthers; filaments 4-5 mm long, subulate, glabrous except for a some cilia on the proximal half; anthers 0.8-0.9 × 0.4 mm, bluish. Nectaries glabrous. Gynoecium ca. 4-5 mm long. Fruit 20-23 mm long; mericarps 2.2-2.8 × 1.5 mm, without a strand of fibres, smooth, without longitudinal rib, with a basal callus, covering the seed completely, with scattered eglandular, ± patent hairs 0.2-0.3 mm long, brownish; rostrum 18-19 mm long, with a narrowed apex 4 mm long, with erect-patent, eglandular hairs 0.1-0.3 mm long; stigmatic remains ca. 2 mm long, with 5 glabrous lobes. Seeds 2.2-2.4 × 1.6-1.8 mm, pitted, reddish, the hilum 1/6 as long as the perimeter. Cotyledons entire.  $2n = 18$ .

Flowering May-September. Edge of forest, prairies, fields, and disturbed areas; 0-1300 m; introduced from the Old World; Eastern U.S.A. and Western U.S.A. Fig. 10.

*Illustrations.* Fig. 19a; CAVANILLES (1787, tab. 81 fig. 1); ROSS-CRAIG (1952, Part 6, pl. 38); HOLMGREN (1998: 339 fig. 7).

*Geranium columbinum* seems close to the three annuals native from North America (*G. bicknellii*, *G. carolinianum*, and *G. texanum*) by its accrescent calyx. However, it may easily distinguished by its palmatisect and opposite basal leaves, longer calyx and longer petals.

So far, the specimens supporting the following records of *G. columbinum* have not been studied: Arkansas (SMITH, 1994: 154), Colorado (KARTESZ, 1998), Massachusetts (KARTESZ, 1998), Michigan (VOSS, 1985: 507), North Dakota (KARTESZ, 1998), South Dakota (FERNALD, 1935: 296), and Wisconsin (KARTESZ, 1998).

#### *Representative specimens examined*

U.S.A. CALIFORNIA: Humboldt Co., about 7.5 roadmiles S of ferndale, along Wildcat road, near Green Pond Ranch, 40°28'N, 124°15'W, 20-V-1987, *Pykälä & Norris 751* (MO); Solano Co., 5.6 milles W of Winters, 38°31'N, 121°59'W, 16-IV-1968, *Ishizuka 19* (MA). DELAWARE: New Castle Co., Townsend, 39°23'N,

75°41'W, VI-1864, *Canby s.n.* (NY). DISTRICT OF COLUMBIA: Washington, 38°55'N, 77°0'W, 1867 (MO). INDIANA: Jefferson Co., along Harbarts Creek on the Kellar farm about a mile SW of Wirt, 38°48'N, 85°27'W, 22-V-1935, *Banta 56002* (MO). KENTUCKY: Henry Co., Ky 22, 4.6 mi NE of road junct. Ky 22 and Ky 1360, 38°27'N, 85°9'W, 3-VI-1962, *Gentry 194* (NY); Madison Co., Grant House, 37°34'N, 84°17'W, 12-VII-1960, *Grossman 416* (NY). MARYLAND: Laurel, 30-V-1894, *Knowlton s.n.* (MO); Port Deposit, 39°36'N, 76°5'W, 2-VII-1864, [illegible] (MO). NEW JERSEY: Atlantic Co., Northfield, 39°22'N, 74°33'W, 20-V-1913, *Lighthipe s.n.* (NY). NEW YORK: Near foot of Overbook mt., Woodstock, 42°19'N, 74°0'W, 20-IX-1871, *Redfiled 975* (MO); Northfield, 42°14'N, 75°11'W, 20-V-1913, *Lighthipe s.n.* (NY). NORTH CAROLINA: Asheville, 35°36'N, 82°33'W, 3-IX-1933, *Alexander & al. s.n.* (NY); Buncombe Co., Bald Knob mt., Bull Meadows, 35°42'N, 82°16'W, 7-VII-1934, *Correll 110* (DUKE); Burke Co., 35°46'N, 85°42'W, 16-VI-1915, *Huger s.n.* (NY); Haywood Co., Crabtree, 35°38'N, 82°54'W, 1928, *H.L.B. 4055* (DUKE); Haywood Co., Fincher mt., Lake Junaluska, 35°30'N, 82°57'W, 12-VI-1935, *Price 183* (DUKE); Haywood Co., Rd. to Eagles Nest, Wagensville, 35°7'N, 82°39'W, 20-VI-1932, *H.L.B. 4054* (DUKE); Madisch Co., Max Patch Mt. Field, 35°47'N, 82°57'W, 1-VII-1956, *Mark s.n.* (DUKE). OHIO: Jackson Co., Little Salt Creek, 39°6'N, 82°46'W, 24-V-1936, *Bartley & Pontius 245* (NY). OREGON: Douglas Co., Glide, 43°18'N, 123°6'W, 10-VII-1950, *Earle 4428* (NY); Multnomah Co., Cascade Locks, 45°40'N, 121°53'W, 24-VI-1925, *Peck 9858* (F). PENNSYLVANIA: Dauphin Co., Lower Paxton Township, 8 mi E of Harrisburg, 40°16'N, 76°53'W, 10-VI-1984, *Plowman 13805* (F); Lancaster City, 40°2'N, 76°18'W, 1-VI-1894, *Eby s.n.* (MO); Lancaster, Safe Harbor, 39°55'N, 76°22'W, 18-V-1889, *Small s.n.* (MO); Monroe Co., Buck Hill Falls, 41°11'N, 75°16'W, 15-X-1919, *Ferguson s.n.* (NY); York Co., 40°7'N, 77°0'W, 30-V-1895, [illegible] (MO). TENNESSEE: Sullivan Co., Holston Mountain, 36°27'N, 82°4'W, 17-VI-1934, *Underwood & Sharp 1532* (MO); Unicoi Co., Erwin, 36°8'N, 82°25'W, 13-VI-1969, *Sharp & al. 43111* (NY). VIRGINIA: Arlington, 38°54'N, 77°6'W, *Deane s.n.* (MO); Fauquier Co., W slope of Bull Run Mountains, 38°54'N, 77°40'W, 25-V-1941, *Allard 8687* (MO); Giles Co., along New River, 0.5 mi NW of Klotz, 37°20'N, 80°40'W, 8-VII-1938, *Fogg 14872* (MO); Giles Co., Rich Creek, 37°22'N, 80°49'W, 8-VI-1962, *Comte 4642* (MO); Massanutten Mountains, 38°23'N, 78°46'W, 6-VI-1941, *Allard 8775* (MO); near Potomac river above of opposite Washington, 38°54'N, 77°6'W, 23-V-1889, *Churchill s.n.* (MO); Shenandoah Co., vicinity of Endless Caverns, 38°35'N, 78°40'W, 17-VI-1973, *Boufford 10080* (MO). WASHINGTON: Lewis Co., Lucas Creek, 46°38'N, 122°46'W, 13-VII-1954, *Bechuel 18643* (NY); Thurston Co., along Perry Creek, about 5 mi W of Olympia, 47°2'N, 122°55'W, 11-VII-1936, *Meyer 613* (MO). WEST VIRGINIA: Jackson Co., on hillside near Fairplain, 38°45'N, 81°41'W, 27-VI-1930, *Beskluy 858* (MO); Mercer Co., Camp Creek State Forest, Lower Wash Fork Creek, off St. Rt. 19, 37°31'N, 81°8'W, 26-V-1987, *Brant*

& O'Donnell 1084 (MO); Mineral Co., 250 feet E of Legion Home, Keyser, 39°26'N, 78°58'W, 25-V-1954, *Brown s.n.* (MO); Monroe Co., Sweet Springs, 37°37'N, 80°14'W, 5-IX-1903, *Steele 225* (MO).

**5. *Geranium rotundifolium* L., Sp. Pl.: 683 (1753)**

*Ind. loc.*: "Habitat in Europae cultis"

*Typus*: LINN-858.83 (color slide!) [lectotype, designated by CAROLIN (1965: 335)]

Herbs, annual, 10-40 cm tall. Stem erect, usually branched from the base, pilose, with patent, glandular and eglandular hairs 0.2-1.2 mm long. Basal leaves in a persistent rosette; lamina 1.2-3.3 × 1.9-4.4 cm, orbicular in outline, palmatifid -divided for 0.55-0.65 of its length-, pilose, with appressed, eglandular -and sometimes glandular- hairs; segments 5-7, obtriangular, 5-10 mm wide at the base, (3)6-8-lobed in the apex -ratio main-sinus length of the middle segment/middle-segment length = 0.13-0.2-; cauline leaves opposite; petioles to 17 cm long, with patent, glandular and eglandular hairs 0.2-1 mm long; stipules 3-4 × 1-2 mm, lanceolate, pilose with eglandular hairs on abaxial surface and on the margin, usually glabrous adaxially. Cymules 2-flowered, solitary; peduncles 1.8-3 cm long, pilose, with patent, glandular and eglandular hairs 0.3-1 mm long; bracteoles 2-3 × 0.5 mm, linear-lanceolate, pilose, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 0.7-2 cm long, pilose, with patent, glandular and eglandular hairs 0.3-1 mm long; pedicel and peduncle together not overtopping the subtending leaf. Sepals 4.5-6 × 1.5-2.8 mm -ratio pedicel length/sepal length = 3-5.25-, smooth, not accrescent, 3-nerved, mucronate (with mucro 0.3-0.6 mm long), with scarious margins 0.2 mm wide, with patent, glandular and eglandular hairs 0.4-1 mm long on the abaxial side, glabrous on the adaxial side. Petals 6-7 × 2-2.5 mm, entire, with claw 2 mm long -bicarinated-, glabrous -sometimes with scattered hairs on the adaxial side-, purple. Stamens 10, both whorls bearing anthers; filaments 3-3.5 mm long, lanceolate to subulate, glabrous except for a some cilia on the proximal half; anthers

0.5 × 0.4 mm, yellowish. Nectaries glabrous. Gynoecium ca. 4-4.5 mm long. Fruit 16-18 mm long; mericarps 2.5-3 × 1.5-1.7 mm, without a strand of fibres, smooth, without longitudinal rib, with a basal callus, covering the seed completely, hairy, with eglandular, patent hairs 0.2-0.3 mm long, brownish; rostrum 12-13 mm long, with a narrowed apex 2-3 mm long, with patent, glandular and eglandular hairs 0.1-0.5 mm long; stigmatic remains 0.1 mm long, with 5 hairy lobes. Seeds 1.8-2 × 1.2 mm, reticulate, brownish, the hilum 1/4 as long as the perimeter. Cotyledons entire.  $2n = 26$ .

Flowering May. Disturbed areas; 0-100 m; introduced from the Old World; Eastern U.S.A. Fig. 11.

*Illustrations*. Fig. 19b. CAVANILLES (1787, tab. 93 fig. 2); ROSS-CRAIG (1952, Part 6, pl. 36); HOLMGREN (1998: 340).

*Geranium rotundifolium* is a very distinctive species, readily identified by its entire petals, its seed-ejection fruit with smooth mericarps, and its reticulate seeds. It has been frequently confused with *G. pusillum* or *G. molle*, both belonging in subg. *Robertium* (which is characterised by carpel-projection-type fruits).

So far, the specimens supporting the following records of *G. rotundifolium* have not been studied: California (KARTESZ, 1998), Colorado (RYDBERG, 1932: 500), Kansas (GATES, 1940: 45, 148), Maryland (KARTESZ, 1998), New Jersey (KARTESZ, 1998), and Pennsylvania (SCHAEFFER, 1949: 357). According to VOSS (1985: 502) reports of *G. rotundifolium* from Michigan appear to have been based on misidentifications.

*Representative specimens examined*

U.S.A. NEW YORK: Ballast grounds, at Hunter's Point, 40°42'N, 74°0'W, 10-VII-1879, *Brown s.n.* (NY); Ballast, Northern Terminus of 8th Ave., 40°42'N, 74°0'W, 16-V-1880, *Brown s.n.* (NY).

**6. *Geranium dissectum* L., Cent. Pl. I: 21 (1755)**

*Ind. loc.*: "Habitat in Europa australiori"



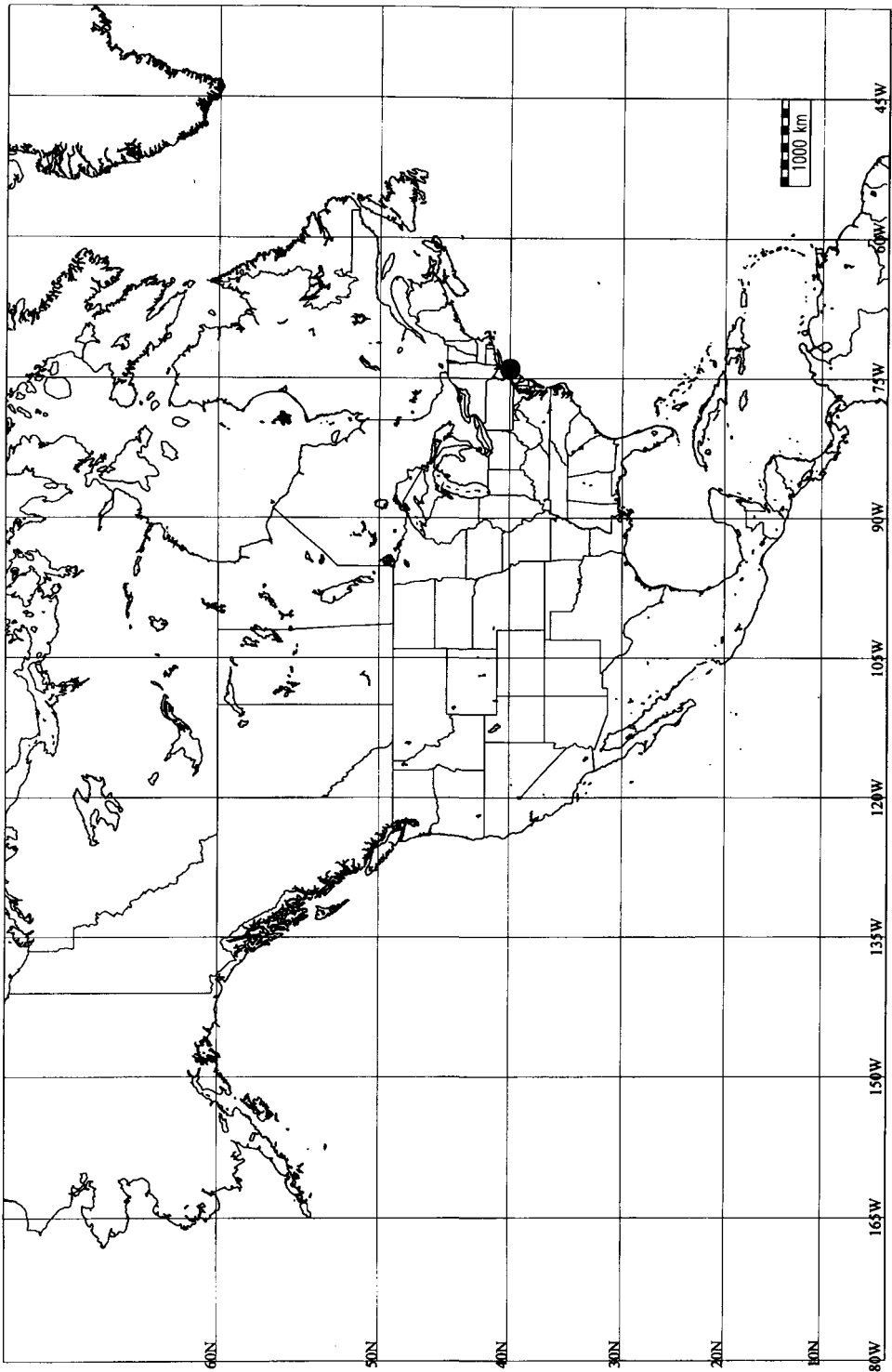


Fig. 11.—Distribution of *Geranium rotundifolium* in North America.

