A REVISION OF THE NORTH AMERICAN SPECIES OF SAGINA (CARYOPHYLLACEAE)

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ABSTRACT

A REVISION OF THE NORTH AMERICAN SPECIES
OF SAGINA (CARYOPHYLLACEAE)

By

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The genus Sagina consists of perennial and annual herbs indigenous to the cool temperate regions of the Northern Hemisphere. About 15 species are now recognized in the genus, 10 of which occur in North America, either as native or adventive taxa. Two lines of divergence are recognized at the sectional level. These are section Sagina, with a center of diversity in Eurasia, and section Maxima, with a center of diversity in eastern Asia. The latter section is newly described. Two new combinations at the subspecific level have also been made.

A phenetic diagram has been constructed to provide a graphic representation of the interspecific relationships of the North American taxa. An index of divergence has also been prepared for the taxa concerned. Sagina nodosa is regarded as the most primitive species in section Sagina and S. maxima is considered primitive in section Maxima.

Most of the species appear to be polythetic and have been recognized on the basis of combinations of various characters. For the most part the species of Sagina are inbreeders. Sterility barriers appear to be weak in the genus, while actual occurrence of hybrids is

largely reduced due to the inbreeding reproductive system and by different ecological preferences or flowering times of the taxa.

An analysis of the seed morphology, utilizing the scanning electron microscope, has been helpful in assessing relationships within the genus. This study included European and east Asian taxa as well as North American material. Two basic types of seeds occur and are diagnostic for sectional subdivisions of the genus. The saginoid seed type, characteristic of section _Sagina_ is obliquely triangular, possesses a dorsal groove and has its lateral surfaces drawn inward. The crassuloid seed type, characteristic of section _Maxima_, is more nearly reniform or globose, lacks a dorsal groove and its lateral surfaces remain full and plump.

The geographical distribution of _Sagina_ species have been evaluated in the light of effect of Pleistocene glaciation. An attempt has been made to determine where the taxa may have survived the glacial advances.

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By

Garrett E. Crow

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During my field work several persons took time to guide me to collecting sites: Drs. E. K. Longpre and H. Barclay in Colorado, Dr. J. H. Thomas in California and Dr. E. G. Voss in Ontario. Mr. Robert L. Watson accompanied me in the field. Special thanks is extended to Dr. H. Z. Snyder, who provided travel support for field work through the Snyder Foundation.

Mr. William MacAfee, of the Electron Microscope Laboratory, Michigan State University, took the SEM photographs.

Dr. J. K. Morton graciously provided me with his unpublished chromosome counts of North American material of *Sagina*.

I also wish to thank the curators of the herbaria from which specimens have been used for this study. These herbaria are listed at the beginning of the taxonomic treatment.

A special word of appreciation goes to my wife, Charlyn, whose love, patience, and encouragement has been an important factor in the completion of this dissertation.

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INTRODUCTION

Sagina (Pearlwort), a genus of the Charyophyllaceae, consists of about 15 species indigenous to the cool temperature regions of the Northern Hemisphere. The genus is well defined, although it is occasionally confused with superficially similar taxa of Spergularia and Arenaria. Confusion with taxa of Colobanthus, the genus most closely related to Sagina (Pax and Hoffmann, 1934), seldom occurs because Colobanthus is a circumaustral genus.

There has been, however, confusion within the genus regarding delineation of taxa. Wright (1935, p. 1) commented "I find among my friends many who are unwilling to give a definite opinion on Saginas, regarding them difficult to determine. I think such opinion arises from inadequate realisation of the extreme variability of these plants." The extreme variability within the genus has generated nomenclatural recognition of numerous variants, especially in Eurasia, the primary center of diversity for the genus. Many of these taxa were based on characters which are variable.

Previous work of a revisionary nature in Sagina is limited. Those works include only William's (1918) revision of the British species of Sagina and a treatment of the species of Sagina occurring in Japan by Mizushima (1960).

My study was undertaken with the intention of assessing the variability within the genus and attempting to clarify interspecific and intraspecific relationships. Nearly 6000 herbarium specimens, Eurasian and east Asian as well as North American, were examined. Most of the North American taxa have also been studied in the field and grown in a growth chamber. An analysis of the seed morphology, utilizing the scanning electron microscope, has been helpful in assessing relationships within the genus.

The revision should first of all contribute to a better understanding of the North American species. Secondarily, it may contribute to the knowledge of the entire genus and to a resolution of problems in the classification of other genera of the subfamily Alsinoideae.

HISTORICAL ACCOUNT

Botanical history of *Sagina* begins in the 17th Century with the finding of *S. nodosa* by John Goodyer on August 12, 1626, "on the boggy ground below the red Well of Wellingborough in Northamptonshire" in Great Britain, recorded in Johnston's Herball in 1633 under the name "Saxifraga palustris alsine folia" (Williams, 1918; Druce, 1932). In 1719 Dillenius included the Pearlworts under the generic name *Alsinella* in his *Catalogus Plantus*, a pre-Linnean name perpetuated by Hill (1756) in *The British Herbal* and by Greene (1891) in *Flora Franciscana*.

The generic name *Sagina* first appears in print in Linnaeus' *Systema Naturae* in 1735. His *Genera Plantarum* (1737) indicates it was based on *S. procumbens*. In *Species Plantarum* (Linnaeus, 1753) the genus included two tetramerous members of the tribe Alsineae, *Sagina procumbens* and *Moenchia erecta*, and a third species, *Bartonia virginica*, now recognized as belonging to the Gentianaceae.

Presl (1826), in his *Flora Sicula*, was the first to include any of the exstipulate Spergulas in the genus *Sagina*. Dumortier (1827), on the other hand, recognized the non-stipulate Spergulas of Linnaeus as a distinct genus, *Phaloe*. Reichenbach (1827) likewise regarded this group as a separate genus, giving it the name *Spergella*. Fenzl's (1833) redefinition of *Sagina* retained only *S. procumbens* of Linnaeus' genus and incorporated Reichenbach's *Spergella*. Koch (1837), in the first edition of Synopsis Florae Germanicae et Helveticae retained Reichenbach's Spergella in the genus Spergula as sect. Spergella. In the second edition (Koch, 1843) he transferred sect. Spergella to Sagina, thus erecting the subdivisions in Sagina as sect. Saginella, including the 4-merous taxa, and sect. Spergella, comprising the 5-merous taxa.

Although this subdivision is sometimes followed in European floristic works, it neither adequately reflects natural relationships, nor provides a practical basis for classification. Not only are there both 4- and 5-merous plants within taxa, but individual plants may have both types of flowers.

Moss (1920), in this treatment of Sagina for the Cambridge British Flora regarded the species as being too closely allied to be meaningfully subdivided into distinct groups higher than series. Thus, he treated the British Saginas in four series: Nodosae, Subulatae, Procumbentes, and Apetalae. With the exception of ser. Apetalae his groupings are quite natural. However, they deal only with the British species.

