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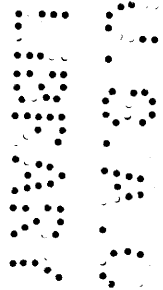
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A CYTO-TAXONOMIC STUDY OF THE
GENUS GERANIUM WITHIN THE WASATCH REGION

by

Richard J. Shaw



A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

BOTANY

1950

UTAH STATE AGRICULTURAL COLLEGE
Logan, Utah

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I wish to express appreciation to Professor W. S. Boyle and Professor A. H. Holmgren.

Professor W. S. Boyle gave guidance and assistance in the cytological phase of this study and also made very helpful suggestions in the preparation of the manuscript.

Professor A. H. Holmgren directed the taxonomic study and greatly aided in the collection of source materials.

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CHAPTER I

INTRODUCTION

The western North American species of the genus Geranium have never been satisfactorily clarified. The perennial, indigenous species of this interesting group have been particularly confusing. One important reason for confusion in this group is the fact that the taxonomic problems of the perennial species have never been studied from the genetic point of view. A sound delimitation of specific and subspecific boundaries and phylogenetic relationships cannot be achieved without the application of cyto-genetic principles.

In respect to the cytological phase of this study, the author has placed emphasis on chromosome numbers in order to show evidences for and possible origin of polyploidy. Detailed chromosome morphology has not been attempted because of the very small size of the chromosomes.

This study has been limited to the Wasatch region. This area represents a natural geographical unit which is small enough to permit a detailed field study of the group and yet provide a wide range of habitats, both ecologic and geographic. This region forms the western front of the Rocky Mountain province and extends 200 miles south from the great bend in the Bear river at Soda Springs, Idaho, to the pass south of Mt. Nebo and east of Nephi, Utah (3).

CHAPTER II
REVIEW OF LITERATURE

The first comprehensive monographic study of the North American species of Geranium was published in 1907 by Hanks and Small (6). This included 64 annual and perennial species, 31 of which were native to Mexico. In 1912, R. Knuth (8) prepared a world-wide monograph in which the treatment of North American species follows in part the pattern of Hanks' and Small's earlier work. The annual species were treated very briefly and incompletely in 1935 by M. Fernald (4). G. N. Jones and F. F. Jones (7) presented a taxonomic revision of the perennial species of the United States and Canada in 1943, in which 18 species are recognized. This revision has been presented without the benefit of research on the cytology and genetics of the genus. The writer feels that such studies are seriously handicapped in the light of recent advances made in experimental taxonomy.

The first cytological work was done in Europe by Tjebbes (10) in 1928, when he published the chromosome numbers of 2 species (G. pratense L. $n=12$ and G. sylvaticum L. $n=12$). In 1937, Gauger (5) submitted a list of chromosome numbers of 23 European species within the genus, 6 of which have become established in North America as weedy annuals. Warburg (11) in 1938, published a comprehensive cytological study of the Order Geraniales, 43 species of Geranium were included. Of these only 2, G. maculatum and G. Richardsonii, were native to North America.

CHAPTER III
CYTOLOGICAL STUDIES

Materials and Methods

Observations of chromosome numbers and behavior were made from pollen mother cells and root tips. Root tips were taken from germinating seeds or potted plants grown from seed or transplanted from the field. In one case the root tips came from seeds of a specimen on a herbarium sheet which was 19 years old, indicating extraordinary seed viability. Anthers were collected from plants throughout the Wasatch region. Both anthers and root tips were killed and fixed in a fresh solution of absolute alcohol and glacial acetic acid (3:1) for 24 hours and then smeared using iron-aceto-carmin technique. Most of the temporary mounts were made permanent. All source material is on deposit at the Intermountain Herbarium, U. S. A. C., Logan, Utah, with the exception of one herbarium sheet which is on deposit at Idaho State College Herbarium at Pocatello, Idaho.

Drawings were made with the aid of the camera lucida at a magnification of 3000X and are reproduced at the same magnification.

Chromosome Behavior and Number

The chromosomes of this genus are extremely small and this, of course, interfered with a detailed study of meiosis. Because of the minute size of the anthers of the annual species, the writer was not successful in locating any meiotic divisions. However, in the perennial species several

meiotic plates were observed, and they were of sufficient clarity so that some rather general statements can be made as to meiotic behavior. Diakinesis was studied in both G. nervosum and G. Richardsonii (see Figs. 1, 7, and 8). The pairing of chromosomes appeared normal and complete. The chiasmata are mostly terminalized at this stage, and rod and ring-shaped bivalents were the only type of configurations observed. At metaphase the bivalents appeared round in polar view and dumb-bell shaped in side view. The last stages of meiosis were also seen and no irregularities were observed (see Figs. 6 and 10).

Little variation in size of somatic chromosomes was observed within a species. The centromeres were quite difficult to locate, however, most of them had a median position.

Chromosome numbers follow in Table 1.

Table 1. Chromosome numbers of 4 species of Geranium

Species	g*	s*	Number of determinations †
<u>G. nervosum</u>	26		6
<u>G. Richardsonii</u>	26	52	5
<u>G. pusillum</u>		26	2
<u>G. carolinianum</u>		52	2

* In order to avoid confusion, the letter "g" will refer to the gametophytic nuclear condition and "s" will refer to the sporophytic nuclear condition.

† Collector and source of materials are included in Table 3.