*Typus*: LINN-858.82 (color slide!) [lectotype, designated by CAROLIN (1965: 336)] = *G. laxum* Hanks ex Hanks & Small in Underw. & Britton (eds.), N. Amer. Fl. 25(1): 9 (1907)

*Ind. loc.*: "Type collected at Oyhut, Chehalis County, Washington, July 8, 1897, Frank H. Lamb 1263"

*Typus*: U.S.A. Washington, Chehalis Co., Oyhut, 7 Aug. 1897, Lamb 1263 (lectotype, here designated, MO!)

Herbs, annual, (7)15-69 cm tall. Stem erect, usually branched from the base, pilose, with retrorse, not appressed, eglandular hairs up to 0.8 mm long. Basal leaves in a  $\pm$  persistent rosette; lamina 4.5-8  $\times$  2.5-4 cm, polygonal in outline, palmatifid –divided for more than 0.9 of its length–, pilose, with appressed, eglandular –and sometimes glandular– hairs; segments 5-7, rhombic, 2-5 mm wide at the base, 3-9-lobed in distal half –ratio main-sinus length of the middle segment/middle-segment length = 0.4-0.5–; cauline leaves usually opposite, sometimes basal ones alternate; petioles to 15 cm long, with retrorse or subpatent, eglandular hairs up to 0.9 mm long; stipules 5-9  $\times$  1-3 mm, lanceolate, sometimes lobed, pilose with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Cymules 2-flowered, solitary; peduncles 0.6-5 cm long, pilose, with patent, mainly eglandular hairs up to 1.2 mm long; bracteoles 2-2.5  $\times$  0.7 mm, lanceolate, pilose, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 1-1.3 cm long, pilose, with patent, glandular and eglandular hairs up to 1 mm long; pedicel and peduncle together not overtopping the subtending leaf. Sepals 5-7  $\times$  2-2.5 mm –ratio pedicel length/sepals length = 1.1-2.2–, smooth, not accrescent, 3-nerved, mucronate (with mucro 1.2-2 mm long), with scarious margins 0.1-0.2 mm wide, with  $\pm$  patent, glandular and eglandular hairs 0.3-0.6 mm long on the abaxial side, glabrous adaxially. Petals 5-5.5  $\times$  2.5-3 mm, emarginate (with notch c. 0.5 mm deep), with claw 1 mm long, ciliate on the basal margin, purple. Stamens

10, both whorls bearing anthers; filaments 3-4 mm long, subulate, ciliate on all its length; anthers 0.4-0.5  $\times$  0.3 mm, purplish. Nectaries glabrous. Gynoecium 3-4 mm long. Fruit 12-17 mm long; mericarps 2-2.5 mm, without a strand of fibres, smooth, without longitudinal rib, without a basal callus –with a prong–, covering the seed completely, with eglandular –and sometimes small glandulae–, patent hairs 0.2-0.6 mm long, brownish; rostrum 7-10 mm long, with a narrowed apex 1-2 mm long, with patent, glandular hairs 0.5-0.6 mm long and patent, eglandular hairs up to 0.3 mm long; stigmatic remains 0.5-0.7 mm long, with 5 hairy lobes. Seeds 1.9-2.1  $\times$  1.5-1.6 mm, reticulate, reddish, the hilum 1/8 as long as the perimeter. Cotyledons entire.  $2n = 22$ .

Flowering March-July. Edge of forest, prairies, fields, and disturbed areas; 0-1500 m; introduced from the Old World; Eastern Canada, Eastern, South and Western U.S.A. Fig. 12.

*Illustrations*. Fig. 18a, 19c; CAVANILLES (1787, tab. 78 fig. 2); ROSS-CRAIG (1952, Part 6, pl. 37); HOLMGREN (1998: 339).

*Geranium dissectum* has mericarps without basal callus. Instead of this structure there are remains of a prong, which is in texture similar to that of the rest of the mericarp. It has been frequently confused with *G. columbinum*, characterised by seed-ejection with callus fruit. Additionally, *G. dissectum* has cymules not overtopping the subtending leaf whereas in *G. columbinum* pedicel and peduncle together clearly overtop the subtending leaf.

So far, the specimens supporting the following records of *G. dissectum* have not been studied: Arkansas (SMITH, 1994: 154), Connecticut (KARTESZ, 1998), Delaware (TATNALL, 1946: 162), Illinois (MOHLENBROCK, 1986: 301), Indiana (KARTESZ, 1998), Massachusetts (KARTESZ, 1998), New Jersey (KARTESZ, 1998), and Oklahoma (TAYLOR & TAYLOR, 1989: 59). VOSS (1985: 507) does not find authentic specimens of *G. dissectum* from Michigan.

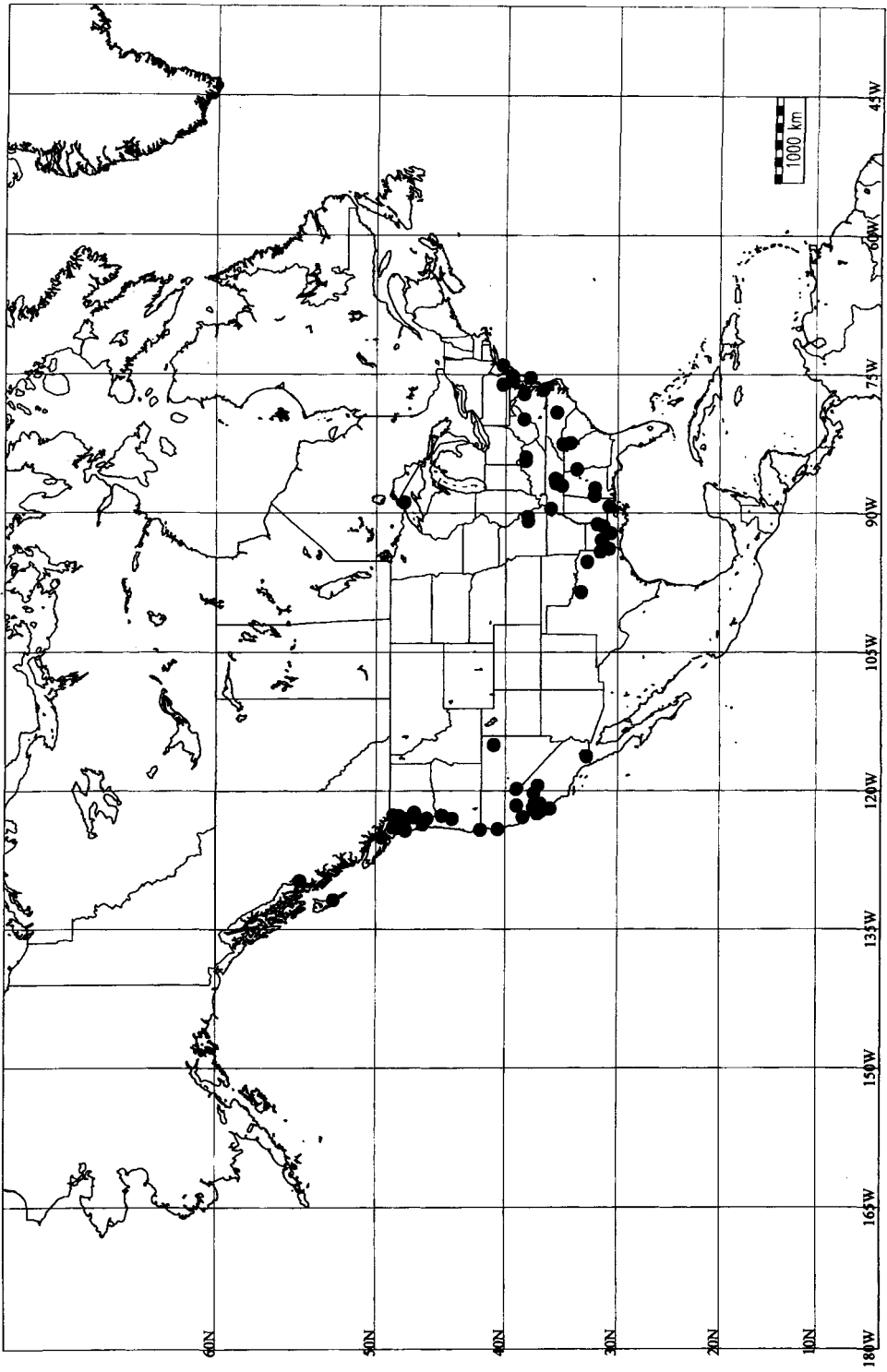


Fig. 12.—Distribution of *Geranium dissectum* in North America.

*Representative specimens examined*

CANADA. BRITISH COLUMBIA: Esquimalt, 48°27'N, 123°25'W, 25-V-1931, *Groh s.n.* (DAO); Milner, 49°8'N, 122°37'W, 28-VII-1939, *Groh 359* (DAO); Mitlenatch Island in Strait of Georgia. SE of Campbell River, 49°57'N, 125°0'W, 14-VI-1961, *Calder & MacKay 30508A* (DAO); N of Wickan, on Tofino-Uclulet highway, 3-VI-1971, *Harcombe & Wille 60303* (CAN); Queen Charlotte Islands. Moresby Island, Sandspit, 53°15'N, 131°49'W, 22-VI-1964, *Calder & Taylor 35329* (MO); Vancouver Is., Nanaimo, 49°10'N, 123°56'W, 1946, *Taylor 46045* (CAN); Vancouver Is., Thomas Point near Port Hardy airport, 55°23'N, 129°44'W, 13-VII-1961, *Calder & MacKay 31469A* (DAO); Victoria, Gonzales Hill, 48°24'N, 123°18'W, 15-VII-1966, *Harrison 1111* (QFA); Whiffin Spit at Sooke west of Victoria, 48°21'N, 123°45'W, 4-VI-1961, *Calder & MacKay 29978* (DAO). ONTARIO: Lake Superior, Silver Islet, 48°22'N, 88°50'W, 31-VIII-1871, *Gillman 62* (NY).

U.S.A. ALABAMA: Perry Co., 4.3 mi N Dallas Co. line, 32°39'N, 87°18'W, 14-IV-1970, *Kral 38463* (MO); Sumter Co., Epes, 32°41'N, 88°7'W, 19-V-1989, *Anderson 11977* (MO). CALIFORNIA: Butte Co., E side of Pacific Heights Road, 3 mi SW of Oroville, 39°30'N, 121°33'W, 8-IV-1990, *Ahart 6434* (MO); Butte Co., Table Mountain, Oroville, 39°30'N, 121°33'W, 20-IV-1968, *Sheldahl 19* (MA); Contra Costa Co., Danville, 37°49'N, 121°59'W, 8-IV-1959, *Twisselmann 5022* (MO); Humboldt Co., Spruce Cove, Trinidad, 41°3'N, 124°8'W, IV-1938, *Parks & Parks 24118* (MO); Lake Co., Kelseyville, 38°58'N, 122°50'W, 20-V-1925, *Blankinship s.n.* (MO); Monterey Co., Point Pinos, Pacific Grove, 36°38'N, 121°55'W, 5-V-1942, *Rose 42029* (MO); Riverside Co., Santa Rosa Plateau, 33°25'N, 116°13'W, 23-V-1973, *Thorne 45515* (NY); San Francisco, San Miguel Hills, canyon E of O'Shaughnessy Boulevard, 37°44'N, 122°26'W, 27-IV-1956, *Rubroff 2332* (MO); San Francisco, SW part of Lake Merced, 37°44'N, 119°24'W, 5-V-1954, *Raven 6879* (MO); San Joaquin Co., 3 mi N of Stockton, 37°57'N, 121°17'W, 18-VI-1964, *Alexson 30* (NY); San Mateo Co., Crystal Spring Lake, 37°31'N, 121°21'W, VI-1903, *Elmer 4730* (MO); Santa Clara Co., Stanford, Cedro way, 37°25'N, 122°9'W, 21-IV-1968, *Porter 1650* (MO); Tuolumne Co., Twain Harte Post Office, 38°2'N, 120°13'W, 9-VI-1944, *Alexander & Kellogg 3668* (MO). KENTUCKY: Pendleton Ballast, 38°47'N, 84°22'W, 11-V-1983, *Buddell II & Thieret 1032* (NY). LOUISIANA: Avoyelles Co., Effie, 31°12'N, 92°9'W, 2-VI-1979, *Allen 8737* (WVA); Madison Co., 1 mile W of US 65, exit at Tallulah, 32°24'N, 91°11'W, 1-V-1988, *Thomas & C. Slaughter 104232* (MO); Natchitoches Co., Goldona, 32°1'N, 92°55'W, 16-III-1974, *Terrell 26* (MO); Sabine Co., Pleasant Hill, 31°49'N, 93°30'W, 8-IV-1977, *Allen & al. 7716* (WVA); Tensas Co., 3 mi N of Helena, 31°52'N, 91°23'W, 20-IV-1957, *Ewan 19053* (MO). MARYLAND: Wicomico Co., Willards, 38°23'N, 75°20'W, 1-V-1939, *Earle 2007* (PH). MISSISSIPPI: Forrest Co., 3 mi S of Hattiesburg, 31°19'N, 89°17'W, 29-III-1971, *Rogers 6113* (MO). MISSOURI: New Madrid Co., Mississippi River front at New Madrid, 36°35'N, 89°31'W, 14-V-1992, *Summers 4968* (MO); St. Charles Co., Augusta,