Mizushima (1960) likewise concluded that generic subdivision does not merit rank above series level and attempted to apply Moss' series to the east Asian Saginas, but found it necessary to redefine these series. Unfortunately he based these divisions on 4-merous taxa versus 5-merous taxa.

CHROMOSOME NUMBERS

Very little information is presently available on chromosome numbers in *Sagina*. It appears from the published chromosome numbers that two basic chromosome numbers occur in the genus, $x = 6$ and $x = 11$ (Darlington and Wylie, 1956).

In section *Maxima* all the taxa are based on $x = 11$. Both diploid and tetraploid populations are known in *Sagina maxima* subsp. maxima ($2n = 22$, 44). A tetraploid count has been reported for *S. japoinca* ($2n = 44$) and a hexaploid count ($2n = 66$) has been reported for *S. maxima* subsp. *crassicaulis*.

Section *Sagina* contains taxa based on $x = 6$ and $x = 11$. The taxa based on $x = 6$ are annuals and consist of *Sagina apetala*, whose published count is diploid ($2n = 12$) and *S. decumbens*, with an unpublished hexaploid count ($2n = 36$). The remaining taxa in section *Sagina* are perennials whose chromosome numbers are based on $x = 11$. *Sagina saginoides*, *S. procumbens* and *S. subulata* are reported as being diploids ($2n = 22$). The polyploids reported include *S. nodosa* ($2n = 44$, 56) and *S. nivalis* and *S. caespitosa* (both $2n = 88$).

Table 1 summarizes the chromosome numbers known for the taxa of *Sagina* occurring in North America. A large portion of the published counts are based on European material. Dr. J. K. Morton has graciously provided his unpublished counts, all based on his collections of North American material.

TABLE 1. CHROMOSOME NUMBERS FOR TAXA OF SAGINA OCCURRING IN NORTH AMERICA

Taxon	2n Number	Reference
S. nodosa	56	Blackburn, in Tischler (1938)
	56	Blackburn and Morton (1957)
	56	Gadella and Kliphuis (1968)
	44	Löve and Löve (1956)
	56	Morton (unpublished)
S. saginoides	22	Blackburn, in Wright (1938)
	22	Blackburn and Morton (1957)
	22	Löve and Löve (1956)
	22	Morton (unpublished)
	22	Packer (1968)
S. procumbens	22	Blackburn, in Tischler (1938)
	22	Blackburn and Morton (1957)
	22	Calder and Taylor (1968)
	22	Gadella and Kliphuis (1966, 1971)
	22	Morton (unpublished)
	22	Rohweder (1937, 1939)
	22	Wulff and Lindschau, in Tischler (1938)
S. subulata	22	Blackburn and Morton (1957)
	22	Findlay and McNeill (1973)
	22	Löve and Löve (1956)
	18	Rohweder (1937, 1939)
S. nivalis	84	Blackburn and Morton (1957)
	88	Löve and Löve (1948, 1956)
	c.88	Morton (unpublished)
S. caespitosa	88	Knaben (1950)
	88	Löve and Löve (1956)
	100 (higher than)	Löve and Löve (1944)
S. decumbens subsp. decumbens	36	Morton (unpublished)
S. apetala	12	Blackburn and Morton (1957)
	12	Diers (1961)
S. maxima subsp. maxima	42 or 44	Blackburn, in Wright (1940)
	44	Calder and Taylor (1968)
	22	Taylor (1967)
S. maxima subsp. crassicaulis	66	Calder and Taylor (1968)
S. japonica	42 or 44	Blackburn, in Wright (1940)

EVOLUTION

Two centers of diversity are present in *Sagina*. A primary center is located in Eurasia (sect. *Sagina*) and a secondary center occurs in eastern Asia (sect. *Maxima*).

In order to provide an assessment of interspecific relationships a phenetic diagram was constructed. The method is one described by Wiffin and Bierner (1972) which allows the use of characters without designating which is the primitive or derived state. It is, however, necessary to designate one taxon as the most primitive. The procedure consists of the following:

1. A listing of characters used and their two states (Table 2).
2. Tabulation of the character states for each taxon (Table 3).
3. Designation of one taxon as the most primitive.
4. Tabulation of the computed differences between taxa (Table 4).
5. Construction of a phenetic diagram.

The diagram produced is constructed by listing the taxa in order of absolute difference, least to greatest, from the designated most primitive taxon, *Sagina nodosa*. Taxa are then joined to the developing tree in order of difference and connected to the pathway of the taxon already in the tree which is least different. The resulting tree is more or less cladistic in arrangement.

TABLE 2. CHARACTERS AND CHARACTER STATES IN SAGINA

Character	Character State	
	0	1
1. Life history	Perennial	Annual
2. Habit	Slender with filiform stems	Decidedly succulent
3. Habit	Loose, ascending or sprawling	Caespitose
4. Lower cauline leaves	Linear	Subulate
5. Upper cauline leaves	Linear	Subulate
6. Primary rosettes or basal tuft of leaves	Present	Absent
7. Secondary leaf fascicles	Present	Absent
8. Leaf tips	Aristate	Lacking aristae
9. Leaf base	Ciliate	Lacking cilia
10. Connate portion of leaf base	Forming shallow cup	Not cup-like
11. Pubescence of calyx base and pedicel	Present	Absent
12. Sepal margin and/or tip	Purple	Colorless
13. Flower parts	4-merous (predominantly or always)	5-merous (predominantly or always)
14. Petals	Present	Absent
15. Petals	Sometimes caducous	Always persistent or always absent
16. Sepals	Remaining appressed at capsule dehiscence	Divergent at capsule dehiscence
17. Pedicels	Reflexed during capsule maturation	Erect during capsule maturation
18. Capsule dehiscence	Less than half the length of sutures	Entire length of sutures
19. Seed shape	Crassuloid	Saginoid
20. Seed surface	Smooth or pebbled	Tuberculate or papillate

TABLE 3. TABULATION OF CHARACTER STATES FOR THE NORTH AMERICAN TAXA OF SAGINA

Taxon	Character State																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
S. nodosa	0.0	0.5	0.0	0.0	1.0	0.0	0.0	1.0	1.0	1.0	0.5	1.0	1.0	0.0	1.0	0.0	1.0	1.0	0.5	0.0
S. saginoides	0.0	0.5	0.5	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.0	1.0	1.0	0.0
S. procumbens	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
S. subulata	0.0	0.5	0.5	1.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	0.0	0.0	1.0	1.0	0.0
S. nivalis	0.0	0.5	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	1.0	1.0	1.0	0.0
S. caespitosa	0.0	0.5	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	1.0	1.0	1.0	0.0
S. decumbens ssp. decumbens	1.0	0.0	0.0	0.5	1.0	0.5	1.0	1.0	1.0	0.5	0.5	0.5	1.0	0.0	0.0	0.0	1.0	0.0	1.0	0.5
S. decumbens ssp. occidentalis	1.0	0.0	0.0	0.5	1.0	0.5	1.0	1.0	1.0	0.5	0.5	0.5	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
S. apetala	1.0	0.0	0.0	1.0	1.0	0.5	1.0	0.0	0.0	1.0	0.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5
S. maxima ssp. maxima	0.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0
S. maxima ssp. crassicaulis	0.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	1.0	0.5	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0
S. japonica	1.0	0.5	0.0	0.0	0.0	0.5	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0