Discussion

The chromosome numbers of 3 species listed by Warburg (11) do not agree with those found by the writer. G. carolinianum was reported by Warburg as (S)=46 or 48. Two root tip smears made by the writer showed 52 to be the (S) number (Figs. 12 and 13). Warburg and Gauger (5) disagree on the count of G. pusillum; the former listed (S)=34 and the latter (S)=26. Mitotic counts made in this study agree with Gauger's work (Fig. 14). Warburg recorded the (g) number for G. Richardsonii as follows: "n=26?", indicating he was uncertain of his count. In both meiotic and mitotic divisions the writer definitely found that (g)=26 and (S)=52, respectively (Figs. 7, 8, 9, 10, and 11).

G. pusillum and G. carolinianum belong to the section Columbina, a group of annual species. Warburg describes this section as forming an aneuploid series and reports the chromosome numbers as follows: G. pusillum (S)=34 and G. carolinianum (S)=46 or 48. The writer's investigations, however, do not substantiate this point of view as only euploid series were found (see Table 1).

For his cytological studies Warburg used sections of root tips and flower buds, whereas the writer used smears exclusively. When the microtome is used on materials with such high chromosome numbers, it is very possible that the microtome knife could remove some of the chromosomes, and this may be an explanation of the differences in chromosome

numbers. Warburg found all smear preparations unsatisfactory for this genus. The writer, however, found this technique extremely useful.

Another explanation for the differences of chromosome numbers is the possibility of 2 different chromosomal races within one species or a variety being tetraploid and the rest of the species being diploid. Only further research will clarify these discrepancies.

The chromosome number of G. nervosum has not previously been reported.

After making chromosome counts of 43 species within this genus, only 2 of which are North American species, Warburg concluded that 14 was the base number for the genus. Nevertheless, the writer is suggesting that 13 is the base number at least for those species which are endemic to North America (see Table 1).

On the basis of the cytological data presented certain suggestions can be made regarding the nature of polyploidy within this genus. From the figures of the meiotic divisions it can be seen that there are no multivalents present and that pairing is normal and complete (see Figs. 1, 2, 7, and 8). Furthermore, fertility of all species is high. These facts suggest that the tetraploids studied in this genus are probably the typical allopolyploid types as described by Stebbins (9).

Assuming that the suggestions of true allopolyploidy or amphiploidy are correct, it can be further suggested that

this group is well advanced in its evolutionary development, and that it has gone through the evolutionary stages of forming ecotypes, ecospecies, cenospecies and comparia as used in the sense of Clausen, Keck and Hiesey (2).

Comparison of Guard Cell Length

The average guard cell length was determined for 4 species of the genus. Two leaves were taken from 5 living plants of each species in the greenhouse and 10 measurements were made from each leaf. The following table summarizes the results:

Table 2. Mean and range of guard cell length of 4 species of Geranium

<u>Species</u>	<u>Mean in microns</u>	<u>Range in microns</u>
<u>G. pusillum</u> (diploid)	20.1	18-24
<u>G. carolinianum</u> (tetraploid)	24.21	20-27
<u>G. nervosum</u> (tetraploid)	30.18	25.5-34.5
<u>G. Richardsonii</u> (tetraploid)	32.4	25.5-33

Guard cell length was also checked on herbarium specimens from other western states and in no case did the mean vary more than 2 microns from that recorded in the above table.

Gain (1) compares morphological characters between diploids and polyploids and points out that, as a general rule observed in many plants, polyploids have increased cell

size over diploids. Measurements of guard cell lengths in this study seem to substantiate the above general rule.

Further research may demonstrate that guard cell length provides a reasonably reliable check for polyploidy in this genus.

Table 3. Key to Illustrations and Sources of Material

Figure Number	Species	Source of Material
1	<u>G. nervosum</u>	R. J. Shaw No. 68, Bear Lake Co., Idaho. Anthers collected in the field.
2	<u>G. nervosum</u>	R. J. Shaw No. 68, Bear Lake Co., Idaho. Anthers collected in the field.
3	<u>G. nervosum</u>	R. J. Shaw No. 45, Cache Co., Utah. Anthers collected in the field.
4	<u>G. nervosum</u>	R. J. Shaw No. 37, Weber Co., Utah. Anthers collected in the field.
5	<u>G. nervosum</u>	R. J. Shaw No. 50, Wasatch Co., Utah. Anthers collected in the field.
6	<u>G. nervosum</u>	R. J. Shaw No. 37, Weber Co., Utah. Anthers collected in the field.
7	<u>G. richardsonii</u>	R. J. Shaw No. 30, Wasatch Co., Utah. Anthers collected in the field.
8	<u>G. richardsonii</u>	R. J. Shaw No. 30, Wasatch Co., Utah. Anthers collected in the field.
9	<u>G. richardsonii</u>	A. H. Holmgren & R. J. Shaw No. 7649, San Pete Co., Utah. Anthers collected in the field.
10	<u>G. richardsonii</u>	R. J. Shaw No. 30, Wasatch Co., Utah. Anthers collected in the field.
11	<u>G. richardsonii</u>	R. J. Shaw No. 30, Wasatch Co., Utah. Grown from seed.
12	<u>G. carolinianum</u>	R. J. Davis No. 2290, Idaho Co., Idaho. Grown from seed.
13	<u>G. carolinianum</u>	E. Miller No. 16, Payne Co., Oklahoma. Grown from seed.
14	<u>G. pusillum</u>	R. J. Shaw No. 36, Cache Co., Utah. Grown from seed.