38°34'N, 90°52'W, 6-XI-1997, *Darigo & Sullivan s.n.* (MO); St. Louis Co., Glendale, 38°35'N, 90°22'W, 7-VI-1952, *Steyermark 73314* (MO). NEVADA: California Co., Loomis, 41°26'N, 114°59'W, 23-IV-1955, *Vetter 11* (RENO); Washoe Co., Sparks, 39°32'N, 119°45'W, 15-VII-1985, *Williams 85-65-1* (NY). NEW YORK: New York, 40°42'N, 74°0'W, 30-V-1887, *Brown s.n.* (NY). NORTH CAROLINA: Buncombe Co., Biltmore, 35°33'N, 82°32'W, 4-VI-1897 (MO); Orange Co., Hillsboro, 36°4'N, 79°6'W, 29-IV-1960, *Ahles 53286* (WVA). OHIO: Brown Co., White Oak Creek, 38°47'N, 83°57'W, 16-X-1991, *McCormac 468* (KE). OREGON: Benton Co., 8 mi S of Corvallis, 2-VI-1928, *Thompson 4374* (MO); Curry Co., Rogue River, 42°29'N, 124°12'W, 30-V-1948, *Baker 5314* (NY); Marion Co., near Santiam R., near Jefferson, 44°43'N, 123°0'W, 22-VI-1930, *Stanford 1668* (MO); Multnomah Co., Portland, 45°31'N, 122°40'W, 23-VII-1902, *Sheldon 10980* (F). PENNSYLVANIA: Ballast, 39°54'N, 75°8'W, VI-1876, *Porter s.n.* (NY); Chester Co., Brookfield, 39°51'N, 75°39'W, VI-1862, *Canby s.n.* (NY); Schuylkill Co., Middleport, 40°43'N, 76°05'W, 18-VI-1936, *Wagner 1740* (PH). SOUTH CAROLINA: Greenville, 34°51'N, 82°23'W, 5-IV-1976, *Rodgers & Mullens 7692* (ILL). TENNESSEE: Maury Co., N side Columbia by US 31, 35°36'N, 87°2'W, 13-IV-1974, *Kral 52470* (MO); Rutherford Co., Stones, 36°0'N, 86°29'W, 27-IV-1973, *Kral 49722* (MO); Wilson Co., Lebanon, 36°12'N, 86°17'W, 20-IV-1986, *Hill 16506* (MO). TEXAS: Franklin Co., Sulphur River just N of Hagansport, 33°20'N, 95°14'W, 29-IV-1969, *Correll 37119* (TEX); Panola Co., small lake on Alexander Ranch, 4 mi N of Deadwood, 32°8'N, 94°8'W, 9-V-1962, *Correll & E.C. Ogdon 25189* (TEX); Sabine Co., 1 mi SW of Hemphill, 31°20'N, 93°50'W, 10-V-1969, *Correll 37228* (TEX); Wichita Co., Wichita Falls, 33°54'N, 98°29'W, 5-VI-1976, *Higgins 10021* (NY). VIRGINIA: Arlington, 38°54'N, 77°6'W, 2-VI-1951, *Allard 19904* (WVA); Williamsburgh, 37°16'N, 76°42'W, 21-IV-1921, *Grimes 3469* (NY). WASHINGTON: Chehalis Co., near Montesano, 46°58'N, 123°36'W, 16-VI-1898, *Heller 3949* (MO); Chehalis Co., Oyhut, 46°40'N, 122°58'W, 7-VIII-1897, *Lamb 1263* (MO); Clallam, 48°15'N, 124°15'W, 1-VI-1905, *Grant 145* (NA); King Co., Brooklyn, 47°36'N, 122°19'W, 12-VII-1898, *Savage & al. s.n.* (MO); King Co., Seattle, 47°36'N, 122°19'W, 2-VI-1889, *Piper 41* (MO); Kitsap Co., Seabeck, 47°38'N, 122°49'W, 12-VI-1934, *Eyerdam s.n.* (MO); Montesano, 46°58'N, 123°36'W, VII-1919, *Grant s.n.* (MO); Whatcom Co., Gooseberry Point, 48°43'N, 122°40'W, 21-VI-1939, *Muenschner 9995* (MO). WEST VIRGINIA: Randolph Co., Elkins, 38°55'N, 79°50'W, 27-VI-1957, *Davis 12113* (WVA).

**II. Geranium subg. *Robertium***

Fruit of "carpel-projection-type", with seeds actively discharged by the explosive recoiling of the awn. The whole mericarp, containing the seed, is dispersed, whereas the

awn remains with the columella; mericarps without basal callus or prong.

**7. *Geranium aequale* (Bab.) Aedo in Anaes**  
Jard. Bot. Madrid 55: 466 (1997)

*G. molle* var. *aequale* Bab., Man. Brit. Bot. Ed. 2 65 (1847)

*Ind. loc.*: "near Leamington (1845). Mr. J.J. Murcott" [52° 15'N 1° 29'W]

*Type*: United Kingdom. England, near Leamington, *Murcott s.n.* [lectotype, designated by CAROLIN (1965: 333), CGE]

Herbs, annual to 40 cm tall. Stem erect or decumbent, usually branched from the base, pilose, with long eglandular hairs 1-1.2 mm long and short glandular and eglandular hairs < 0.5 mm long. Basal leaves in a persistent rosette; lamina 1.5-3(5) × 1.5-3.7(5.8) cm, orbicular or reniform in outline, palmatifid—divided for 0.6-0.75 of its length—, pilose, with eglandular, appressed hairs; segments 7-9, obtriangular, 2-4 mm wide at the base, 3(5)-lobed at apex—ratio main-sinus length of the middle segment/middle-segment length = 0.27-0.31—; lower cauline leaves alternate; petioles to 14 cm long, with patent, long eglandular hairs ca. 1 mm long and short glandular and eglandular hairs < 0.5 mm long; stipules 6-7 × 3-4 mm, ovate-lanceolate, sometimes lobed, pilose with eglandular hairs on abaxial surface, glabrous adaxially. Cymules 2-flowered, solitary; peduncles 1-7 cm long, pilose, with eglandular patent hairs 1-1.7 mm long and short (< 0.5 mm) glandular and eglandular hairs; bracteoles 1.5-3 × 1-1.5 mm, lanceolate, sometimes lobed, pilose with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 1-2.2 cm long, pilose, with eglandular, patent hairs 1-1.8 mm long and short (< 0.5 mm) glandular and eglandular hairs; pedicel and peduncle together overtopping the subtending leaf. Sepals 3-5 × 1.5-2 mm—ratio pedicel length/sepal length = 1.5-2.5—, smooth, not accrescent, 3-nerved, mucronate (with mucro 0.1-0.2 mm long), with scarious margins 0.1 mm wide, with eglandular hairs 1-2 mm long and some shorter (< 0.5 mm) eglandular

and glandular ones on the abaxial side, glabrous adaxially. Petals 3.5-4.5 × 2-3 mm, emarginate (with notch 1 mm deep), with short claw, bright purple. Stamens 10, both whorls bearing anthers; filaments 3-4.5 mm long, lanceolate, glabrous except for a few cilia on the proximal half; anthers 0.4-0.6 × 0.2-0.3 mm, purplish. Nectaries glabrous. Gynoecium ca. 5 mm long. Fruit 9-12 mm long; mericarps 1.4-1.5 × 1-1.1 mm, without a strand of fibres, smooth, without longitudinal rib, not covering the seed completely, glabrous on most of the surface, densely ciliate at the base; rostrum 7-10.5 mm long, with a narrowed apex 1-1.5 mm, pilose (with erect-patent eglandular hairs 0.1-0.3 mm long), brownish; stigmatic remains ca. 1-2 mm long, with 5 hairy lobes. Seeds 1.6-1.7 × 0.9-1 mm, brownish, the hilum 1/5-1/6 as long as the perimeter. Cotyledons entire.  $2n = 26$ .

Flowering May-August. Cultivated fields and dry places near villages; 0-200 m; introduced from Europe; Central and Northeastern U.S.A. Fig. 13.

*Illustrations*. AEDO & al. (1998a: 605).

*Geranium aequale* is close to *G. molle*, from which it is easily distinguished by its smooth, densely ciliate mericarps (AEDO & al., 1998a).

*Representative specimens examined*

U.S.A. COLORADO: Boulder, 40°0'N, 105°16'W, 22-IX-1906, *Cockerey s.n.* (NY). INDIANA: Monroe Co., Indiana University Campus, 39°9'N, 86°31'W, 13-VI-1913. *Anderson 1752* (IND). KENTUCKY: Bullitt Co., Mountain Maples, Tablet Wall, 37°54'N, 85°37'W, 29-VI-1958, *Gunn 1223* (KY). MASSACHUSETTS: Barnstable Co., Falmouth, 41°33'N, 70°36'W, 4-VII-1895. *Deane s.n.* (MO); Barnstable Co., Hyannis, 41°39'N, 70°17'W, VIII-1930, *Knowlton s.n.* (MO); Barnstable Co., Cape Cod, 41°50'N, 70°00'W, 16-VI-1950, *Bacon 22* (MSC); Wellesley, 42°17'N, 71°17'W, 27-V-1[?]48, *Cummings s.n.* (NY). MICHIGAN: Emmet Co., Harbor Spring, 45°32'N, 84°55'W, 12-VI-1903. *Morrice s.n.* (MSC). NEW JERSEY: Morris Co., above Sterlington, 40°50'N, 74°32'W, 28-V-1905. *Mackenzie 1261* (NY); Tom's River, 39°57'N, 74°11'W, 3-VII-1916. *Wilson s.n.* (NY). NEW YORK: Long Island, Hewlett, 40°38'N, 73°41'W, 12-VI-1913, *Bicknell 5392* (NY); Sweden, Brockport, 43°10'N, 77°56'W, 13-XI-1975. *Hammond 8256c* (NY); Tompkins Co., Lawn of East Roberts Hall, 42°27'N,

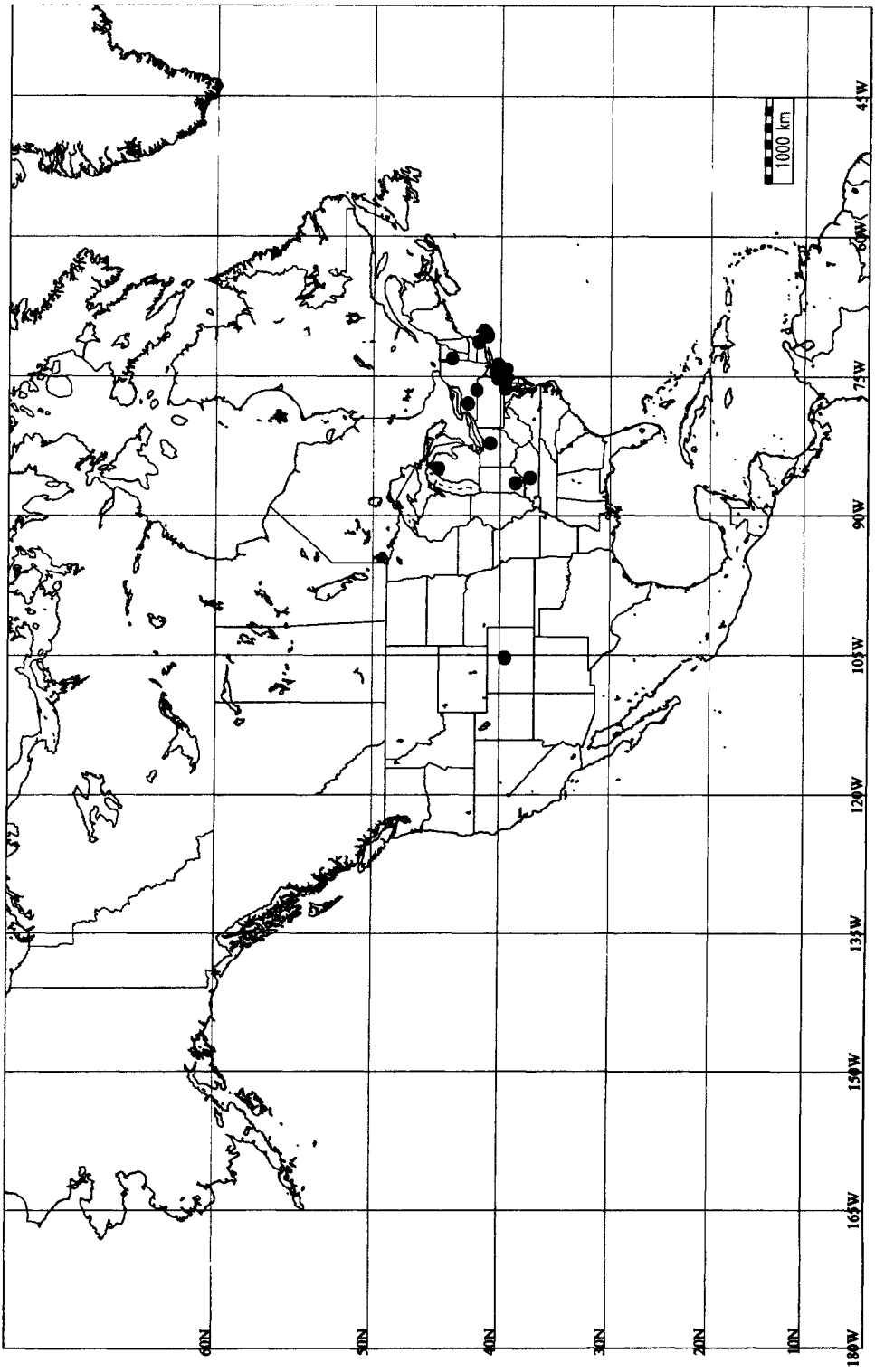


Fig. 13.—Distribution of *Geranium aequale* in North America.