TABLE 4. COMPUTED DIFFERENCES BETWEEN NORTH AMERICAN TAXA OF SAGINA

Taxon	A	B	C	D	E	F	G	H	I	J	K	L
A. S. nodosa	0.0	3.5	5.5	3.5	8.0	8.0	7.5	6.0	10.5	5.5	6.0	8.5
B. S. saginoides		0.0	3.0	3.0	8.5	9.5	10.0	8.5	13.0	7.0	6.5	10.0
C. S. procumbens			0.0	6.0	8.5	11.5	11.5	10.5	10.0	9.0	8.5	12.0
D. S. subulata				0.0	7.5	6.5	9.0	7.5	10.0	8.0	9.5	11.0
E. S. nivalis					0.0	3.0	9.5	8.0	9.5	9.5	8.0	12.0
F. S. caespitosa						0.0	8.5	7.0	9.5	8.5	9.0	10.5
G. S. decumbens ssp. decumbens							0.0	1.5	9.0	8.0	7.5	5.0
H. S. decumbens ssp. occidentalis								0.0	8.5	6.5	6.0	6.5
I. S. apetala									0.0	13.0	14.5	12.0
J. S. maxima ssp. maxima										0.0	1.5	4.0
K. S. maxima ssp. crassicaulis											0.0	5.5
L. S. japonica												0.0

Figure 1. Phenetic diagram for taxa of *Sagina* occurring in North America. Taxa: A. *S. nodosa*; B. *S. saginoides*; C. *S. procumbens*; D. *S. subulata*; E. *S. nivalis*; F. *S. caespitosa*; G. *S. decumbens* ssp. *decumbens*; H. *S. decumbens* ssp. *occidentalis*; I. *S. apetala*; J. *S. maxima* ssp. *maxima*; K. *S. maxima* ssp. *crassicaulis*; L. *S. japonica*.

The phenetic diagram clearly defines the species complexes present in the North American Saginas and the connecting pathways give a rather reliable representation of the interspecific relationships of the taxa concerned. Unfortunately, it implies that Sagina nodosa is ancestral to the other taxa. It does not appear to me that any extant species of Sagina can adequately serve as the ancestral taxon to the rest of the genus.

An index of divergence was also prepared, utilizing primitive versus derived characters, in order to provide an assessment of divergence from hypothetical ancestral stock. The evaluation uses a scheme patterned after the "Wagner Divergence Index" (Wagner, 1969; Fryxell, 1971). The method employed here consists of the following:

1. A listing of characters where recognizable evolutionary tendencies can be determined as to primitive or advanced status (Table 5).

2. Assignment of value to character states. (In character states involving sequential development, value assignment is dependent upon level of specialization.)

3. Tabulation of the character states for all taxa included (Table 6).

4. Construction of diagramatic representation of divergence from the hypothetical unspecialized form (Figure 2).

In construction of the diagram, vertical displacement is based on tabulation of divergence. Horizontal displacement and grouping, however, are based on overall phenological similarities, both those which show evolutionary tendency and those whose evolutionary significance cannot be determined.

The system does not suggest the time element involved in divergence. However, horizontal displacement does incorporate the two geographical centers of diversity within Sagina.

Analysis of derived characters:

1. Perennial duration is predominant in Sagina. The annual condition is therefore regarded as derived. A trend of perennial to annual life histories occurs widely in the order Caryophyllales (Pax and Hoffman, 1934).

2. The majority of taxa within the genus are, at most, only very slightly succulent. Both the filiform habit of inland taxa of drier habitats and the decidedly succulent habit of some coastal taxa are described as divergent from the generalized form.

3. The caespitose habit occurs only in the harsh environmental conditions of the arctic-alpine habitat. The montane S. saginoides becomes caespitose only when it extends into alpine zones.

4. The crassuloid seed type is regarded as primitive even though fewer taxa retain this feature. Developmentally, within taxa possessing the saginoid seed type, the seed appears crassuloid prior to maturity but forms the dorsal groove and obliquely triangular shape of the saginoid seed type at capsule dehiscence and dissociation with the placenta.

5. and 6. There is a general tendency in the Alsinoid line of the Caryophyllaceae from outcrossing to inbreeding (Pax and Hoffman, 1934). In Sagina the tendency is well advanced, selfing being more common than outcrossing. This is reflected both in progressive

reduction of the pollinator-attracting apparatus (the corolla) and in the progressive tendency for the flowers to remain closed.

7. Reduction of stamens from two whorls to one is a tendency recognized at both the familial and ordinal levels (Pax and Hoffmann, 1934).

8. In most of the perennial species of the genus vegetative reproduction takes place by a rooting at nodes along prostrate branches, especially where fascicles of leaves are located on these branches. Bulbils are modified fascicles consisting of tiny succulent leaves which become detached as a unit and are blown about by the wind.

9. The linear leaf form predominates throughout the genus. The subulate leaf form appears to be correlated with progressively more xeric situations.

10. The majority of seeds, both crassuloid and saginoid types, are smooth to slightly pebbled. Thus, the ornamented papillate or tuberculate seed surface is regarded as derived.

Divergence: section Sagina

Sagina nodosa has remained much like the hypothetical unspecialized ancestor of the genus in floral structure. The protandrous flowers strongly encourage outcrossing, although the species is reportedly quite able to inbreed (Wright, 1935). There appears to be some degree of self-incompatibility, however. I have noticed that plants I collected on the shore of Lake Superior, Ontario, produced few capsules and little seed when grown under insect-free conditions of a growth chamber. Dr. J. K. Morton (personal communication) confirms this observation in greenhouse