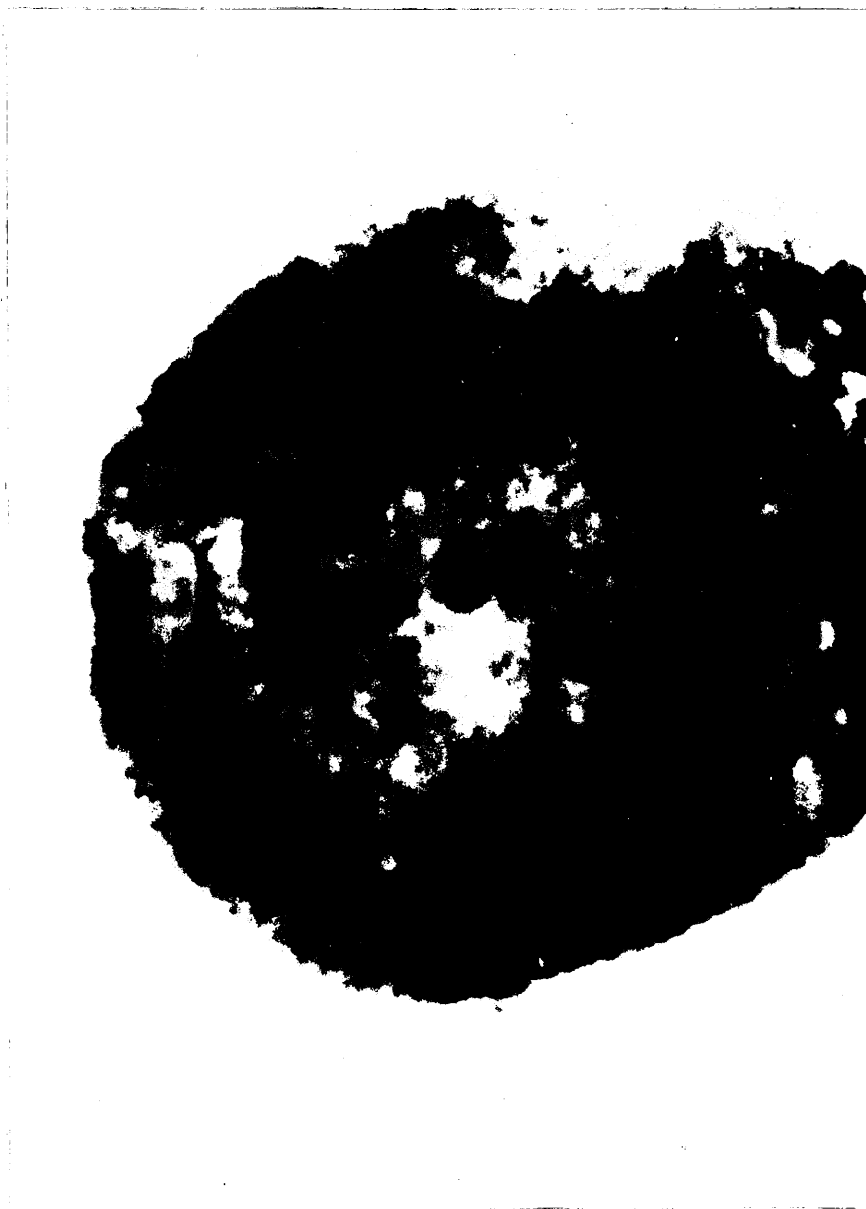


Fig. 1. G. nervosum P. M. C. Diakinesis 1700X

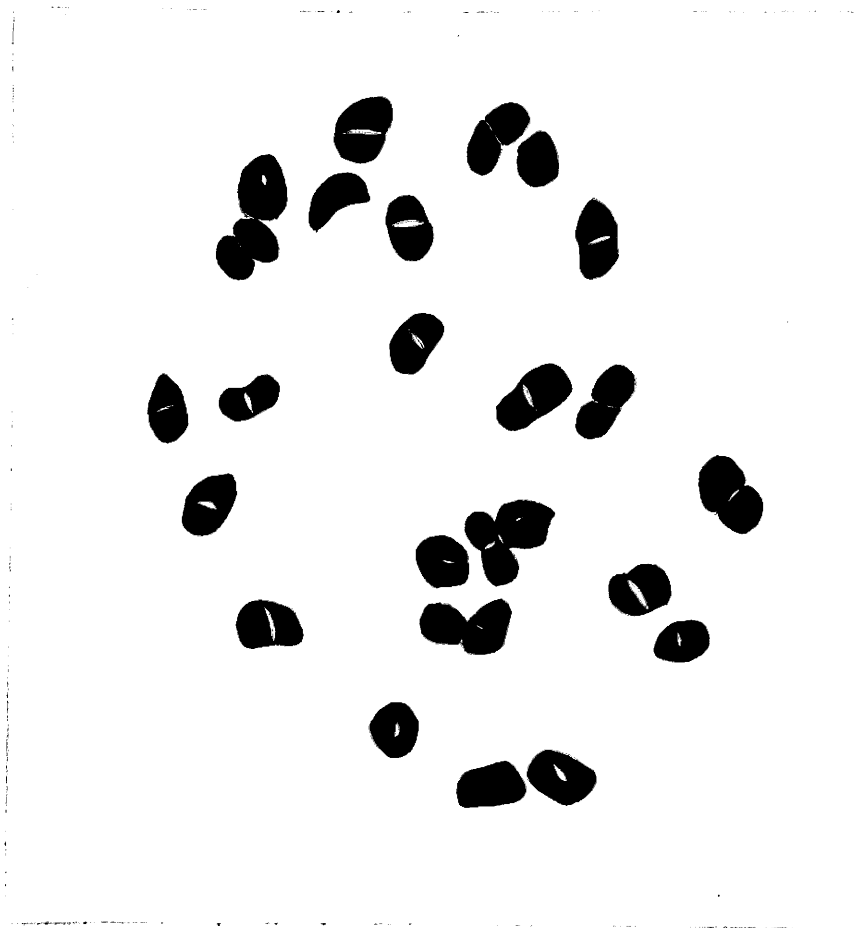


Fig. 2. G. nervosum P. M. C. Metaphase I

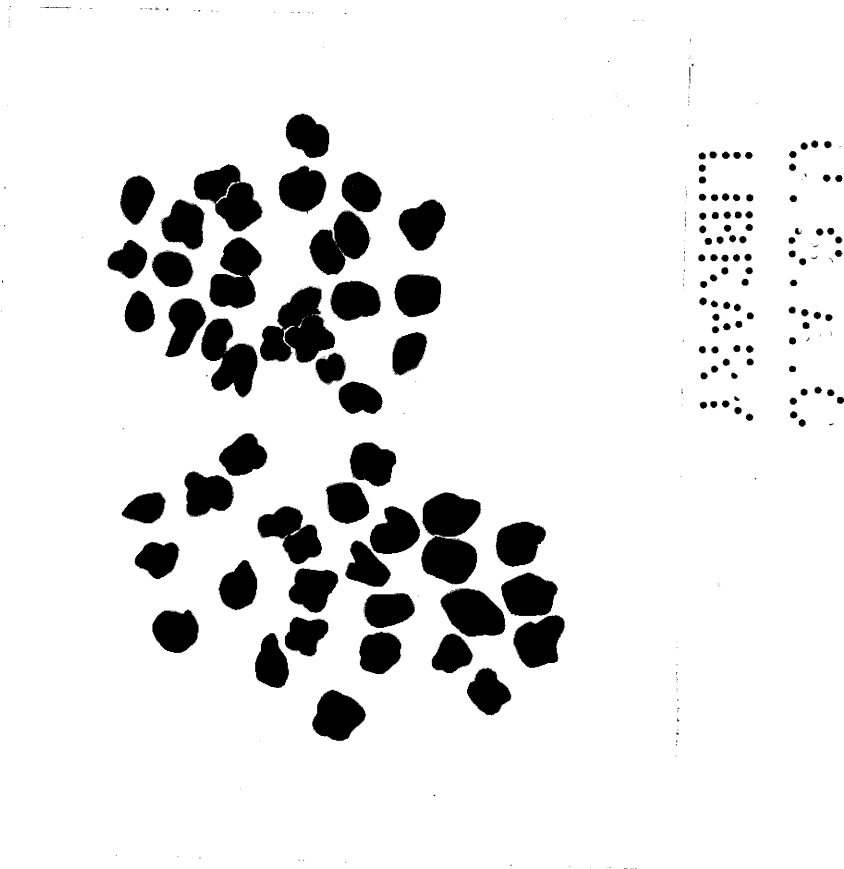


Fig. 3. G. nervosum P. M. C. Anaphase I

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Fig. 4. G. nervosum P. M. C. Anaphase I
(other half of plate not shown)



Fig. 5. G. nervosum P. M. C. Telophase I 1500X

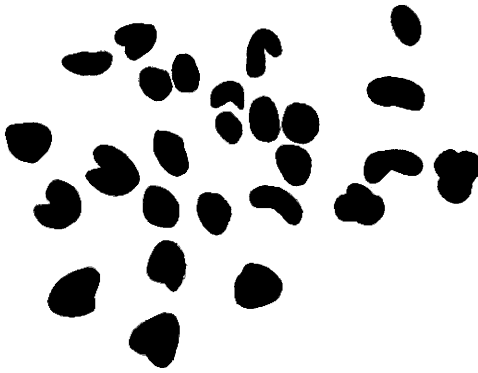


Fig. 6. G. nervosum P. M. C. Telophase II
(other plates not shown)