76°28'W, 6-VI-1927, *Burnham 16985* (MO). OHIO: Lorain Co., Oberlin, 41°17'N, 82°13'W, 15-VII-1895, *Dick s.n.* (MICH). PENNSYLVANIA: Lancaster, 40°2'N, 76°18'W, VII-1894, *Bitner s.n.* (NY); on the Delaware River, N of Easton, 40°41'N, 75°13'W, 4-VII-1890, *Small s.n.* (NY); Philadelphia, 39°57'N, 75°9'W, *Williamson s.n.* (NY). VERMONT: Chittenden Co., Burlington, 44°27'N, 73°3'W, 11-V-1965, *Seymour 22651* (MO).

### 8. *Geranium molle* L., Sp. Pl.: 682 (1753)

*Ind. loc.*: "Habitat in Europa ad plateas"

*Typus*: Vaill., Bot. Paris., tab. 15 fig. 3-3a (1727) [lectotype, designated by CAROLIN (1965: 332-333)]

Herbs, annual to 45 cm tall. Stem erect or decumbent, usually branched from the base, pilose, with long eglandular hairs 1-1.7 mm long and short glandular and eglandular hairs < 0.5 mm long. Basal leaves in a persistent rosette; lamina 0.9-4 × 0.9-5.2 cm, orbicular or reniform in outline, palmatifid-divided for 0.5-0.75 of its length-, pilose, with eglandular appressed hairs; segments 7-9, obtriangular, 1.5-5 mm wide at the base, usually 3(4)-lobed at apex -ratio main-sinus length of the middle segment/middle-segment length = 0.14-0.25-; lower cauline leaves alternate; petioles to 14 cm long, with patent, long eglandular hairs 1-1.5 mm long and short glandular and eglandular hairs < 0.5 mm long; stipules 6-9 × 1.5-4 mm, ovate-lanceolate, sometimes lobed, pilose with eglandular hairs on abaxial surface, glabrous adaxially. Cymules 2-flowered, solitary; peduncles 0.5-8 cm long, pilose, with eglandular patent hairs 1-1.8 mm long and short (< 0.5 mm) glandular and eglandular hairs; bracteoles 1-2 × 0.5-1.2 mm, lanceolate, sometimes lobed, pilose with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 0.5-1.5 cm long, pilose, with eglandular patent hairs 1-1.8 mm long and short (< 0.5 mm) glandular and eglandular hairs; pedicel and peduncle together shorter or overtopping the subtending leaf. Sepals (1)2.5-5.5(6) × (0.9)1.2-2.1(2.5) mm -ratio pedicel length/ sepal length = 2.3-4.2-, smooth, not accrescent, 3-5-nerved, mucronate (with mucro 0.1-0.2 mm long), with scarious margins 0.1-0.2 mm wide, with eglandular hairs 1-1.5 mm long and some shorter

(< 0.5 mm) eglandular and glandular hairs on the abaxial side, glabrous adaxially. Petals (3)4.5-8.5(10.5) × (1.5)2-5(7) mm, emarginate (with notch 1-2.5 mm deep), with short claw, bright purple. Stamens 10, both whorls bearing anthers; filaments 4-5 mm long, lanceolate, glabrous except for few cilia on the proximal half; anthers 0.7-1.5 × 0.3-0.5 mm, purplish. Nectaries glabrous. Gynoecium 5-6 mm long. Fruit 8-14 mm long; mericarps 1.8-2.1 × 1.2-1.4 mm, without a strand of fibres, transversely wrinkled, without longitudinal rib, covering the seed completely, glabrous on the surface, with a few cilia at the base; rostrum 6-11 mm long, with a narrowed apex 1-3 mm, pilose (with erect-patent eglandular hairs ca. 0.3 mm long); stigmatic remains ca. 1-2 mm long, with 5 pilose lobes. Seeds 1.4-1.8 × 1-1.2 mm, brownish, the hilum 1/6 as long as the perimeter. Cotyledons entire.  $2n = 26$ .

Flowering February-August. Cultivated and waste places, open habitats, dunes, dry grassland, or roadsides; 0-1500 m; introduced from the Old World; widespread on Canada and U.S.A. Fig. 14.

*Illustrations*. Fig. 18c, 19e; CAVANILLES (1787: tab. 83 fig. 3); ROSS-CRAIG (1952, Part 6, pl. 34); HOLMGREN (1998: 340); AEDO & *al.* (1998a: 608).

So far, the specimens supporting the following records of *G. molle* have not been studied: Connecticut (SEYMOUR, 1969: 368), Illinois (JONES, 1945: 179), Maine (KARTESZ, 1998), Montana (BOOTH & WRIGHT, 1966: 143), Nova Scotia (ROLAND & SMITH, 1969: 488), New Hampshire (KARTESZ, 1998), and Ontario (SCOGGAN, 1978: 1046). DEAM (1910: 1069) indicated that *G. molle* was collected on the campus of Indiana University. However, the only specimen examined from Indiana -from the University campus, but collected in 1913- was *G. aequale*.

#### *Representative specimens examined*

CANADA. BRITISH COLUMBIA: Douglas, 49°0'N, 122°44'W, 29-IV-1906, *Spreadborough 79744* (NY); Goldstream, Van Island, 17-V-1887, *Macoun s.n.* (BM);

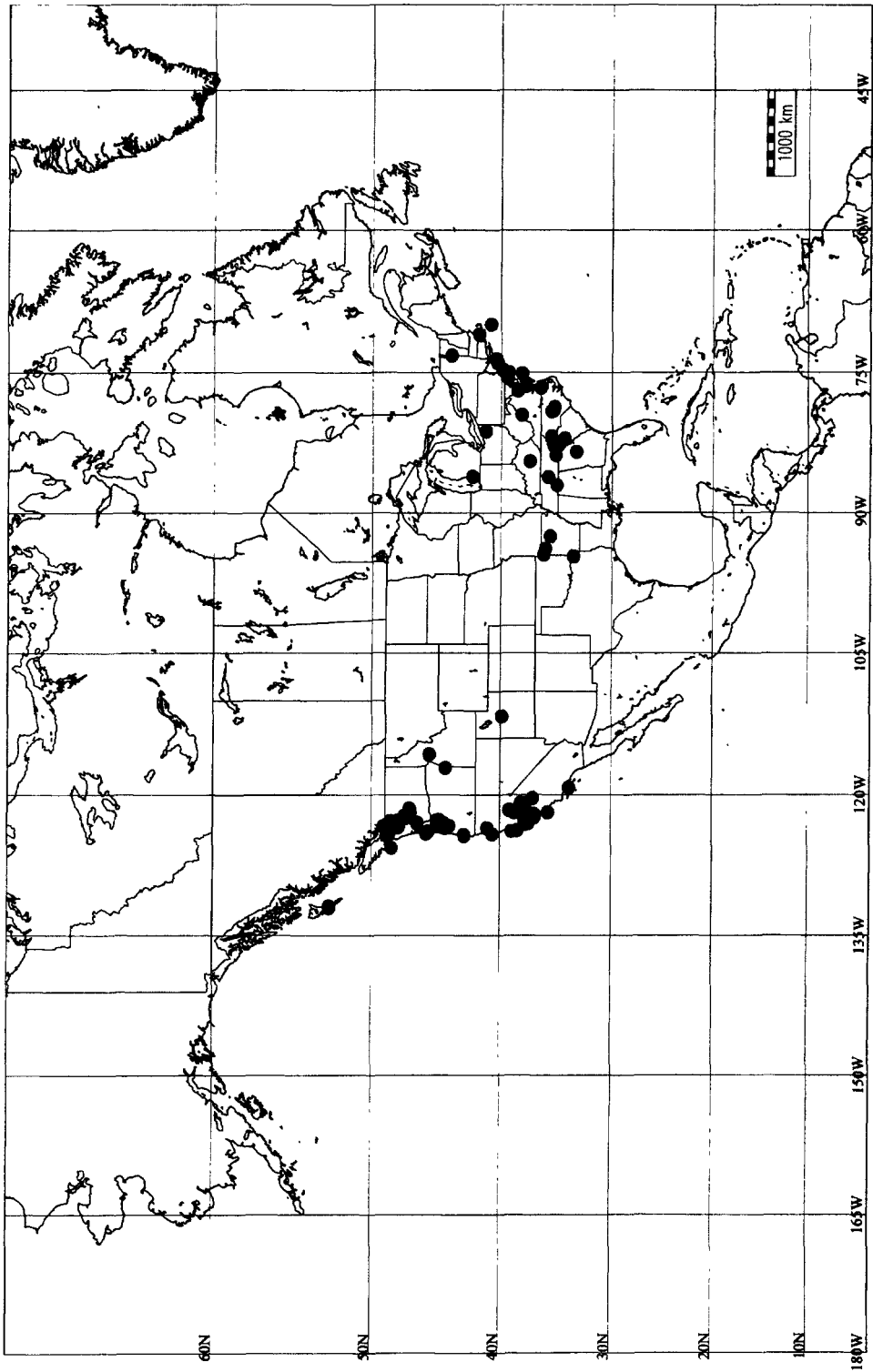


Fig. 14.—Distribution of *Geranium molle* in North America.



Haida Point, near Skidegate, Graham Island, 53°15'N, 132°1'W, 24-V-1957, *Calder & al. 20864* (NY); Image Point, between Skidegate and Skidegate Mission, Graham Island, 53°15'N, 132°0'W, 5-VI-1964, *Calder & al. 34682* (G); Moresby Island, Sandspit, 53°15'N, 131°49'W, 22-VI-1964, *Calder & al. 35330* (MO).

U.S.A. ARKANSAS: Marion Co., Buffalo State Park, ca. 15 miles SE Yellville, 36°10'N, 92°27'W, 23-V-1970, *D'Arcy & Porter 4426* (MO). CALIFORNIA: Alameda Co., between aqueduct and Alameda Creek where aqueduct crosses Niles Canyon rd., 37°34'N, 122°0'W, 13-IV-1969, *Wetzel 716* (CAS); Amador Co., Pardee lake, 38°15'N, 120°51'W, 30-III-1983, *McNeal 2796* (NY); Butte Co., E side of Pacific Heights Road, 3.5 mi SW of Oroville, 39°30'N, 121°33'W, 8-IV-1990, *Ahart 6435* (CAS); Butte Co., NE Highway 99 & Pentz Road, 39°39'N, 121°34'W, 10-IV-1983, *Ahart 3926* (CAS); Humboldt Co., Trinidad, 41°3'N, 124°8'W, 21-V-1907, *Eastwood 11* (CAS); Marin Co., 38°4'N, 122°44'W, 30-V-1932, *McCoy 210* (NY). DELAWARE: Sussex Co., Rehoboth, 38°39'N, 75°5'W, 23-V-1931, *Jones s.n.* (PH). IDAHO: Idaho Co., Clearwater River Canyon between Syringa and Orofino, ca 5 miles downstream of Syringa, 46°9'N, 115°43'W, 1-V-1983, *Henderson & Cholewa 6486* (NY). KENTUCKY: Fayette Co., Lexington, 37°59'N, 84°28'W, 12-V-1956, *Wallace 59* (KY). MARYLAND: access road to national Seashore, 38°20'N, 76°24'W, 14-IV-1984, *Hill 13530* (NY); causeway E side of bridge, National Seashore, 38°20'N, 76°24'W, 13-V-1984, *Hill 13815* (MO); Prince George Co., Beltsville, 39°2'N, 76°54'W, 10-V-1986, *Hill 16730* (NY). MASSACHUSETTS: Dorchester, 42°17'N, 71°4'W, 1874, *Churchill s.n.* (MO); Nantucket Island, Siasconset, 41°15'N, 69°58'W, 11-V-1966, *Mackeever 991* (BM). MICHIGAN: Ottawa Co., Holland, 42°47'N, 86°6'W 9-V-1977, *Gillis 13667A* (MSC). MISSOURI: Barry Co., Roaring river State Park, 36°35'N, 93°48'W, 13-V-1974, *Christ 129* (MO); McDonald Co., 1.5 miles S of Goodam, T23N, R32W S 19, roadside park on W side of Hwy 71, 36°44'N, 94°24'W, 3-VII-1989, *Summers 2944* (MO). NEW JERSEY: Camden Co., Ballust, 39°47'N, 74°58'W, 11-VI-1876, *Parker s.n.* (NY); W Lawrenceville, 40°17'N, 74°43'W, 25-V-1911, *Volk s.n.* (NY). NEW YORK: Long Island, Hunter's Point, 40°44'N, 73°57'W, 19-V-1880, *Brown s.n.* (NY); Long Island, Setanket, 40°49'N, 73°35'W, 10-VI-1924, *Ferguson 2948* (NY). NORTH CAROLINA: Avery Co., entrance to Grandfather Mountain on US 221, 36°6'N, 81°48'W, 2-VI-1988, *Boufford & Wood 23898* (MO); Buncombe Co., Biltmore, 35°33'N, 82°32'W, VI-1897, *Cornaz 4885* (G); Madison Co., Hot Springs, 35°53'N, 82°49'W, 18-V-1974, *Boufford & al. 13131* (MO). OHIO: Lake Co., Painesville, 41°43'N, 81°14'W, 4-VI-1886, *Werner s.n.* (NY). OKLAHOMA: McCurtain Co., 4.3 miles SE of Eagletown, 34°2'N, 94°34'W, 11-VI-1973, *Goodman 8336* (G). OREGON: Baker Co., old campground along Pine Creek, below North Pine Creek, between Halfway and Homestead, 44°52'N, 117°6'W, 11-VI-1950, *Conquist 6543* (NY); Benton Co., N slope of Baldie, W of Corvallis, 44°33'N, 123°15'W, 7-VI-1918, *Lawrence 1662* (CAS). PENNSYLVANIA: Chester Co., Brookfield, 39°51'N, 75°35'W, VII-1817, *Canby s.n.* (NY). SOUTH CAROLINA:

Spartanburg Co., Woffod College, 34°55'N, 81°59'W, 5-VI-1960, *Kirby 165* (DUKE). TENNESSEE: Blount Co., Walland, Mt Nebo, 35°43'N, 83°49'W, 26-IV-1980, *Thomas 71177* (MO); Maury Co., N side of Columbia by US 31, 35°36'N, 87°2'W, 13-IV-1974, *Kral 52469* (MO); Trousdale Co., North bank Cumberland River by Tenn 141, 0.5 mi N Hartsville, 36°23'N, 86°10'W, 4-V-1973, *Kral 49798* (MO). UTAH: Utah Co., Provo Bench near Pleasant View, Utah Ditchbank, 40°18'N, 111°39'W, 1-VI-1934, *Harrison 7543* (MO). VERMONT: Burlington, 44°28'N, 73°12'W, 16-V-1962, *Johnson 28* (VT). VIRGINIA: Isle of Wight Co., Fort Boykin, 37°2'N, 76°37'W, 5-V-1991, *Grimm s.n.* (BM). WASHINGTON: King Co., 1 mile N Snoqualmie Falls on the road between Falls City and Snoqualmie, Cascade Mountains, 47°32'N, 121°50'W, 20-VI-1964, *Anderson 2138* (MO); King Co., Seattle, 47°36'N, 122°19'W, VI-1909, *Eyendam s.n.* (G); Lake Washington, 47°34'N, 122°17'W, IV-1908, *Gavett s.n.* (NY); Long Beach, 46°21'N, 124°3'W, 12-VII-1907, *McGregor s.n.* (CAS); Olympia, near Main St., 47°2'N, 122°53'W, 26-V-1904, *Townsend s.n.* (MO). WEST VIRGINIA: Pendleton Co., Pike Gap rd., 0.5 mi SE jet of St. Rt. 28 at Circleville, 38°40'N, 79°29'W, 31-V-1989, *Cusick 28120* (NY). WISCONSIN: Olga, 10-VI-1905, *Engberg s.n.* (NY).

**9. *Geranium pusillum* L., Syst. Nat. ed. 10, 2: 1144 (1759) [V-VI, 1759]**

*Ind. loc.*: "Habitat in Anglia, Gallia" [according to L., Sp. Pl. ed. 2: 957 (1763)]  
*Typus*: LINN-858.86 (color slide!) [lecto-type, designated by AEDO & al. (1998a: 611)]

Herb, annual up to 50 cm tall. Stem erect or decumbent, usually branched from the base, pilose, with short glandular and eglandular patent hairs (<0.3 mm long). Basal leaves in a persistent rosette; lamina 1.5-3.8 × 1.5-4.8 cm, orbicular or reniform in outline, palmatifid -divided for 0.3-0.75 of its length-, pilose, with eglandular, appressed hairs; segments 7, obtriangular, 2-4 mm wide at the base, 3-5-lobed at apex -ratio main-sinus length of the middle segment/middle-segment length = 0.16-0.29-; lower cauline leaves opposite; petioles to 12 cm long, with short (< 0.3 mm) eglandular and glandular patent hairs; stipules 2-4 × 1-1.5 mm, lanceolate, sometimes lobed, pilose with eglandular hairs on abaxial surface, glabrous adaxially. Cymules 2-flowered, solitary; peduncles 0.5-3.2 cm long, pilose, with short (< 0.3 mm) glandular and eglandular patent hairs; bracteoles 1.5-2 × 0.5 mm, linear-

lanceolate; pedicels 0.6-1.6 cm long, pilose, with short (< 0.3 mm) glandular and eglandular patent hairs; pedicel and peduncle together overtopping the subtending leaf. Sepals 3-4.5 × 1.5-2 mm –ratio pedicel length/sepal length = 1.5-2.6–, smooth, not accrescent, 3-5-nerved, mucronate (with mucro 0.1 mm long), with scarios margins ca. 0.1 mm wide, with eglandular hairs ca. 1 mm long and some shorter (< 0.5 mm) eglandular and glandular hairs on the abaxial side, glabrous adaxially. Petals 2-3 × 1-1.5 mm, emarginate (with notch 0.2-0.5 mm deep), with short claw, pale purple. Stamens 10, the inner whorl with filaments 1.2-1.5 mm long, lanceolate, pilose on the abaxial side, ciliate on the proximal half; anthers 0.3 × 0.2 mm, purplish; external whorl with filaments 1 mm long, almost glabrous, lacking anthers. Nectaries glabrous. Gynoecium ca. 3 mm long. Fruit 9-11 mm long; mericarps 1.7-1.9 × 1-1.1 mm, without a strand of fibres, smooth, with a longitudinal rib, covering the seed completely, pilose, with appressed-eglandular hairs to 0.2 mm long, with a few cilia at the base; rostrum 7-9 mm long, obtuse at apex, pilose (with erect-patent, eglandular and glandular hairs ca. 0.2 mm long); stigmatic remains 0.5-0.7 mm long, with 5 pilose lobes. Seeds 1.7-1.8 × 1-1.1 mm, reddish; hilum 1/6 as long as the perimeter. Cotyledons entire.  $2n = 26$ .

Flowering March-September. Cultivated and waste places, open habitats, rocky slopes, and dry grassland; 0-1500 m; introduced from the Old World; widespread in Canada and U.S.A. Fig. 15.

*Illustrations.* CAVANILLES (1787, tab. 83 fig. 1); ROSS-CRAIG (1952, Part 6, pl. 35); HOLMGREN (1998: 340); AEDO & al. (1998a: 613).

So far, the specimens supporting the following records of *G. pusillum* have not been studied: Iowa (KARTESZ, 1998), Maine (SEYMOUR, 1969: 368), Minnesota (KARTESZ, 1998), North Carolina (RADFORD & al., 1968: 651), New Hampshire (KARTESZ, 1998), New

Mexico (MARTIN, 1980: 1124), and South Carolina (KARTESZ, 1998).

### *Representative specimens examined*

CANADA. ALBERTA: Banff, 51°10'N, 115°34'W, IX-1925, *Sanson 1028* (NY). BRITISH COLUMBIA: Agassiz, 49°14'N, 121°52'W, 20-V-1889, *Macoun 2889* (CAN); Sardis, 49°8'N, 121°57'W, 27-V-1954, *Faris 48* (DAO); Vancouver, 49°15'N, 123°7'W, 6-V-1875, *Macoun 268* (K). MANITOBA: Brandon, 49°50'N, 99°57'W, 17-VIII-1953, *Stevenson 788* (CAN). ONTARIO: Algoma, Sault Ste. Marie, 46°31'N, 84°20'W, 11-VII-1954, *Bragg & Bassett 457* (DAO); Bruce Co., Crane Lake, 45°10'N, 81°24'W, 19-VI-1977, *Soper & al. 13637* (CAN).

U.S.A. ARKANSAS: Carroll Co., Elk Ranch, 36°27'N, 93°45'W, 2-VI-1931, *Palmer 39459* (NY); Eureka Spring, 36°24'N, 93°44'W, 9-V-1902, *Bush 1542* (NY); Madison Co., Withrow Springs, 36°9'N, 93°44'W, 23-IV-1933, *Moore 330038* (NY). CALIFORNIA: Inyo Co., Independence, 36°48'N, 118°11'W, 23-VI-1941, *Kerr s.n.* (CAS); Santa Cruz Co., Boulder Creek, 37°7'N, 122°7'W, 13-VI-1953, *Hesse 1118* (CAS); Tulare Co., Tule River, Sierra Nevada, 36°2'N, 119°49'W, 10-VIII-1908, *Peirson 2021* (CAS). COLORADO: Denver, 39°44'N, 104°59'W, XI-1911, [*illegible*] (NY); St. Lupton, 40°5'N, 104°48'W, 2-VI-1914, *Johnston 555* (MO). CONNECTICUT: Fairfield Co., Bridgeport, 41°10'N, 73°12'W 18-VI-1908, *Eames 5929* (PH). DELAWARE: New Castle Co., Brandywine, 39°49'N, 75°32'W, VIII-1863, *Canby s.n.* (NY); Wilmington, 39°44'N, 75°32'W, 13-VI-1866, *Commons s.n.* (NY). IDAHO: 11 miles S of White Bird on US hwy 95, in old orchard by Salmon River, 45°45'N, 116°17'W, 2-VI-1970, *Cox & al. 1827* (NY); Coeur d'Alene Mountains, 47°45'N, 116°0'W, 20-VI-1895, *Leiberg 1325* (NY). ILLINOIS: Alton, along the track of the Illinois Terminal Railroad, E of Piasa Street, 38°53'N, 90°11'W, 26-V-1979, *Muehlenbach 4336* (MO); Hancock Co., Augusta, 40°13'N, 90°57'W, 1841, *Meade s.n.* (MO). INDIANA: Elkhart Co., 41°34'N, 85°50'W, 5-VII-1941 (NY); Lagrange Co., in lawn of Williams sisters at Howe, 41°43'N, 85°25'W, 15-VI-1945, *Friesner 18971* (NY). KANSAS: Ellsworth Co., Kanopolis Reservoir, N Shore St. Park, 38°37'N, 97°58'W, 20-VI-1984, *Brooks 17145* (NY); Wabaunsee Co., 2.2 mi N Alma, 39°1'N, 96°17'W, 15-V-1991, *Brooks 20689* (NY). KENTUCKY: Boyle Co., Bellevue Cemetery, N Danville, 37°39'N, 84°46'W, 1-VI-1992, *Cusick 30297* (NY); Fayette Co., Iris Place, Lexington, 37°59'N, 84°28'W, 21-V-1942, *McFarland 67* (NY). MARYLAND: Bladensburg, 38°56'N, 76°56'W, VI-1879, *Chickering s.n.* (MO). MASSACHUSETTS: Dorchester Co., Percival & Mariel streets, 42°17'N, 71°4'W, 28-X-1922, *Churchill s.n.* (MO); Edgartown, Martha's Vineyard, 41°23'N, 70°30'W, 19-VI-1961, *MacKeever 445* (NY); Nantucket Island, 41°17'N, 70°6'W, 11-VIII-1906, *Bicknell 5395* (NY). MICHIGAN: Genesee Co., Flint, 43°0'N, 83°41'W, *Clarke s.n.* (NY); Lambton Co., near Sarnia, 42°58'N, 82°24'W, 6-VI-1896, *Dodge s.n.* (NY); Washtenaw Co., Packard road, 42°15'N, 83°31'W, 4-VI-1937, *Hermann 8695* (NY). MISSOURI: Noel, 36°32'N, 94°29'W, 25-V-1909, *Bush 5727* (NY). MONTANA:

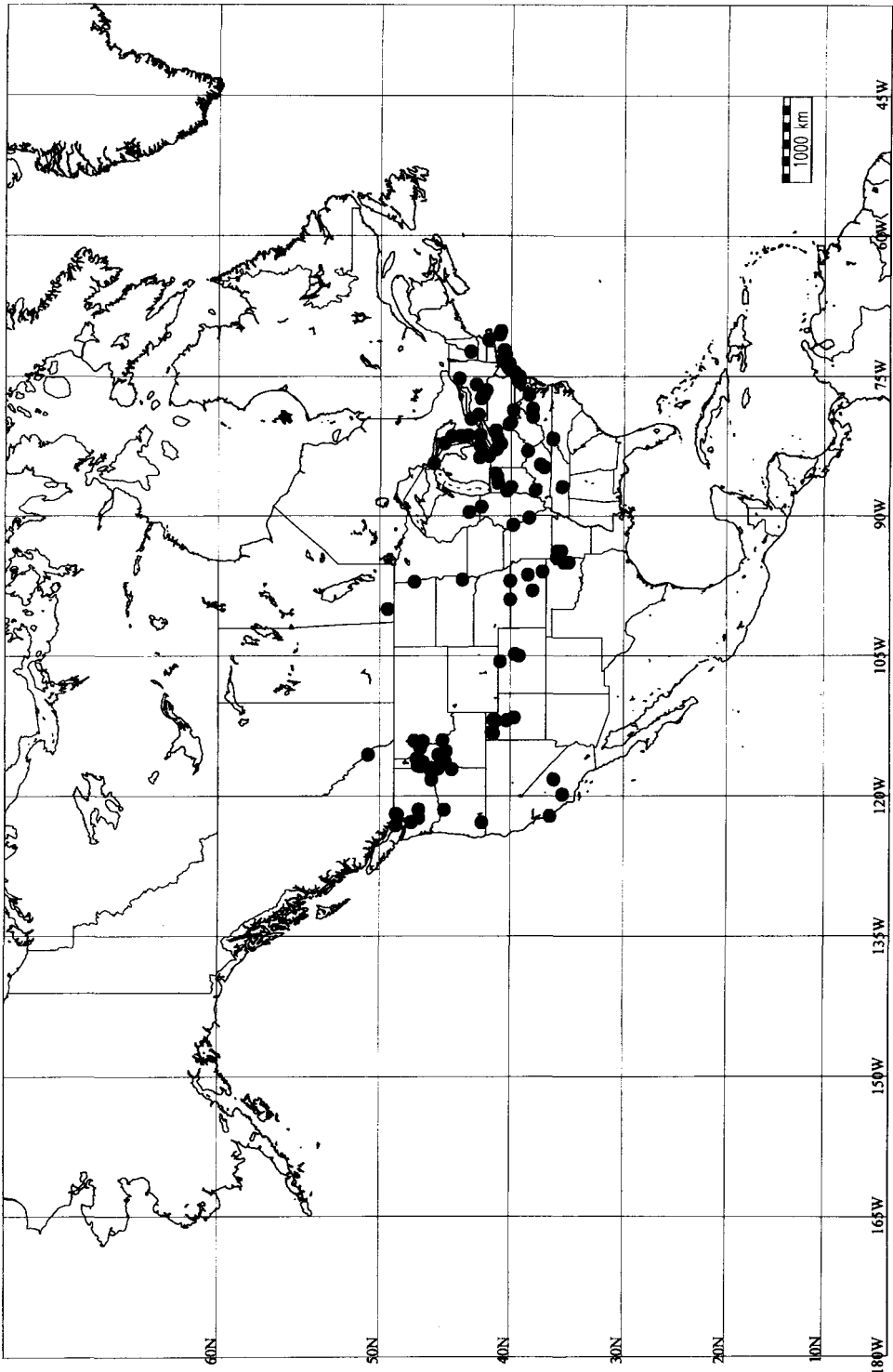


Fig. 15.—Distribution of *Geranium pusillum* in North America.