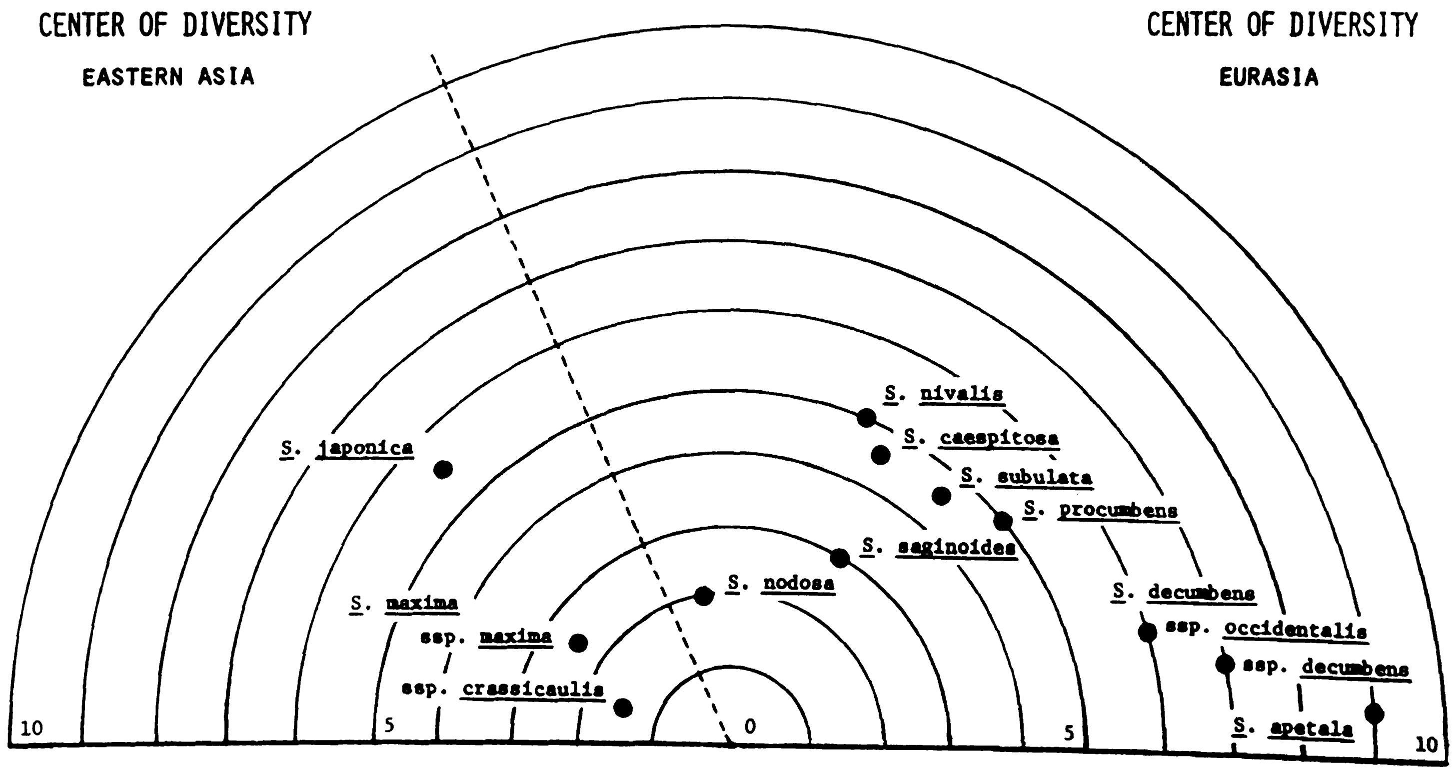
TABLE 5. COMPARISON OF PRIMITIVE AND ADVANCED CHARACTER STATES IN SAGINA

Generalized Condition	Derived Condition
1. Perennial	1. Annual
2. Habit slightly succulent	2. a. Habit slender with filiform stems b. Habit decidedly succulent
3. Habit loose, ascending or sprawling	3. Habit caespitose
4. Seed crassuloid	4. Seed saginoid
5. Petals conspicuous, greatly exceeding the sepals	5. a. Petals conspicuous, but equal or slightly exceeding sepals b. Petals slightly shorter than sepals c. Petals reduced, much shorter than sepals d. Petals absent, or if present, quickly caducous
6. Flowers generally open	6. a. Flowers remaining closed on cloudy days b. Flowers frequently closed on fair days c. Flowers generally cleistogamous
7. Stamens in two whorls	7. Stamens in one whorl
8. Vegetative reproduction by rooting of prostrate branches	8. Vegetative reproduction by bulbils
9. Cauline leaves linear	9. a. Only upper cauline leaves subulate b. All cauline leaves subulate
10. Seed smooth to slightly pebbled	10. Seed ornamented, papillate or tuberculate

TABLE 6. INDEX OF DIVERGENCE FOR NORTH AMERICAN TAXA OF SAGINA; TABULATION OF CHARACTER STATES

Characters	Taxa												Value
	A	B	C	D	E	F	G	H	I	J	K	L	
1. Annual	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.5	0.0	1.0	1.0
2. a. Habit slender with filiform stems	0.0	0.0	0.0	0.5	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.5	1.0
b. Habit succulent	0.0	0.0	0.5	0.0	0.5	0.5	0.0	0.0	0.0	1.0	1.0	0.5	1.0
3. Habit caespitose	0.0	0.5	0.0	0.5	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4. Seed saginoid	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0
5. a. Petals equalling or slightly exceeding sepals	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.5	0.0	0.5
b. Petals slightly shorter than sepals	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0
c. Petals reduced, much shorter than sepals	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
d. Petals absent or caducous	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	2.0	0.0	0.0	0.0	2.0
6. a. Flowers remaining closed on cool cloudy days	0.0	0.5	0.0	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5
b. Flowers frequently closed on fair days	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0
c. Flowers generally cleistogamous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.5	0.0	0.5	1.5
7. Stamens reduced to one whorl	0.0	0.0	1.0	0.0	0.0	0.0	0.5	0.5	1.0	0.0	0.0	1.0	1.0
8. Vegetative reproduction by bulbils	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
9. a. Only upper cauline leaves subulate	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.5
b. All cauline leaves subulate	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0
10. Seed ornamented (papillate or tuberculate)	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0	1.0	1.0
Total	2.0	3.0	5.0	4.5	5.0	4.5	7.0	6.0	9.0	2.5	1.5	5.5	11.5

Taxa:
A. *S. nodosa*
B. *S. saginoides*
C. *S. procumbens*
D. *S. subulata*
E. *S. nivalis*
F. *S. caespitosa*
G. *S. decumbens* ssp. *decumbens*
H. *S. decumbens* ssp. *occidentalis*
I. *S. apetala*
J. *S. maxima* ssp. *maxima*
K. *S. maxima* ssp. *crassicaulis*
L. *S. japonica*



INDEX OF DIVERGENCE

NORTH AMERICAN SPECIES OF SAGINA

Figure 2. Index of divergence for North American taxa of *Sagina*.

grown plants, while plants of the species grown in his outdoor plots were subject to visitation by insects and freely set seed.

An intermediacy in seed type is further suggestive of the primitiveness of Sagina nodosa. The frequency of seeds appearing saginoid, with a distinct dorsal groove, nearly equals that of the crassuloid seed type.