Fig. 7. G. richardsonii P. M. C. Diakinesis 2500X



Fig. 8. G. richardsonii P. M. C. Diakinesis

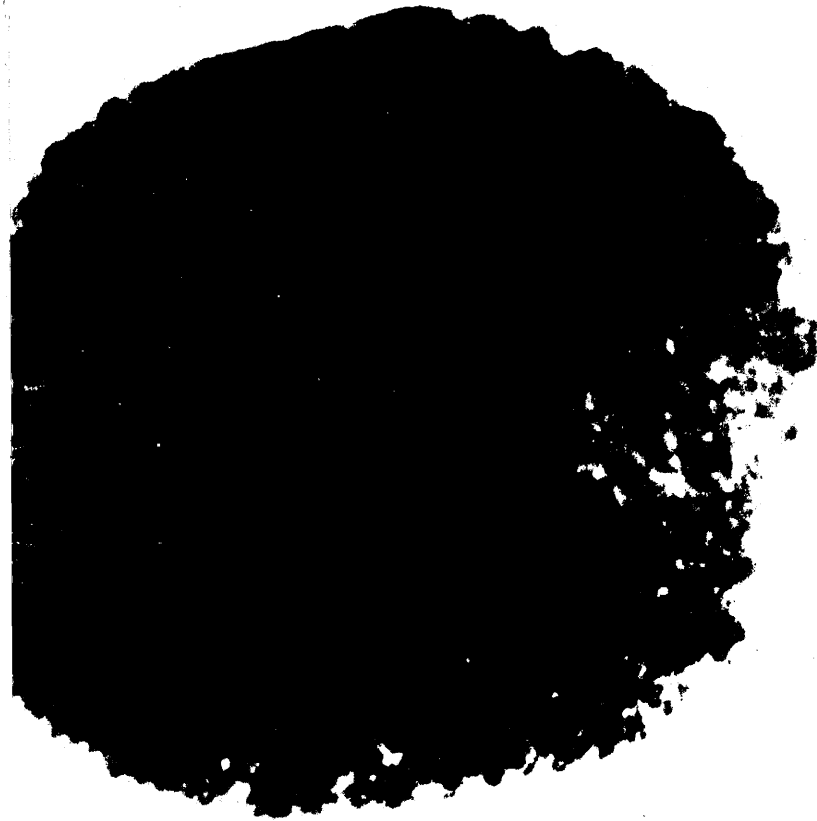


Fig. 9. G. Richardsonii P. M. C. Anaphase I 1700X



Fig. 10. G. richardsonii P. M. C. Telophase II 1700X



Fig. 11. G. Richardsonii root tip



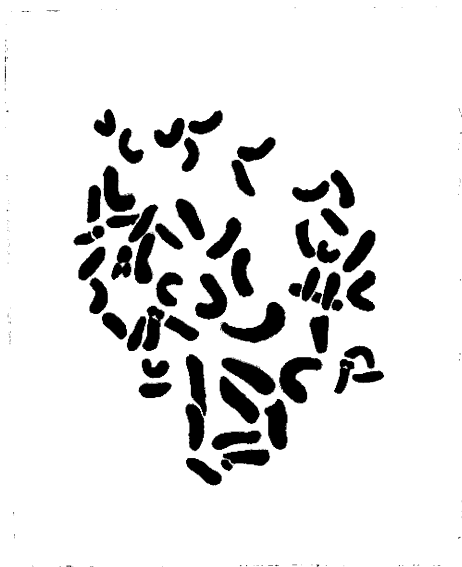


Fig. 13. G. carolinianum root tip



Fig. 14. G. pusillum root tip

CHAPTER IV
TAXONOMIC TREATMENT

Methods

Two summers were spent collecting specimens and making ecological observations of all the species of Geranium of the Wasatch region. This included 12 counties in Utah and Idaho. Emphasis was placed on collecting in the many canyons which cross the Wasatch mountains from east to west. All of these specimens are now on file at the Intermountain Herbarium, U. S. A. C., Logan, Utah.

To aid in the study, additional herbarium specimens were obtained from the following sources: Gray Herbarium (G), New York Botanical Gardens (NY), Herbarium of Idaho State College (IS), Herbarium of University of Utah (U), and Intermountain Herbarium, Utah State Agricultural College (IM).

Living material was grown in the greenhouse permitting careful observation of all species under uniform controlled conditions.

Greenhouse Observations

All of the species of Geranium discussed in this study were grown in pots in the greenhouse during 1949 and part of 1950. Time did not permit extensive genetic or breeding experiments, however, and attempt was made to cross G. Richardsonii with G. nervosum but no seed was formed. While this is negative evidence, the writer found no indication of crossing in the field even though occasionally the 2 species were found in very close proximity.

The main purpose of these observations was to check the consistency of various morphological characters which have taxonomic significance. The information gained from these observations has been included as supporting evidence in the following section.

Evaluation of Morphological and Ecological Characters

In 1943, when Jones and Jones (7) revised the taxonomic status of the perennial species of North America, they placed emphasis on the length of the mature stylochia, the amount of pubescence on the inner surface of the petals and the type of indument on pedicels, stems, and leaves. They also pointed out that color of petals was useful only when combined with other morphological characters.

Since only 2 perennial species (G. nervosum and G. Richardsonii) are found within the Wasatch region, it is necessary to separate these 2 entities according to Jones' and Jones' key on the basis of whether the petals are pilose on the inner surface not more than one-fourth their length in the case of G. nervosum or one-third to one-half their length in G. Richardsonii.

In discussing the separation of these 2 species, Jones and Jones state that they have a similar range, habitat and habit and that they can be easily distinguished in the field by the color of the glandular pubescence found on the pedicels.

After collecting over 100 specimens of these 2 species within the Wasatch region, observing them in the field for 2 summers, and growing them under controlled conditions in the greenhouse, the writer feels that the characters of Jones and

Jones are insufficient to separate these 2 species. The pilose condition of the petals of G. Richardsonii is quite consistent, however, in G. nervosum the pilose condition varies from one-fourth to three-fourths the length of the petals.

The morphological character, color of the glandular hairs on the pedicels, was also found to be extremely variable ranging from colorless to purple in both species depending upon locality.

The writer cannot agree with the statement of the above-mentioned authors concerning the similar habitats of these 2 species. G. Richardsonii is generally found in moist, shaded areas especially along fast moving streams, while G. nervosum is a plant of more open xeric sites and is frequently associated with Artemisia tridentata Nutt.

After comparison of all specimens collected during this study, those obtained from other herbaria, and plants grown in the greenhouse, the writer found that the length of the mature stylar column (including the carpels) and the length of the seed are additional morphological characters that can be used in identification. When these characters are combined with flower color and the habitat is taken into consideration, the 2 perennial species of this region can be separated easily.

When Fernald (4) briefly treated some of the annual species in 1935, he made use of fruit and seed characters. The writer feels that the characters which he used are wholly adequate for the annual species found within the Wasatch region.