Flathead Mission, 47°55'N, 114°5'W, IX-1899, *Blankinship s.n.* (NY); Lake and Sanders Co., along Pauline Cr. and adjacent grasslands, National Bison Range, 47°19'N, 114°13'W, 23-VI-1966, *Thomas & Bromley 11733* (CAS). NEBRASKA: Kearney Co., Minden, 40°29'N, 96°56'W, 10-VI-1931, *Hapeman s.n.* (MO). NEW JERSEY: Camden, 39°47'N, 74°58'W, *Parker s.n.* (NY); pr. Philadelphia, 39°47'N, 74°58'W, VI-1841, *Watson s.n.* (K). NEW YORK: Albany, 40°42'N, 73°49'W, 16-VI-1882, *Dudley s.n.* (CAS); Ballast grounds, at Hunter's Point, 40°44'N, 73°57'W, 9-VII-1879, *Brown s.n.* (NY). NORTH DAKOTA: Grand Forks, 47°55'N, 97°1'W, 23-VII-1920 (F). OHIO: Ashtabula Co., 41°42'N, 80°46'W, 6-VI-1893, *Goodrich 147* (MO); Euclid, 41°34'N, 81°33'W, *Scair s.n.* (NY); Lorain Co., Oberlin, 41°17'N, 82°13'W, 10-VII-1894, *Dick s.n.* (MONTU). OKLAHOMA: Sequoyah Co., Vian, 35°29'N, 94°58'W, 7-V-1955, *Goodman 6060* (OKL). OREGON: Pilot Rock, 42°46'N, 122°48'W, VII-1902, *Griffiths & Hunter 20* (NY); Wallowa Co., Imnaha canyon, 45°6'N, 117°6'W, 8-VII-1933, *Peck 17528* (NY). PENNSYLVANIA: Allegheny Co., 40°37'N, 80°7'W, 1869, *Porter s.n.* (NY); Bedford Co., 1/8 mi E of Janiatta Crossing, 40°15'N, 78°37'W, 26-V-1944, *Berkheimer 4633* (MIN); Philadelphia, 39°57'N, 75°9'W, *James s.n.* (NY). SOUTH DAKOTA: Brookings, 44°18'N, 96°47'W, VI-1892, *Thorner s.n.* (MO). TENNESSEE: Davison Co., Belle Meade area, 36°5'N, 86°51'W, 28-V-1973, *Kral 50321* (MO). UTAH: Bidolph's garden on road to Green Canyon, 41°58'N, 113°9'W, 13-VI-1949, *Shaw 36* (NY); Cache Co., 0.5 mile S of Smithfield sugar refinery, 41°50'N, 111°49'W, 22-VI-1942, *Maguire 21582* (NY). VERMONT: Norwich, 43°42'N, 72°18'W, 7-VI-1903, *Loveland s.n.* (VT). VIRGINIA: Page Co., Luray, 38°39'N, 78°27'W, 14-VI-1936, *Camp 1486* (NY); Smyth Co., Broad Ford, 36°55'N, 81°40'W, *Small s.n.* (MIN); Smyth Co., Fork Holston river, near Broad Ford, 36°55'N, 81°40'W, 20-VI-1892, *Small s.n.* (MO); Smyth Co., S slope of White Rock Mountains, 36°56'N, 81°45'W, 21-VI-1892, *Small s.n.* (K). WASHINGTON: Asotin Co., 10 mi S of Asotin, on bluffs along W side of Snake River, 46°10'N, 117°2'W, 10-VI-1959, *Hitchcock & Muhlick 21801* (NY); Asotin Co., on cliffs above Snake River 3 miles S of Asotin, 46°20'N, 117°2'W, 27-V-1944, *Hitchcock & Muhlick 8366* (NY); King Co., Seattle, 47°36'N, 122°19'W, VII-1915, *Freiberg s.n.* (MO). WEST VIRGINIA: Pendleton Co., Franklin, 38°38'N, 79°19'W, 30-VI-1936, *Burton s.n.* (NY). WISCONSIN: Marquette Co., Oxford, 43°46'N, 89°34'W, 1-VII-1929, *Wilkins s.n.* (WIS); Rock Co., Newville, 42°49'N, 89°1'W, 30-V-1985, *Thomson s.n.* (WIS). WYOMING: Laramie Expt. Farm, 41°18'N, 105°35'W, 30-VI-1896, *Nelson 2038* (NY).

## 10. *Geranium lucidum* L., Sp. Pl.: 682 (1753)

*Ind. loc.*: "Habitat in Europae rupibus umbrosis"

Typus: LINN 858.72 (color slide!) [lectotype, designated by GHAFOOR (1978: 43)]

Herbs annual, 5-45 cm tall. Stem erect, solitary, glabrous. Basal leaves in a persistent rosette; lamina 1.7-3.8 × 2-4.2 cm, orbicular in outline, palmatifid—divided for 0.58-0.68 of its length—, pilose, with ± appressed, eglandular hairs; segments 5, obtriangular, 4-6 mm at the base, 3-7-lobed at apex—ratio main-sinus length of the middle segment/middle-segment length = 0.1-0.2—; cauline leaves opposite; petioles to 8 cm long, glabrous or with some eglandular, antrorse hairs 0.2-0.3 mm long; stipules 1.5-2 × 1 mm, lanceolate, glabrous. Cymes 2-flowered, solitary; peduncles 1-3.5 cm long, pilose, with antrorse, eglandular hairs 0.2-0.4 mm long; bracteoles 1-1.5 × 0.5 mm, lanceolate, glabrous on both sides; pedicels 0.6-1.3 cm long, pilose, antrorse, eglandular hairs 0.2-0.4 mm long; pedicel and peduncle together overtopping the subtending leaf. Sepals (4.5)5.8-6.5 × 2.5-3 mm—ratio pedicel length/sepal length = 0.8-3—, with lengthwise keels and transverse flaps between these, not accrescent, 3-nerved, mucronate—with mucro 0.5-1 mm long—, with scarious margins 0.3 mm wide, usually glabrous, sometimes with small glands on the abaxial side, glabrous adaxially. Petals 5-9 × 1.8-2.4 mm, entire, with claw 4.5-5 mm long—bicarinated—, glabrous—sometimes with some cilia on the basal margin—, purplish. Stamens 10, both whorls bearing anthers; filaments 4.5-6.5 mm long, lanceolate, glabrous; anthers 0.5 × 0.5 mm, yellow. Nectaries absent. Gynoecium 7-9 mm long. Fruit 16-17 mm long; mericarps 2.5-2.8 × 1.3-1.6 mm, without a strand of fibres, reticulate, with 2-3 overlapping collar-like keels—carrying some lines of glandular hairs 0.2 mm long—at the apex, without longitudinal rib, without basal beak, covering the seed completely, glabrous on most of the surface, with glandular cilia on the margin, brownish; rostrum 12-13 mm long, with a narrowed apex 5 mm long, glabrous in the proximal half, with erect-patent, eglandular hairs ca. 0.1 mm long in the distal half; stigmatic remains c. 1 mm long, with 5 glabrous lobes. Seeds 2-2.2 × 1-1.2 mm, smooth, uniformly, reddish; hilum

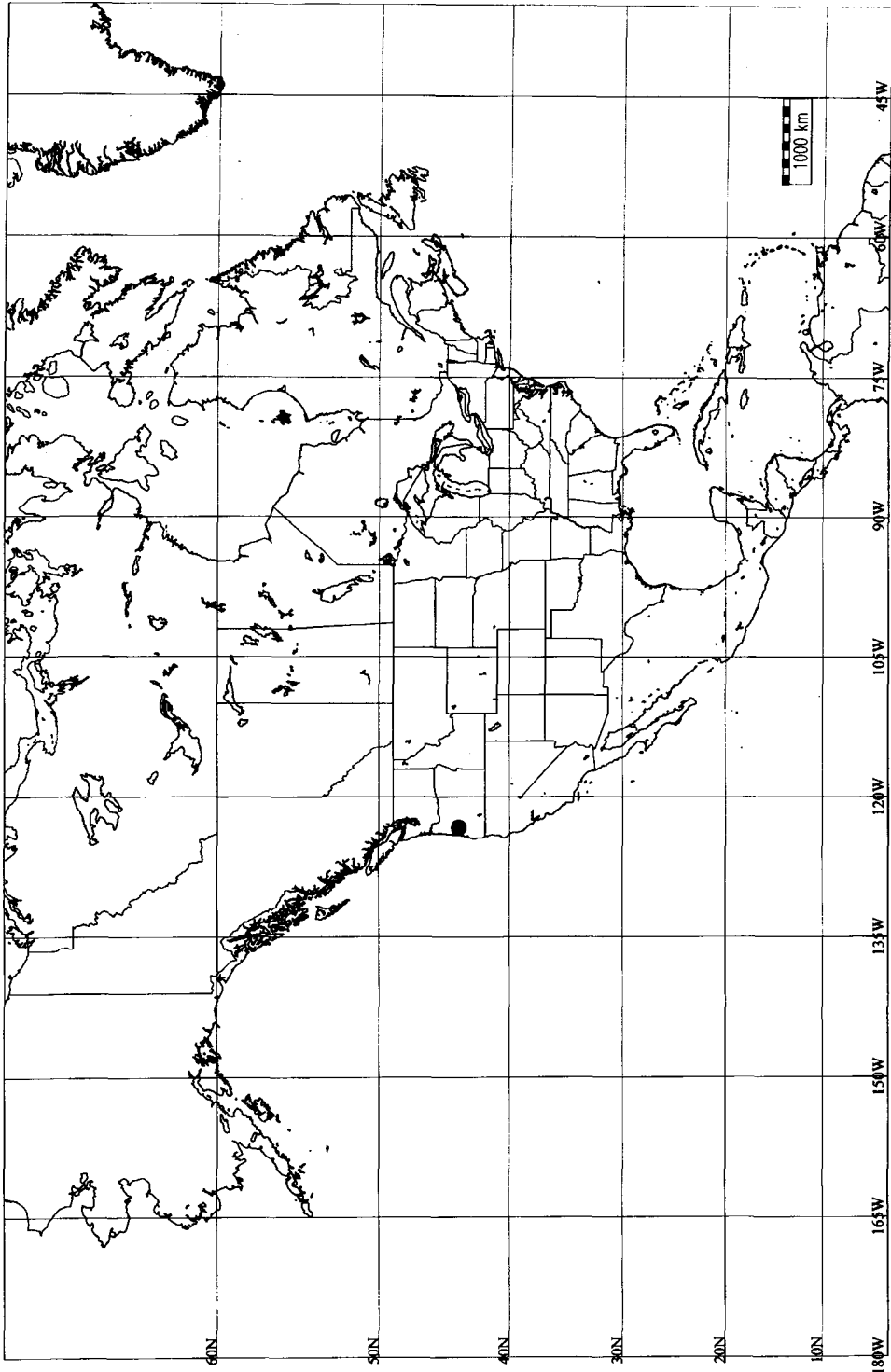


Fig. 16.--Distribution of *Geranium lucidum* in North America.

1/6 as long as the perimeter. Cotyledons entire.  $2n = 20, 40-44, 60$ .

Flowering May. Disturbed areas; 0-100 m; introduced from the Old World; Western U.S.A. Fig. 16.

*Illustrations.* Fig. 18d, 19f; CAVANILLES (1787, tab. 80 fig. 2); ROSS-CRAIG (1952, Part 6, pl. 39).

*Representative specimens examined*

U.S.A. OREGON: Benton Co., Corvallis, along Witham Hill Drive, 44°35'N, 123°16'W, 16-V-1999, *Halse 5530* (MA).