In terms of vegetative reproduction, however, S. nodosa possesses the most advanced mechanism of the genus. By the formation of axillary bulbils which are readily detached in late autumn (Wright, 1935) the species has developed a disseminule which can be dispersed by the wind. The leaves of the bulbils have a xerophytic anatomical structure (Wright, 1935), thus enhancing the chances of establishment for the propagules. On Baffin Island, N. W. T., the species is reported to reproduce exclusively by bulbils (Polunin, 1959).

Sagina saginoides, S. subulata and S. procumbens form a species complex which remains little divergent from the ancestral stock. The three species of this complex appear to be capable of interbreeding but largely maintain their integrity through inbreeding, ecological preference, and geographical affinities.

Sagina saginoides is the least divergent of these three species. Sagina subulata appears to be slightly more advanced. The latter's possession of subulate leaves and a tendency toward a filiform growth habit are correlated with its tolerance of dryish sandy, gravelly or rocky habitats.

Sagina procumbens expresses a greater amount of divergence than S. saginoides and S. subulata, especially in the context of reproductive biology. The trend toward obligate inbreeding is evidenced by reduction of the androecium to one whorl, reduction of the petals, and a tendency for flowers to remain closed even on fair days. Wright (1935) observed that nearly all flowers of the species produced during autumn were cleistogamous. The species is weedy and has become dispersed widely in cool temperate regions of both hemispheres.

Sagina nivalis and S. caespitosa comprise a complex of the high Arctic region for which the highest chromosome counts in the genus are reported (see Table 1). Both taxa are densely caespitose. Inbreeding is well developed, although S. caespitosa, with petals slightly longer than the sepals, has a greater potential for outcrossing. Vegetative reproduction, however, plays an extremely important role in the survival of this high latitude complex. John Schindler (personal communication, 1970) notes that in the region around the Naval Arctic Research Laboratory at Point Barrow, Alaska, S. nivalis has been seen to set seed once in a ten-year period. Indeed, I found it difficult to obtain well-formed, mature seeds of either taxon from herbarium material for scanning electron microscope studies.

Sagina nivalis appears to have greatest affinity with S. saginoides. Where disjunct populations of S. nivalis bring the otherwise allopatric species together in alpine situations in the Cordillera of Alberta, there appears to be some intergradation and species occur which are difficult to assign to either taxon.

Sagina decumbens, with subspp. decumbens and occidentalis, and S. apetala form a complex of annuals which appear to be highly divergent from the ancestral stock. Divergence in this group appears to be related to adaptation to stress of moisture deficiency and is expressed by the presence of subulate leaves and a loose, slender, much branched habit. In each taxon the habitat is one subject to a relatively brief period of moisture availability in early spring. Moisture deficiencies of late spring require rapid completion of the life cycle. Plants of all three taxa grown in a growth chamber exhibited the capability of producing flowers only two weeks after seeds were sown. In portions of the geographical range where climate is milder during the winter months these taxa successfully prolong their life histories by functioning as winter annuals, whereby seeds germinate under moist conditions of fall and may pass the winter in a weakly developed rosette state.

Sagina apetala scores highest in the divergence index. In addition to having a loose, slender habit and possession of subulate leaves, this taxon shows the greatest amount of floral reduction and more nearly approaches obligate inbreeding and cleistogamy than any other species of Sagina. Native to Eurasia, S. apetala is weedy and has become introduced as widely as Japan (Mizushima, 1960), Chile, Argentina and North America.

Divergence: section Maxima

Sagina maxima subsp. crassicaulis, a perennial of northern Pacific coastal bluffs and gravelly-sandy beaches, appears to be the least divergent member of section Maxima. Although the taxon can be successful as an inbreeder, I have observed that the flowers generally remain open, even under dull, cloudy days, thus encouraging outcrossing.

Sagina maxima subsp. maxima is primarily an east Asiatic taxon. Like its American counterpart, its flowers generally encourage outcrossing, but also successfully self-pollinate. Divergence, however, has proceeded a step further in floral biology. Cleistogamous flowers may be produced in autumn and sometimes in winter in portions of the range where the climate is milder (Mizushima, 1960). There is also a tendency in this taxon toward an annual life history.

Divergence in section Maxima parallels that in section Sagina and is more fully realized in S. japonica. This inland species has developed an annual life history and a loose, slender, much branched habit, as has occurred in S. decumbens and S. apetala, but the primitive linear, somewhat succulent leaf form has been retained. Floral structure is S. japonica expresses a trend toward obligate inbreeding. The petals are reduced, the androecium is generally reduced to one whorl, and cleistogamous, as well as chasmogamous flowers occur. This species has greatest affinities with S. maxima subsp. maxima.

Figure 3 summarizes the presumed relationships of the taxa of Sagina occurring in North America.

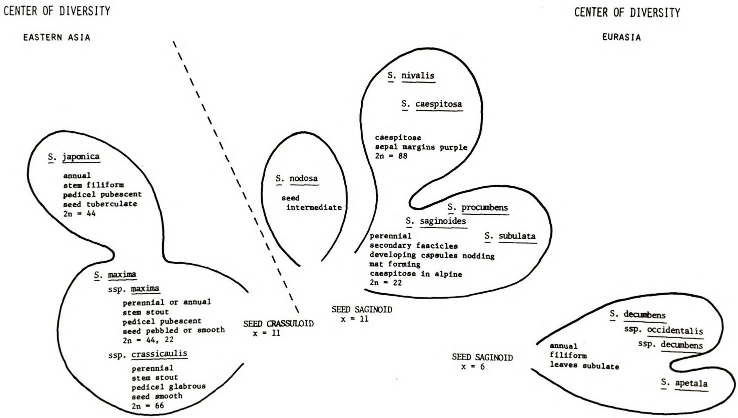


Figure 3. Presumed relationships of taxa of Sagina occurring in North America.

PHYTOGEOGRAPHY

The modern distribution patterns of boreal and cool temperate species in North America reflect the effect of Pleistocene glaciation. The postglacial distributions of Sagina must, therefore, be evaluated in this light and an attempt made to determine where the taxa may have survived the glacial advances.

Circumpolar Sagina nivalis is widespread in the North American Arctic and appears to have survived the Pleistocene in the Beringian refugium. A large portion of Alaska, including the Bering Straight region and the North Slope remained ice-free during glacial advances (Péwé et al., 1965; Heusser, 1965) and the geographical distributions of numerous arctic species suggest a "Beringia radiant" pattern (Hultén, 1937).

Although portions of the high Arctic Archipelago do not show signs of glaciation (Flint, 1957; Savile, 1961), this region probably did not serve as a refugium. One would not expect a region like the northwest Elizabeth Islands, with a depauperate flora and stunted plant growth, to function as a survivium (Savile, 1961). Savile is of the opinion that the flora of this region is one recently derived.