Key to the Species

- A. Plants annual.
 B. Fertile stamens 5; sepals
 awnless.....1. G. pusillum
 BB. Fertile stamens 10; sepals
 awned.....2. G. carolinianum
 AA. Plants perennial.
 C. Mature styler column 2-2.5 cm.
 long; petals usually white;
 seeds 2-3 mm. long.....3. G. Richardsonii
 CC. Mature styler column 3-3.5 cm.
 long; petals rose pink; seeds
 3-4 mm. long.....4. G. nervosum

1. Geranium pusillum Burm.

Geranium pusillum Burm. f. Sp. Geran. 27, 1759.

Annual; stems diffusely branched, decumbent or prostrate, puberulent, 1-5 (2)* dm. long, base of branches swollen; basal petioles of leaves 10-18 (13) cm. long, puberulent; blade 1-6 (4) cm. broad, orbicular-reniform, 7-9 parted, the division 3-5 toothed or lobed at apex; cauline leaves with short petioles, 3-7 deeply incised segments otherwise similar to lower leaves; stipules 1-2 mm. long, lanceolate, ciliate on margins; peduncles short, glandular pubescent, 2-flowered; pedicels paired, 3-16 (6) mm. long, bending upward as fruit matures; sepals elliptic to ovate, awnless, 2.5-5 mm. long, minutely glandular pubescent, hispid on the margins; petals pale purple to violet, about as long as sepals, notched, cuneate; 5 fertile stamens; styler column 7-9 mm. long, glandular puberulent; carpel bodies 2 mm. long, strigose; seeds 1.5-1.8 mm. long, smooth.

* The number in parenthesis indicates the mean measurement.

Type locality: England and France.

Range: Naturalized from Europe; United States and southern Canada. A weed common in lawns and waste places.

Representative specimens: Nebraska. Minden, Nebraska, Dr. Hapeman (IM), Utah. Cache Co., No. Logan, R. J. Shaw 36 (IM); Logan, Charles Piper Smith 17669 (IM); Pelican Ponds, J. Thieret 149 (IM).

2. Geranium carolinianum L.

Geranium carolinianum L. Sp. Pl. 682, 1753.

Geranium atrum Moench, Meth. 285, 1794.

Geranium lanuginosum Jacq., Hort. Schoenb., 2:8, 1797.

Annual; stems 1-3 rather stout and freely branched, erect, 2-4 (2.8) dm. high, closely short pubescent; petioles of basal leaves 5-15 (9) cm. long, short pubescent; blades 3-7 (4) cm. broad, orbicular-reniform in outline, 5-7 palmately parted and cleft into linear or oblong, obtuse lobes; cauline leaves with varying petioles, 5-13 cm. long, 3-7 deeply parted, the tips of the segments more acute than the lower leaves; stipules 5-10 cm. long, linear lanceolate; flowers and fruit in compact clusters as a result of the very short peduncles; pedicels 3-15 mm. long, glandular-pubescent, straight at maturity; sepals 5-7 mm. long, ovate, 3 nerved with glandular-pubescence, hyaline, ciliate margin; macro 1-2 mm. long; petals as long as the sepals, pale pink or whitish, oblanceolate; ten fertile stamens; mature stylar column 12-20 mm. long with glandular hairs; styloids very short, 1 mm. or less; carpel bodies 3-3.5 mm. long, with villous ascending hairs, black at maturity;

seeds 2-2.5 mm. long, oblong, reticulate.

Type locality: Carolina.

Range: Open places or fields throughout North America.

Representative specimens: Arizona: San Carlos Ind. Res., Aven & Ruth Nelson 1842 (IM). Idaho: Owyhee Co., Ray J. Davis 4253 (IS). Oklahoma: Stillwater, Oklahoma, E. Miller (IS). Utah: Weber Co., Fern Hollow, Ogden, Utah, Winona Cardon 313 (IM). Washington: Whitman Co., F. L. Pickett 1550 (IM); Whatcom Co., Bassett Maquire & W. C. Muenscher 16055 (IM).

G. carolinianum has been confused with G. Bicknellii Britton. The latter has been included within the Wasatch region in several keys. However, no evidence of this species was found. One specimen on file at the Intermountain Herbarium might possibly belong to the species G. Bicknellii. However, it was collected in 1910 (Charles Piper Smith 2164, Logan Canyon) and the stage of the plant's development makes it impossible to determine its true identity.

3. Geranium Richardsonii Fisch. & Trautv.

Geranium Richardsonii Fisch. & Trautv., Ind. Sem. Hort. Petrop. 4:37, 1837.

Geranium albiflorum sensu Hooker, Fl. Bor. Am. 1:116, t. 40, 1830, in Curtis' Bot. Mag. lxx. t. 3124, 1832; Torr. & Gray, Fl. N. Am. 1:206, 1838. Non Ledeb., 1829.

Geranium Hookerianum Walpers, Rep. Bot. Syst. 1:450, 1842.

Geranium pentagynum Engelman in Wislizenus, Mem. Northern Mexico, 90, 1848, and in Gray, Mem. Am. Acad. n. s. 4:27, 1849.

Geranium gracilentum Greene in Rydberg, Colo. Exp. Sta. Bull. 100:218, 1906.

Geranium lolense St. John, Fl. Se. Wash. & Adj. Idaho, 242,
1937.