**11. *Geranium robertianum* L., Sp. Pl.: 681 (1753)**

*Robertiella robertianum* (L.) Hanks in Underw. & Britton (eds.), *N. Amer. Fl.* 25(1): 3 (1907)

*Ind. loc.:* "Habitat in Europae borealis rupibus"

*Typus:* LINN-858.70 (color slide!) [lectotype, designated by GHAFOR, 1978: 44]

= *Geranium inodorum* G. Don, *Gen. Hist.* 1: 721 (1831)

*Ind. loc.:* "Native of North America, from New York to Virginia, in shady moist places on rocks"

*Typus:* no original material found

Herbs, biennial, sometimes annual to 55 cm tall. Stem erect, usually branched from the base, pilose, with  $\pm$  patent, glandular hairs 0.4-1 mm long. Basal leaves in a persistent rosette; lamina 3-9  $\times$  3.5-10 cm, polygonal in outline, palmatisect, pilose, with  $\pm$  appressed, glandular hairs; segments 5, rhombic, 1 mm wide at the base, usually 16-46-lobed in distal half -ratio main-sinus length of the middle segment/middle-segment length = 0.26-0.5-; cauline leaves opposite; petioles to 20 cm long, with patent, retrorse, not appressed, eglandular hairs 0.3-0.5 mm long and patent, glandular 0.4-2.4 mm long; stipules 2-5  $\times$  1.8-3 mm, ovate, glabrous on both sides, ciliate -with eglandular and glandular hairs-. Cymes 2-flowered, solitary; peduncles 1-6 cm long, pilose, with patent, glandular hairs 0.4-0.9 mm long and retrorse, not appressed, eglandular hairs 0.3-0.5 mm long; bracteoles

1-1.5  $\times$  0.6-1 mm, ovate, glabrous on both sides, ciliate -with eglandular and glandular hairs; pedicels 0.5-2 cm long, pilose, with patent, glandular hairs 0.4-1.5 mm long and retrorse, not appressed, eglandular hairs 0.3-0.5 mm long; pedicel and peduncle together often overtopping the subtending leaf. Sepals 6-8  $\times$  3-3.5 mm -ratio pedicel length/sepals length = 0.7-2.1-, smooth, not accrescent, 3-nerved, mucronate (with mucro 1.8-2.5 mm long), with scarious margins 0.3-0.4 mm wide, with  $\pm$  patent hairs -glandular hairs 0.4-3.2 mm long and eglandular hairs 0.3-0.5 mm long- on the abaxial side, glabrous adaxially. Petals 10-14  $\times$  3.5-5.5 mm, entire, with claw 4.5-6.5 mm long -bicarinated-, glabrous, purple. Stamens 10, both whorls bearing anthers; filaments 6-8.5 mm long, subulate, glabrous; anthers 0.5  $\times$  0.5 mm, purplish. Nectaries glabrous. Gynoecium 4-6 mm long. Fruit 19-23 mm long; mericarps 2.5-3.1  $\times$  1.6-1.8 mm, with a strand of fibres derived from the beak attached near the apex on either side, reticulate -the ridges sparse and scarcely anastomosing in the basal half, denser above and forming 1-2(3) overlapping, collar-like keels at the apex-, without longitudinal rib, covering the seed completely, glabrous or hairy -with eglandular hairs 0.2 mm long, small glandulae or both-, brownish; rostrum 17-19 mm long, with a narrowed apex 4-5 mm long, glabrous in the proximal half, with antrorse, appressed, eglandular hairs ca. 0.1 mm long in the distal half; stigmatic remains ca. 1 mm long, with 5 glabrous lobes. Seeds 2.1-2.2  $\times$  1.1-1.2 mm, smooth, reddish, the hilum 1/6 as long as the perimeter. Cotyledons entire.  $2n = 64$ .

Flowering April-September. Deciduous forests, pastures, and disturbed areas; 0-100 m; introduced from the Old World; widespread in U.S.A., and Canada. Fig. 17.

*Illustrations.* Fig. 18f, 19g; CAVANILLES (1787, tab. 86 fig. 1); ROSS-CRAIG (1952, Part 6, pl. 40); HOLMGREN (1998: 339).

*Geranium robertianum* has reticulate mericarps with ridges sparse and scarcely anastomosing in the basal half, purplish

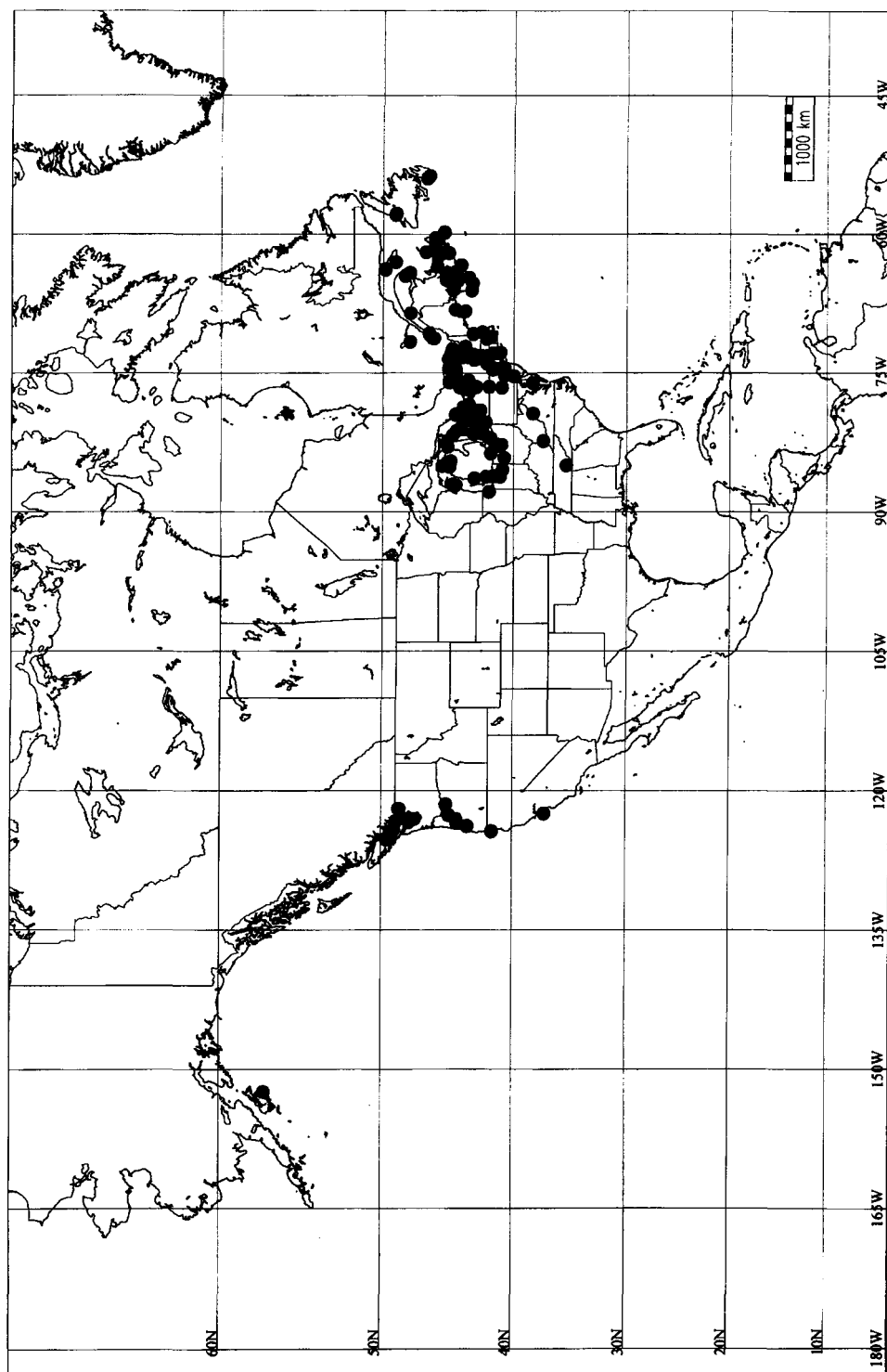


Fig. 17.—Distribution of *Geranium robertianum* in North America.

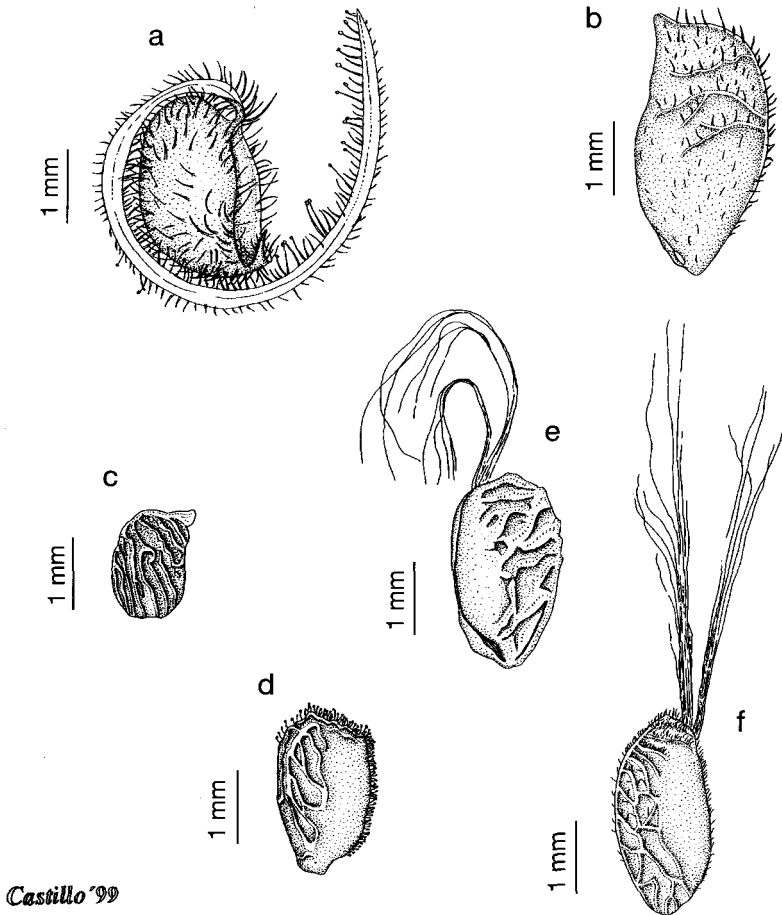


Fig. 18.—Mericarps of: a, *Geranium dissectum*; b, *G. divaricatum*; c, *G. molle*; d, *G. lucidum*; e, *G. purpureum*; f, *G. robertianum*.

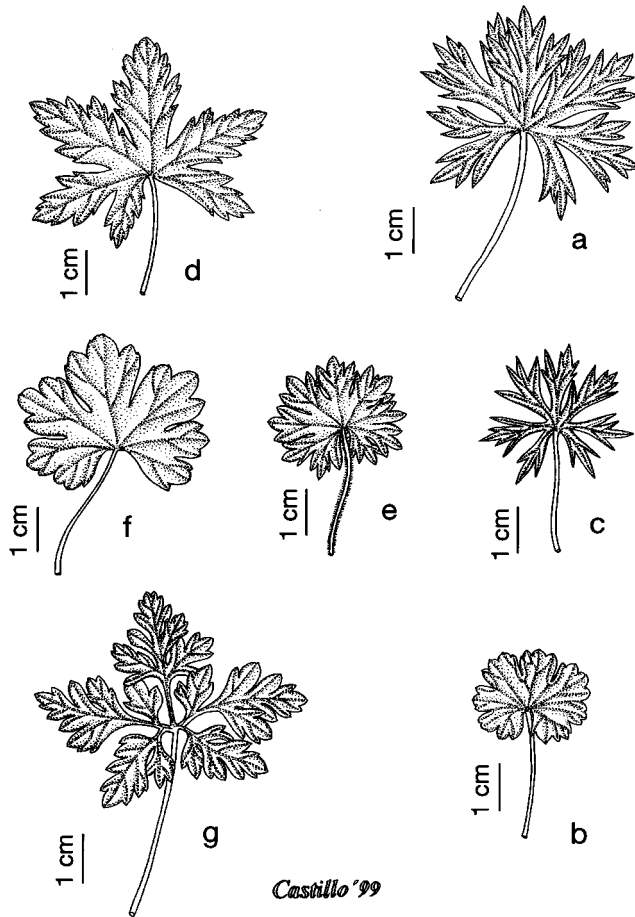
anthers, and petals 10–14 mm long. It has been frequently confused with *G. purpureum* Vill., which is characterised by ribbed mericarps (Fig. 18e), yellowish anthers and petals 6–9.5 mm long. They also differ in chromosome number, *G. purpureum* having  $2n = 32$ .

So far, the specimens supporting the following records of *G. robertianum* have not been studied: Delaware (TAINALL, 1946: 162), Minnesota (TRELEASE, 1888: 78), Missouri (KARTESZ, 1998), Nebraska (PETERSEN, 1912: 81), and Rhode Island (SEYMOUR, 1969: 368).

#### Representative specimens examined

CANADA. BRITISH COLUMBIA: Chilliwack, 49°10'N, 121°56'W, 8-VI-1954, *Faris 84* (DAO); Comox, 49°41'N, 124°56'W, 24-V-1958, *Laing s.n.* (CAN); Sardis, 49°8'N, 121°57'W, 10-VII-1934, *Henson s.n.* (DAO); Vancouver Is., Elk River Falls, W of Campbell River, 50°1'N, 125°14'W, 14-VI-1961, *Calder & MacKay 30404* (DAO). NEW BRUNSWICK: Albert Co., Little Ridge, 45°50'N, 64°55'W, 17-VI-1965, *Roberts & Pugh 65-819* (CAN); Fundy National Park, Herring Cove, 45°37'N, 65°2'W, 12-VII-1949, *Lothiam 80* (DAO). NEWFOUNDLAND I: Bear Head, 47°3'N, 53°44'W, 24-VII-1948, *Rouleau 269* (CAN); Humber distr., Bear Head, 47°3'N, 53°44'W, 24-VII-1948, *Rouleau 269* (DAO); Saint Pierre, 46°50'N, 10°22'W, *Arsene 292* (NY); St. Barbe distr., Bonne Bay, Beachy Point, 49°30'N, 57°55'W, 29-VII-1952, *Rouleau 3349* (DAO).





Castillo '99

Fig. 19.—Leaves of: a, *Geranium columbinum*; b, *G. rotundifolium*; c, *G. dissectum*; d, *G. divaricatum*; e, *G. molle*; f, *G. lucidum*; g, *G. robertianum*.

NOVA SCOTIA: Annapolis Co., Middleton, North Mountain, 44°57'N, 65°4'W, 21-VII-1920, *Long 21741* (CAN); Antigonish, 45°37'N, 62°0'W, 8-VII-1945, *Dore & Gorham 45412* (DAO); Blomidon, 45°13'N, 64°22'W, 7-VI-1928, *Groh s.n.* (DAO); Cape George, 45°52'N, 61°58'W, 11-VII-1941, *Roland 41534* (DAO). ONTARIO: Bruce Co., Lion's Head, 45°0'N, 81°13'W, 1-VII-1939, *Macklin 9* (DAO); Carleton Co., March Twp., 45°23'N, 75°57'W, 6-VI-1941, *Senn & al. 554* (DAO); Carlsbad Springs, 45°22'N, 75°28'W, 4-VI-1938, *Linshall s.n.* (DAO); Clinton, 43°37'N, 81°32'W, 27-V-1942, *Gillet 407* (DAO); Durham Co., Hope Twp., 44°2'N, 78°24'W, 10-VI-1948, *Reeve 46* (DAO). PRINCE EDWARD I: Campbellton, 46°24'N, 62°21'W, 15-VII-1953, *Erskine & Smith 1888* (DAO). QUEBEC: Anticosti, West Point, 49°30'N, 63°0'W, 31-VII-1935, *Adams s.n.* (DAO); Archipel de Mingan, Grande Ile Co., Stanbridge-Est,

50°13'N, 63°50'W, 21-VI-1925, *Louis-Marie 22092* (QFA); Brome Co., Knowlton Landing, 45°13'N, 72°31'W, 12-VII-1964, *Bowers 639* (QFA); Chambly Co., St-Bruno, 48°28'N, 71°39'W, 23-VII-1952, *Bernard 52-109* (QFA); Charlevoix Co., Cap Tourmente, 47°5'N, 70°45'W, 10-VIII-1977, *Claude 77766* (DAO).