The distribution of Sagina nivalis shows a noticeable gap in the region of the northwest Queen Elizabeth Islands, occurring on Prince Patrick Island and Axel Heiberg Island, but not between. The gap apparently does not reflect lack of collecting, for Savile (1961), who has done much collecting in this region, notes that the distributions of a number of widespread arctic species exhibit this pattern.

Rare disjunct populations of Sagina nivalis occur southward in the alpine habitat along the Cordilleran system to Alberta. It is possible that these populations are relictual. Another possible explanation is that these populations are a result of long distance dispersal of the diaspores which have niches in newly opened habitats in the glaciated alpine of the Cordilleran range.

Sagina caespitosa, a rare species, exhibits an amphi-Atlantic distribution, occurring as a coastal plant in the eastern Arctic, western and southern Greenland, and as a montane plant on Iceland and in Scandinavia. The existence of coastal mountain refugia, as described by Dahl (1946) provides the most plausible explanation of survival. Dahl notes that nunataks occurring in western Greenland support a relatively rich flora. The populations occurring in the eastern Arctic of North America have distinct affinity with populations of western Greenland, pubescence of pedicel being present in both, while plants in populations of southern Greenland, Iceland, Jan Mayan and Scandinavia are completely glabrous.

The circumpolar distribution of Sagina saginoides correlates almost entirely with montane regions of the Northern Hemisphere. Hultén (1958) notes that the Pleistocene fragmented many circumpolar distributions. This seems to be the case here.

In North America this species survived Pleistocene glaciation in the southern portion of the Cordillera. Although mountain glaciation occurred during the Pleistocene, Weber (1965) points out that large areas in Colorado were free of ice. In the Sierra Nevada glaciers descended to 1300-2200 meters elevation but numerous refugia existed throughout the range (Wahrhaftig and Birman, 1965). Recession of alpine glaciers in the Olympic Mountains occurred during continental expansion of the Cordilleran ice sheet, thus refugia occurred nearby at the time the Puget Sound lobe reached its maximum (Crandell, 1965).

Mount Albert, on the Gaspé Peninsula of Quebec, is a well known locale whose serpentine summit supports an alpine flora which contains a curious Cordilleran element including S. saginoides. Fernald (1925) considered these disjuncts to be relictual, persisting through the glacial period on this unusual nunatak, but his theory has lost much credibility. Marie-Victorin (1938) does not consider this serpentine habitat as a nunatak, but rather regards it simply as a place where arctic plants can survive while others cannot. Dr. J. K. Morton (personal communication) has been able to show that a number of Fernald's relictual endemics are not good taxa in their own right, but merely environmentally induced growth forms of other taxa, thus further discrediting Fernald's nunatak theory. The presence of S. saginoides at one locality on the eastern shore of Hudson Bay, one locality near Shefferville, Quebec, on the Labrador-Quebec Peninsula, and on the Gaspé Peninsula seems better explained as the result of long distance dispersal. The diaspores of the Saginas clearly have properties conducive to long distance dispersal by wind (Löve, D., 1963; Van der Pijl, 1969). These isolated populations illustrate well "a case-in-point" in support of "Baker's Law" regarding long distance dispersal which basically states that for self-compatible taxa a single propagule is sufficient to start a new colony and that establishment is much more likely than is the chance of establishment for self-incompatible taxa (Baker, 1955, 1967).

Sagina maxima subsp. crassicaulis, a strictly coastal taxon, was largely unaffected in the lower and major portion of its range. To the north, however, its range was abruptly truncated by the Cordilleran ice sheet. Hultén (1937) regards the taxon as one of his "Western America Coast Radiants." Migration northward along the coast was likely rapid during the post-Pleistocene as coastal winds may have facilitated rapid dispersal for species with light disseminules (Calder and Savile, 1960; Savile, 1961). Such dispersal would have been enhanced during periods when sea level was lower (Heusser, 1960). Heusser (1960) notes that some disapores are quite capable of traveling long distances over water, citing as evidence the composition of the flora of Middleton Island, Alaska. Sagina maxima subsp. crassicaulis (as S. crassicaulis) is recorded in this flora (Thomas, 1957). The range of S. maxima subsp. crassicaulis reaches northward and westward to Attu Island in the Aleutians.

With the retreat of the ice along the Alaskan coast, the Asiatic S. maxima subsp. maxima was likewise able to extend its range along the newly opened North American Pacific coast. Intergradation between the two taxa is in evidence on the Queen Charlotte Islands and Vancouver Island.

While the region south of the glacial boundary provided the major source of plants for the revegetation of western North America, nunataks along the coast of British Columbia and Alaska served as refugia during the Pleistocene. One of these was the Queen Charlotte Islands, an island complex which is noted to have both floristic endemics (Calder and Taylor, 1968) and faunal distinctions reflecting separation from mainland relatives (Heusser, 1960). It is entirely possible that Sagina maxima subsp. maxima or perhaps even both subsp. maxima and subsp. crassicaulis could have existed as refugees on this nunatak.

Hultén (1937) considered S. maxima subsp. maxima (as S. litoralis Hult.) as a Beringia radiant.

Locating a survivium for Sagina nodosa presents a problem, as it occurs entirely within the glacial boundaries of eastern North America. A number of northern species display this distribution pattern, perhaps reflecting a periglacial element (Crow, 1969). Some southward migration of northern species was made possible in part by slightly cooler climatic conditions and in part by lack of competition on the newly exposed coastal terraces and alluvial deposits during withdrawal of the sea (Braun, 1947). Sagina nodosa would be well adapted to the periglacial situation, for it is a successful pioneer plant on rocky shores and gravelly beaches. Its capacity for vegetative reproduction through the production of numerous bulbils in the leaf axils increases its effectiveness for rapid migration. Inability to compete well with later successional vegetation might explain its absence from unglaciated regions south of the glacial boundary.

Sagina decumbens subsp. occidentalis, a plant of lower elevations of the coastal mountains of the Northwest and of the Great Valley of California, occurs almost entirely within non-glaciated territory and reaches its northern limits at the southern border of British Columbia. The coastal mountains were free from ice, with the exception of a few high peaks in the northern portion which experienced cirque glaciers (Crandell, 1965; Wahrhaftig and Birman, 1965). In the Great Valley, deposition of large amounts of alluvial soil took place which was derived from erosional activity in surrounding mountain systems (Wahrhaftig and Birman, 1965). This disturbance probably provided numerous habitats for this taxon.

Hultén (1937) considered the taxon as a "Western America Coast Radiant." However, specimens from his area identified as Sagina occidentalis (S. decumbens subsp. occidentalis) were misdeterminations of plants belonging to the Sagina maxima complex.

The present distribution of Sagina decumbens subsp. decumbens does not readily reflect events of the Pleistocene as its distribution in eastern United States, primarily the Coastal Plain and Piedmont, is entirely within unglaciated territory.