Perennial, the caudex often branched and covered with brownish, withered, scale-like leaf bases and stipules; stems solitary or few, erect, 30-90 (52) cm. tall, glabrous becoming pubescent near the top; petioles of the basal leaves 5-20 (sometimes 30) cm. long, glabrous or glandular tipped hairs or pilose; blades 3-17 cm. broad, pentagonal in outline, deeply 5-7 parted, the rhombic segments divided several times, strigose on the upper surface and on the prominent veins of the lower surface; cauline leaves with short petioles, 3-5 sharply incised segments with tapering lobes, pubescence similar to that on basal leaves; stipules lanceolate, attenuate, 6-12 mm. long, ciliate on the margins; inflorescence cymose, the peduncles 2-10 cm. long, glandular pilose, the glands being either translucent or purple; pedicels slender, 1-3 (rarely 4) cm. long, paired, becoming bent upward as fruit matures, copiously pubescent with short viscid glandular tipped trichomes; sepals 6-10 mm. long, lanceolate or narrowly oval, glandular-pubescent especially near the base and veins, margins hyaline; nucre 1-2 mm. long; petals 12-20 mm. long, broadly obovate, entire, milk-white or sometimes pink tinted, usually with purple or pink veins, generally pilose on the inside for about one-half their length; filaments yellowish green, particularly lower portion, sometimes pink at the tip; mature styler column 2-2.5 cm long, glandular-pubescent; stylodia 3-4.5 cm. long, yellowish green; carpel bodies 2.5-4 cm. long, glandular-pubescent along the

keel; seeds reticulate, 2-3 mm. long.

Type locality: Valleys of the Rocky Mountains between Lat. 52°N. and 34°N.

Range: Common throughout British Columbia, Saskatchewan and the western United States.

Representative Specimens: Idaho: Franklin Co., Franklin Basin, R. Shaw 57 (IM); Fremont Co., Henry Lake, E. B. & Lois Payson 1948 (G); Idaho Co., Nez Perce Nat. For., L. Constance and R. C. Rollins 1677 (G); Bear Lake Co., North Canyon, R. Shaw 71 (IM); Bonneville Co., Caribou Mountain, E. B. Payson & G. M. Armstrong 3523 (G). Nevada: Humboldt Co., Percy Train 3035 (NY). Utah: Cache Co., Tony Greve, R. Shaw 54 (IM); Salt Lake Co., Big Cottonwood Canyon, A. O. Garrett 1520 (G); Summit Co., Ashley Nat. For., R. Shaw 13 (IM); Duchesne Co., Moon Lake, Bassett Maquire & George Piranian 12529 (G); Weber Co., North Fork Canyon, R. Shaw 77 (IM); Utah Co., American Fork Canyon, R. Shaw 43 (IM); Wasatch Co., Midway, R. Shaw 30 (IM).

This species is found in a shady moist habitat especially alongside fast moving streams and rivers.

4. Geranium nervosum Rydb.

Geranium nervosum Rydb., Bull. Torr. Club, 28:34, 1901.

Geranium erianthum sensu Lindley in Edwards, Bot. Reg. t. 52, 1842; Torrey in Bot. Wilkes Exped. 251, 1874. Non DC., 1824.

Geranium Hookerianum var. incisum Walpers, Rep. Bot. Syst. 1:450, 1824.

Geranium maculatum sensu Engelm. in Gray Mem. Am. Acad. n. s. 4:27, 1849. Non L., 1753.

Geranium Richardsonii sensu Wats. Bot. King Exped. 5:49, 1871.
Non Fisch. and Trattv., 1837.

Geranium Fremontii sensu Macoun, Cat. Can. Pl. 1:90, 1883;
Garrett, Sp. Fl. Wasatch Reg. editions 1 to 5, 1911-
1936; Holmgren, Hdbk. Vas. Pl. No. Wasatch, 1948. Non
Torr., 1849.

Geranium incisum sensu Trelease, Mem. Boston Soc. Nat. Hist.
4:74, 1888. Non Andrew, Bot. Rep. 1:t.67, 1797, nec
Nutt. ex Torr. & Gray, 1838.

Geranium strigosum sensu Rydberg, Bull. Torr. Club. 29:243
1902. Non N. L. Burm., Fl. Cap. Prodr. 19, 1768, nec
Franch. in Bull. Soc. Bot. France 32:442, 1886.

Geranium canum Rydberg ex Hank & Small in N. Am. Fl. 25
(1):14, 1907; Rydberg, Fl. Rocky Mts. 532, 1917.

Geranium viscosissimum sensu E. H. Graham, Ann. Carnegie
Mus. 26:259, 1937. Non Fisch. & Mey., 1846.

Geranium strigosius St. John. Fl. Se. Wash. & Adj. Idaho.
243, 1937.

Perennial with branched caudex; stems one to several,
erect, 30-115 (70) cm. tall, the lower internodes strigose to
densely retrorsely pubescent with whitish non-glandular hairs,
occasionally nearly glabrous; petioles of the basal leaves
10-55 cm. long, pubescent like the stem, rarely with gland-
ular trichomes; blades 5-22 cm. broad, with white appressed
non-glandular trichomes on both surfaces, especially along
the veins, usually pentagonal in outline, deeply 5-7 parted,
divisions rhombic in outline with acute incised lobes;
cauline leaves smaller, short petioles and with deeper
incised segments; stipules linear lanceolate with an at-
tenuated tip, 5-20 mm. long, densely puberulent and ciliate
along lower margins; inflorescence cymose; peduncles 0.5-6 cm.
long, pilose, occasionally interspersed with glandular hairs;
pedicels 1-6 cm. long, usually paired, sometimes 3 or 4,

copiously pubescent with short viscid glandular tipped trichomes, reflexed and bent upward in fruit; sepals oval, 8-10 mm. long, densely pubescent with glandular trichomes, margins hyaline; mucro 1-2 mm. long; petals 1.5-2.3 cm. long, broadly obovate, obtuse, occasionally slightly emarginate, light pink to rose purple with dark purple veins, pilose varying from one-fourth their length to three-fourths their length; filaments purple on upper half; mature stylar body 3-4 cm. long, glandular-pubescent; styloids 4-5 mm. long, usually purple; carpel body 5-6 mm. long, glandular-pubescent particularly on the keel; seed reticulate, 3-4 cm. long.