U.S.A. ALASKA: Kodiak, 57°47'N, 152°24'W, 25-VI-1970, *Welsh 2550* (ALA). ARKANSAS: Arkansas, *Rafinesque s.n.* (P). CALIFORNIA: San Francisco, 37°45'N, 122°27'W, 6-VIII-1957, *Howell 32884* (MO). CONNECTICUT: New Haven Co., Meriden, 41°32'N, 72°48'W, 5-VIII-1956, *Seymour 16877* (MO); Southington, 41°36'N, 72°53'W, 18-VI-1897, *Bissell 39* (MO). ILLINOIS: Mt. Carmel, 42°26'N, 87°49'W, *Schneck s.n.* (ILL). INDIANA: Noble Co., 1 mi S of Alcinda, 41°21'N, 85°25'W, 25-VII-1931, *Deam 50707* (IND); Saint Joseph Co., 3 mi E of Woodland, 41°33'N, 86°10'W, 15-VII-

1931, *Deam 50469* (MIN). MAINE: Cranberry Is., 45°5'N, 68°9'W, 2-IX-1880, *Redfield 2598* (MO); Mount Desert Island, 44°20'N, 68°20'W, VIII-1890, *White s.n.* (NY); York Co., Limerick, 43°42'N, 70°48'W, 24-VII-1947, *Moldenke 18937* (NY). MARYLAND: Talbot Co., Longwood, 38°51'N, 76°04'W, 6-VII-1947, *Earle 4353* (PH). MASSACHUSETTS: Berkshire Co., Cheshire, Kitchen Brook, 42°33'N, 73°9'W, 27-VII-1916, *Churchill s.n.* (MO); Hampden Co., Bad Luck Mt., Granville, 42°4'N, 72°51'W, 12-IX-1916, *Seymour 358* (MO); Lowell, 42°38'N, 71°19'W, *Ordway s.n.* (MO). MICHIGAN: Allegan Co., Saugatuck, 42°40'N, 86°11'W, 28-VI-1997, *Hill 29365* (NY); Cheboygan Co., Monroe Lake, 45°27'N, 84°30'W, 27-VI-1917, *Ehlers 378* (MO); Detroit River, Grosse Ile, 18-VI-1870, *Gillman s.n.* (NY). NEW HAMPSHIRE: Duck I'd, Isles of Shoals, 42°59'N, 70°36'W, 3-VII-1887, *Churchill s.n.* (MO). NEW JERSEY: Sussex Co., N of Vernon, 41°11'N, 74°29'W, 8-VII-1942, *Chrysler s.n.* (MIN). NEW YORK: Albany Co., New Salem, 42°37'N, 73°58'W, 4-VI-1939, *House s.n.* (MO); Delaware Co., Arkville, 42°8'N, 74°37'W, 2-VII-1915, *Wilson s.n.* (NY). OHIO: Henry Co., Pleasant, 41°13'N, 84°9'W, 9-V-1937, *Shanks 854* (NY); Ottawa Co., Middle Bass Is., 41°40'N, 82°48'W, 16-VI-1925, *Woodson 467* (MO); Sandusky Co., 41°26'N, 82°43'W, III-1894, *Moseley s.n.* (MO). OREGON: Curry Co., Cape Ferrello, 42°6'N, 124°21'W, 20-V-1996, *Stansell 3074* (OSC); Lane Co., Swisshome, 44°3'N, 123°47'W, 27-V-1975, *Mason 10104* (OSC); Marion Co., Salem, 44°56'N, 123°2'W, 28-V-1947, *Peck 24164* (OSC); Multnomah Co., Portland, 45°30'N, 122°35'W, 23-V-1985, *Haun 24* (OSC); Polk Co., Falls City, 44°51'N, 123°26'W, 8-VI-1984, *Halse 2847* (NY). PENNSYLVANIA: Bucks Co., Quakertown, 40°26'N, 75°20'W, VII-1878, *Moyer s.n.* (MO); Monroe Co., Buck Hill Falls, 41°11'N, 75°16'W, 23-VII-1926, *Moldenke 3003* (NY); Sullivan Co., 3 mi NW of Eagles Mere, 41°24'N, 76°34'W, 23-VI-1941, *Wahl 1064B* (MO). TENNESSEE: Smith Co., above Cumberland, 3.8 mi N of Chesnut Mount, 35°57'N, 84°58'W, 20-V-1971, *Kral 42746* (MO). VERMONT: Addison Co., Snake Mt., Weybridge, 44°3'N, 73°16'W, 24-V-1969, *Seymour 27317* (MO). WASHINGTON: Jefferson Co., 15 mi. E of Sequim on US route 101, 48°1'N, 123°1'W, 9-VIII-1996, *Miller & al. 8692* (MO); Klickitat Co., White Salmon, 45°42'N, 121°27'W, 25-V-1992, *Halse 4471* (NY). WEST VIRGINIA: Pendleton Co., Seneca, 38°50'N, 79°22'W, 22-VII-1931, *Core s.n.* (NY); Wilsondale, 37°57'N, 82°19'W, 4-VI-1909 (NY). WISCONSIN: Door Co., Ephraim, 45°9'N, 87°10'W, 5-VI-1907, *Greenman 2185* (MO); Door Co., Garret's Bay near Ellison Bay, 45°17'N, 87°2'W, 14-IX-1925, *Palmer 28774* (MO).

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#### REFERENCES

- ABRAMS, M.D. & D.I. DICKMANN (1984). Apparent heat stimulation of buried seeds of *Geranium bicknellii* on jack pine sites in northern lower Michigan. *Mich. Bot.* 23: 81-88.
- AEDO, C. (1996). Revision of *Geranium* Subgenus *Erodioidea* (Geraniaceae). *Syst. Bot. Monogr.* 49: 1-104.
- AEDO, C., J.J. ALDASORO & C. NAVARRO (1998a). Taxonomic revision of *Geranium* L., sections *Divaricata* Rouy and *Batrachioidea* W. D. J. Koch (Geraniaceae). *Ann. Missouri Bot. Gard.* 85: 594-630.
- AEDO, C., F. MUÑOZ GARMENDIA & F. PANDO (1998b). World checklist of *Geranium* L. (Geraniaceae). *Anal. Jard. Bot. Madrid* 56(2): 211-252.
- ANDERSON, J.P. (1959). *Flora of Alaska and adjacent parts of Canada*. Iowa State Univ. Press, Ames, Iowa.
- BOOTH, W.E. & J.C. WRIGHT (1966). *Flora of Montana*. Montana State Univ., Bozeman.
- BORTENSCHLAGER, S. (1967). Vorläufige Mitteilungen zur Pollenmorphologie in der Familie der Geraniaceen und ihre systematische Bedeutung. *Grana Palynol.* 7: 400-468.
- CARLQUIST, S. & D.R. BISSING (1976). Leaf anatomy of Hawaiian *Geraniums* in relation to ecology & taxonomy. *Biotropica* 8: 248-259.
- CAROLIN, R.C. (1965). The genus *Geranium* L. in the South Western Pacific area. *Proc. Linn. Soc. New S. Wales* 89: 326-361; plates VI-VII.
- CAVANILLES, A.J. (1787). *Monadelphiae classis dissertationes decem. Quarta dissertatio botanica*. Paris.
- DAVIS, P.H. (1970). *Geranium* sect. *Tuberosa*, revision and evolutionary interpretation. *Israel J. Bot.* 19: 91-113.
- DEAM, C.C. (1910). *Flora of Indiana*. Indianapolis.
- EILERS, L.J. & D.M. ROOSA (1994). *The Vascular Plants of Iowa*. Univ. Iowa Press, Iowa City.
- FAWCETT, W. & A.B. RENDLE (1920). *Flora of Jamaica*. London.
- FERNALD, M.L. (1935). *Geranium carolinianum* and allies of Northeastern North America. *Rhodora* 37: 295-301; pls. 371-374.
- GATES, F.C. (1940). Annotated List of the Plants of Kansas: Ferns and Flowering Plants. *Contr. Dep. Bot., Kansas St. Colleg.* 391.
- GHAFOOR, A. (1978). *Geraniaceae In: S.M.H. Jafri & A. El-Gadi, Flora of Libya* 63: 41-57. Tripoli.
- HANKS, L.T. & J.K. SMALL (1907). *Geranium* L. *In: L.T. Britton & J.K. Small, North American Flora* 25: 3-21. New York.

- HARRINGTON, H.D. (1954). *Manual of the plants of Colorado*. Sage Books, Denver.
- HOLMGREN, N.H. (1998). *Illustrated Companion to Gleason and Cronquist's Manual*. The New York Botanical Garden, Bronx, New York.
- JONES, G.N. (1945). Flora of Illinois. *Amer. Midl. Naturalist* 2: 170-171.
- KARTESZ, J.T. (ed.) (1998). *A Synonymized Checklist of the Vascular Flora of the United States, Puerto Rico, and the Virgin Islands*. [http://www.csd.tamu.edu/flora/b98/check98.htm]
- KNUTH, R. (1912). Geranium L. In: A. Engler (ed.), *Das Pflanzenreich*. IV.129 (Heft 53): 43-221, 575-583. Leipzig.
- MARTIN, W.C. (1980). *A Flora of New Mexico*. J. Cramer, Vaduz.
- MCGREGOR, R.L. (1986). Geraniaceae. In: R.L. McGregor, T.M. Barley, R.E. Brooks & E.K. Schofield (eds.), *Flora of the great plains*: 580-582. Univ. Press Kansas, Lawrence, Kansas.
- MILBERG, P. (1994). Germination of up to 129-year old, dry-stored seeds of *Geranium bohemicum* (Geraniaceae). *Nordic J. Bot.* 14: 27-29.
- MOHLENBROCK, R.H. (1986). *Guide to the Vascular Flora of Illinois*. Southern Illinois Univ. Press., Carbondale & Edwardsville.
- MOORE, H.E. (1943). A revision of the genus *Geranium* in Mexico and Central America. *Contr. Gray Herb.* 146: 1-108; 5 "Plate".
- PETERSEN, N.F. (1912). *Flora of Nebraska*. State Printing Co., Lincoln.
- RADFORD, A.E., H.E. AHLES & C.R. BELL (1968). *Manual of the vascular flora of the Carolinas*. Univ. North Carolina Press, Chapel Hill.
- ROLAND, A.E. & E.C. SMITH (1969). *The Flora of Nova Scotia*. Halifax.
- ROSS-CRAIG, S. (1952). *Drawings of British Plants, Part VI*. G. Bell & Sons, London.
- RYDBERG, P.A. (1932). *Flora of the prairies and plains of central North America*. New York.
- SCHAEFFER, R.L. (1949). *The vascular flora of Northampton county Pennsylvania*. Philadelphia.
- SCOGGAN, H.J. (1978). *The Flora of Canada*. Ottawa.
- SEYMOUR, F.C. (1969). *The Flora of New England*. Tuttle Co., Rutland.
- SMITH, E.B. (1994). *Keys to the Flora of Arkansas*. Univ. Arkansas Press, Fayetteville.
- STAFFORD, P. J. & S. BLACKMORE (1991). Geraniaceae. In: W. Punt & S. Blackmore, *The Northwest European Pollen Flora* 4: 49-78. Elsevier, Amsterdam, London, New York & Tokyo.
- STRAUSBAUGH, P.D. & E.L. CORE (1978). *Flora of West Virginia*, ed. 2. Seneca Books, Inc., Grantsville.
- TATNALL, R.R. (1946). *Flora of Delaware and the Eastern Shore*. Soc. Nat. Hist. Delaware, Lancaster.
- TAYLOR, R.J. & C.E.S. TAYLOR (1989). *An annotated list of the ferns, fern allies, gymnosperms and flowering plants of Oklahoma*. Southeastern Oklahoma State Univ., Oklahoma.
- TRELEASE, W. (1888). A study of North American Geraniaceae. *Mem. Boston Soc. Nat. Hist.* 4: 71-103; pl. 9-12.
- VERHOEVEN, R.L. & H.J.T. VENTER (1992). Pollen Morphology of *Geranium* (Geraniaceae) in Southern Africa. *S. African J. Bot.* 58: 440-447.
- VOSS, G.E. (1985). *Michigan Flora*. Cranbrook Institute of Science & Univ. Michigan Herbarium.
- WATSON, S. (1882). List of plants from Southwestern Texas and Northern Mexico, collected chiefly by Dr. E. Palmer in 1879-80.-I. Polypetalae. *Proc. Amer. Acad. Arts* 17: 316-361.
- WELSH, S.L., N.D. ATWOOD, S. GOODRICH & L.C. HIGGINS (1993). *A Utah Flora*, ed. 2. Brigham Young Univ., Provo, Utah.
- WOFFORD, B.E. & R. KRAL (1993). *Checklist of the vascular plants of Tennessee*. Nashville, Tennessee.
- YEO, P.F. (1973). The biology and systematics of *Geranium*, sections *Anemonifolia* Knuth and *Ruberta* Dum. *Bot. J. Linn. Soc.* 67: 285-346.
- YEO, P.F. (1984). Fruit-discharge-type in *Geranium* (Geraniaceae): its use in classification and its evolutionary implications. *Bot. J. Linn. Soc.* 89: 1-36.
- YEO, P.F. (1992). A revision of *Geranium* L. in South-West China. *Edinburgh J. Bot.* 49: 123-211.

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