Introduced taxa

The presence of Sagina procumbens in North America as a native of the flora is a matter open to speculation. In the Northeast the plant occurs frequently on coastal rocks and sands and sea cliffs, along stream banks, stream beds and rocks in streams and in springy places. Occurrence in such habitats might lead one to include it as

a native species. However, it appears to be equally frequent along roadsides, disturbed ground and around gardens, lawns and dwellings, and in cracks between bricks of sidewalks and pavement.

Torrey and Gray (1838) questioned the status of the species as one native to North America, but subsequently Gray (1895-97), and later Fernald (1950), regarded the species as native. Hultén (1958) includes the species among his "amphi-Atlantic plants," but, in a questioning tone, he notes that the species is anthropochorous to a large extent and attributes a great portion of its Eurasian range and possibly its presence in North America to this type of dispersal. It is noteworthy that in North America the species is most widely established in areas of early settlement, New England and the Maritime Provinces, and is especially prevalent in Massachusetts.

Man is certainly responsible for its occurrence in the Southern Hemisphere. Hooker (1847) observed Sagina procumbens to be abundant near the sea in the Falkland Islands and considered it most certainly native. However, he also noted that it was indistinguishable from European material. Is it any wonder? Port Louis had been settled in Berkeley Sound by Bougainville in 1763 (Godley, 1965), and ships from Europe regularly visited the island during the 79 years prior to Hooker's visit to this locale. He searched for it carefully in Fuegia but did not encounter the plant. He also indicated he knew no other locality for the plant in the subantarctic region.

Subsequent to Hooker's explorations in Fuegia, an Anglican mission and settlement of Ushuaia was established along the Beagle

Channel on Isla Grande, Tierra del Fuego. On an expedition to this region in the austral spring of 1971 I found S. procumbens to be very abundant in such disturbed sites as roadsides and grassy meadows of logged and burned sites in the Nothofagus pumilio forest region, but it also appeared very natural growing in a gravelly stream bed on the east side of Lago Fagnano. I must add that this latter site is along a gravel highway (the southern extent of the Pan American Highway). In contrast, the plant was not found on the uninhabited eastern tip of the island, Peninsula Mitre, nor on uninhabited Isla de los Estados, even though "weedy" species native to Fuegia were present.

Sagina procumbens has become frequent throughout the Sub-Antarctic where man has been active. Although the species was not encountered by Hooker on either the Campbell Islands or Kuerguelen Islands, R. C. Harris (personal communication) reports that he found the plant to be frequent at both localities and that the growth was so lush in places on Kuerguelen that, on occasion, reindeer (also introduced) feed on it.

Man's activities are most certainly responsible for the occurrence of the species in central and western North America. By the time of the writing of Part 1 of A Flora of North America (Torrey and Gray, 1838) S. procumbens had appeared in the iron mining regions of the south shore of Lake Superior, presumably introduced from eastern North America.

Introduction into the Pacific Northwest probably took place in the latter part of the 1800s. The earliest collections I am aware of include one specimen from Oregon, collected by Elihu Hall in 1871 and

one specimen from Vancouver Island, collected by John Macoun, May 9, 1875. As of 1894 the species had apparently not reached San Francisco, for it was not included in Greene's Manual of the Botany of the Region of the San Francisco Bay.

I am of the opinion that Sagina procumbens became introduced into northeastern North America shortly after settlement and soon became naturalized. Introduction into the Northwest most likely came by way of ships sailing around Cape Horn and could have originated from plants from eastern North America or Europe. The early collections in the Northwest are associated with coastal civilization while more recent collections indicate the plant is becoming naturalized in more remote areas of this region.

Sagina apetala is an alien which probably appeared in California during the rapid influx of civilization in the mid-1800s. The earliest recorded specimen I have seen is that of Congdon, collected in April, 1883, in Mariposa Co., California, where the species was probably a well established weed by that time. California collections prior to 1900 include: Mariposa Co., Tuolumne Co., Tehama Co., Plumas Co., and San Joaquin Co. As early as 1892 the species had reached southern Jackson Co., Oregon. Greene (1891) described the plant as a new species (Alsinella ciliata) in his Flora Franciscana.

Gray (1895-97) indicated the presence of the species in the Middle Atlantic States region, especially near the coast. The specimens he cited, however, belong to S. decumbens subsp. decumbens. I have seen but three herbarium specimens from eastern North America referable to S. apetala, one from Maryland, one from Illinois and one from Louisiana.

Sagina nodosa var. pubescens appears to have been introduced from Europe prior to the mid-1800s. The earliest collections known were made by J. Blake at Cape Elizabeth, Maine in 1857, and collections prior to 1900 included localities from Massachusetts to Nova Scotia. Several introductions may have occurred but the taxon appears to be especially well established along the coast in Lincoln Co., Maine and in the region of Digby, Nova Scotia. The taxon is not weedy, and Seymour (1969) notes in The Flora of New England that the plant is "uncommon."

The normal range of Sagina maxima subsp. maxima extends into North America by way of the Aleutian Islands down along the Pacific coast. This chiefly northeastern Asia taxon, however, also occurs in eastern North America. Here it is of incidental introduction, occurring sporadically and does not appear aggressive or spreading. Known localities include Toronto, Montreal and Quebec, Canada and Amherst, Massachusetts, where plants were found growing in damp places around buildings and along footpaths.

The eastern Asian Sagina japonica has appeared at only three localities in western North America, all seaports. As early as 1889 Macoun collected the plant at Nanimo, Vancouver Island. Suksdorf made collections of the species at Portland, Oregon in 1899 and 1900. In 1939 the plant was found growing along a railway bed at Prince Ruppert, British Columbia. A single collection is known from eastern North America. This specimen was found as a weed in a botanical garden in Ottawa, Ontario.

SEED MORPHOLOGY

Although the seeds of Sagina are minute, (0.25-) 0.3-0.5 (-0.6) mm long, several manuals make use of seed characters in their attempt to distinguish between the various species of a particular geographical region. Fernald's (1950) key uses the ridged markings on the seeds of S. decumbens and the black color and pebbled surface feature of S. nodosa. Hitchcock et al. (1964) refers to seed size and luster in distinguishing S. crassicaulis (S. maxima subsp. crassicaulis) from S. procumbens. Komarov (1936) employs the somewhat papillose surface feature of S. litoralis to separate it from S. maxima (the two are conspecific). Ohwi (1965) finds the tuberculate seed surface of S. japonica the only reliable character to distinguish it from the smooth seeded S. maxima.

It was such use of the seeds as "key characters" which led me to an investigation of the seed morphology. The study was an attempt to describe the amount of variation within taxa of the genus and to assess the value of seed morphology in determining interrelationships. European and east Asian taxa, as well as North American material, were included in the study.