Type locality: Fish Creek, Teton Forest Reserve, northwestern Wyoming.

Range: British Columbia and Alberta to Montana, Wyoming, western South Dakota, Colorado, Utah, Nevada and northeastern California.

Representative specimens: Idaho: Bear Lake Co., Cache Nat. For. R. Shaw 73 (IM); Franklin Co., Franklin Basin, R. Shaw 58 (IM); Owyhee Co., House Creek, A. Nelson & J. F. Macbride 1819 (G); Valley Co., Payette Lake, L. Constance & F. W. Pennell (G). Nevada: Humboldt Co., Toiyabe Nat. For., Bassett Maquire and A. H. Holmgren 22502 (G). Utah: Box Elder Co., Willard Basin, R. Shaw 60 (IM); Cache Co., Logan Canyon, R. Shaw 46 (IM); Davis Co., Mueller Park, R. Shaw 61 (IM); Rich Co., Logan Canyon, R. Shaw 55 (IM); Salt Lake Co., Little Cottonwood Canyon, R. Shaw 64 (IM); San Pete Co., Manti Nat. For., A. H.

Holmgren & R. Shaw 7648-B (IM); Summit Co., West Fork,
E. B. & L. B. Payson 4829 (NY); Utah Co., American Fork
Canyon, R. Shaw 51 (IM); Wasatch Co., Midway, R. Shaw 48
(IM); Weber Co., North Ogden Canyon, R. Shaw 66 (IM).

This species is found in open dry areas, especially on
hillsides and canyon slopes. Frequently, it is associated
with Artemisia tridentata Nutt. This pink flowered perennial
has been consistently confused with G. Fremontii. However,
Jones and Jones (7) in their monographic study, make it
very clear that G. Fremontii is characteristic of the
southern Rocky Mountain region and is a much smaller plant.

CHAPTER V

SUMMARY

Because of the confusion existing in the western North American species of the genus Geranium, some experimental taxonomic methods were used in studying the genus within the Wasatch region during the years 1948-1950.

Emphasis of the cytological phase of the study was placed on chromosome numbers in an attempt to show phylogenetic relationships between species. Four species were found within this geographical unit and 3 of these were shown to be polyploids on the tetraploid level and the fourth, a normal diploid. The chromosome numbers seem to indicate a base number of 13 for the genus in North America. Lack of multivalents, normal pairing and high fertility strongly suggest that the 3 tetraploids come under the classification of true allopolyploids or amphiploids. Many more of the North American species must be studied cytologically before parental types can be determined.

Checking guard cell length may prove to be a quick and reasonably reliable method of detecting polyploidy within the genus.

Additional morphological characters were found for separating the 2 indigenous species G. nervosum and G. Richardsonii. Over 100 specimens were collected from 12 counties in 2 states, and these helped to verify the fact that the plant which has been called G. Fremontii Torr. ex

Gray is actually G. nervosum.

All of the species were grown in the greenhouse and observed all through 1949 and part of 1950. From the observations in the field and greenhouse it was concluded that the accurate identification of the species by morphological characters must depend on the more mature stage of the plants, particularly the fruiting stage.

LITERATURE CITED

- (1) Cain, Stanley A. Foundations of plant geography. New York; Harper and Brothers, 1944, 556 pp., Illus., charts and maps.
- (2) Clausen, Jens, Keck, David D. and Hiesey, William M. Plant evolution through amphiploidy and autopoloidy with examples from *Madiinae*. Publ. Carnegie Instn. No. 564., 174 pp., 1945.
- (3) Fenneman, Nevin M. Physiography of Western United States. New York; McGraw-Hill Book Co., 1931, 534 pp., Illus., maps.
- (4) Fernald, Merritt Lyndon. Geranium carolinianum and allies of Northeastern North America. *Rhodora* 37 (440):295-301, Aug. 1935.
- (5) Gauger, W. Ergebnisse einer zytologischen untersuchung der familie der Geraniaceae. *Planta* Band 26:529, 1937.
- (6) Hanks, L. T. and Small, J. K. Geraniaceae. *North American Flora* 25 (1):3-21, 1907.
- (7) Jones, George Neville and Jones, Florence F. A revision of the perennial species of Geranium of the United States and Canada. *Rhodora* 45 (529):5-26, Jan. 1943.
- (8) Knuth, R. Geraniaceae in Engler's *Das Pflanzenreich* Leipzig; Engelmann, 1912, Band 4, 640 pp., Illus.
- (9) Stebbins, G. Ledyard. Types of polyploids: their classification and significance. *Advances in genetics*. New York; Academic Press Inc., 1947, Vol. 1, 465 pp., Illus.
- (10) Tjebbes, K. The chromosome numbers of some flowering plants. *Hereditas* Band 10:328-331, 1928.
- (11) Warburg, E. F. Taxonomy and relationships in the Geraniales in the light of their cytology. *New Phytol.* 37:189, 1938.