Seeds were examined with a Bausch and Lomb dissecting microscope at a magnification of 30X and representative samples were further examined with a Zeiss research microscope using epi-illumination at

20X to 80X and with a scanning electron microscope at magnification of 200X, 1000X and 2000X.

Seeds for the scanning electron microscope study were obtained from herbarium specimens on deposit at the following herbaria: CAN, CAS, COLO, DAO, F, GH, MICH, MO, MSC, NY, UC, US. All specimens from which seeds were obtained have been so annotated. The seeds were placed on specimen stubs with double stick cellophane tape. Specimens were coated with 50 angstroms of carbon followed with 100 angstroms of gold-palladium while spinning at a 45° angle to the vapor source in a Ladd vacuum evaporator. The specimens were observed and photographed with an AMR Model 900 High Resolution Scanning Electron Microscope at Michigan State University.

On a morphological basis, two basic seed types can be recognized within Sagina, the saginoid form (as in S. saginoides) and the crassuloid form (as in S. maxima subsp. crassicaulis).

The saginoid seed type is obliquely triangular. The ventrally located hilum, often associated with a distinct notch, is subterminal in position. An invagination occurs along the dorsal surface forming a dorsal groove. The curved embryo lies along this angled dorsal surface. The lateral surfaces are typically flat or drawn inward. The seeds range in size from 0.3 mm to 0.5 mm long, remaining rather constant within taxa. Taxa having the saginoid seed form include: S. saginoides, S. procumbens, S. subulata, S. decumbens subspp. decumbens and occidentalis, S. apetala, S. maritima, S. glabra, S. nivalis and S. caespitosa (Figures 4-7).

The crassuloid form, on the other hand, is more nearly reniform. The hilum is subterminal, although the notch is less distinct. The embryo lies along the convex, dorsal surface. No dorsal groove is present. The lateral surfaces appear full and plump in contrast to the drawn lateral surfaces of most of the taxa with the saginoid form. Seed size is quite consistently 0.5 mm long with the exception of that of Sagina japonica, which is 0.4-0.5 mm long. Taxa of the crassuloid seed type include: S. maxima subsp. maxima and crassicaulis, S. paupuana, S. subuletorum and S. japonica (Figures 9 and 10).

Two taxa have seeds which appear intermediate between the two types. These are S. nodosa and S. abyssinica (Figure 8).

The seeds of both the saginoid type and the crassuloid type have a crassuloid appearance during the developmental stages. With capsular dehiscence, the mature seeds become dissociated with the placenta and upon air drying an invagination occurs along the dorsal surface of the seeds of the saginoid type, while the dorsal surface of the more rigid seed coat of the crassuloid seed type remains without a groove. However, air drying of the crassuloid type seed prior to seed coat maturation will cause dorsal invagination.

At higher magnifications with the scanning electron microscope the testa in both morphological forms appears to be constructed of interdigitating cog-like cells. This pattern is apparent throughout all the species, although quite obscure in S. decumbens subsp. decumbens (Figure 5). At 2000X magnification the pattern is revealed in this taxon also, although the pattern may remain obscure even at this magnification (Figure 5d).

The cog-like cells vary in shape from orbicular to elongate. The elongate cells occur most abundantly on the lateral surfaces of the seed, are oriented toward the hilum, and tend to become more elongate nearer the hilum. The interdigitating cog teeth range from long and acute to short and blunt, the feature being inconsistent within taxa. Topography of the seed surface takes on an array of appearances associated with the amount of uplifting of the central portion of the epidermal cells. The surface of the cog-like cells may be very flat, as seen on the lateral surfaces of some seeds of S. maxima subsp. crassicaulis (Figure 9b). Seeds of S. maxima subsp. maxima with a pebbled appearance show an increased uplifting of the central portion of the cell (Figure 9a). The most pronounced protuberances are the knobbed tuberculae of S. decumbens subsp. decumbens (Figure 5) and S. japonica (Figure 10).

There is some variation in surface features within certain taxa. In S. apetala the seed surface texture ranges from pebbled to densely papillose. The pebbled surface of the seeds of S. nodosa ranges from weak to strong. In S. procumbens the pebbled surfaces of the seed can be so slight as to appear "smooth." Sagina saginoides can be smooth or pebbled. Sagina decumbens subsp. decumbens seeds possess a tuberculate feature of well developed knobbed protuberances. Occasionally the tuberculae are less well developed and the surface appears papillose. In about 40% of the specimens examined, however, the tuberculae were absent. Both tuberculate and non-tuberculate seeds are consistent in the possession of a delicate reticulate ridge pattern. The western

equivalent, S. decumbens subsp. occidentalis, is characteristically smooth seeded, but the surface sometimes appears slightly pebbled. Seeds of the S. maxima complex are smooth to pebbled. Sagina japonica is characteristically densely tuberculate, but less well developed tuberculae give a papillose and, infrequently, a pebbled appearance approaching the seeds of the closely related S. maxima subsp. maxima.

In spite of this variation the surface features have proved to be very helpful in determining relationships between some taxa.

At first glance the tuberculate feature seen in S. decumbens subsp. decumbens (Figure 4), a Coastal Plain and Piedmont species of the eastern U.S. and that of S. japonica (Figure 10), a plant of equivalent habitat in eastern Asia, may suggest a close relationship. The scanning electron microscope, however, reveals that the tuberculae are of distinctly different origin. The tuberculae of S. japonica occur as knobbed or rounded protuberances of the center of individual cells. These tuberculae are as many as the number of cells, thus the distribution appears even and dense.

On the other hand, the tuberculae of S. decumbens occur associated with a ridge system reticulate in pattern. The tuberculae are not always evenly distributed and there is variability in density (Figure 5a and 5c). The fact that the seed of S. japonica is crassuloid and that of S. decumbens is saginoid further discourages one from placing the two taxa close together.

The papillose seed form of S. apetala (Figure 6a) superficially approaches the tuberculate feature. However, the SEM micrographs reveal

the projections to be distinctly nipple-like (Figure 6b). This mammillate condition is not uniform over the surface of a single seed, much less within the species.

In contrast to the situation where relationship is negated, the elongate ridges present in Sagina nivalis and S. caespitosa are identical. The ridges of the lateral surfaces seen under the dissecting microscope are clearly seen in SEM photographs as elongate cells, with the central portion raised. This feature, as well as other characters held in common, suggest that the two should be regarded as very closely related taxa.

The following key to the North American taxa, using the morphological features of seeds, summarizes differences in the seed characteristics.

a. Seed crassuloid (dorsal groove lacking; reniform to nearly globose) . . . b

b. Seed distinctly reniform; surface smooth to pebbled; reddish-brown . . . . S. maxima subsp. maxima
subsp. crassicaulis

b. Seed nearly globose; surface distinctly pebbled, papillose or tuberculate; dark brown . . . c

c. Seed densely tuberculate or papillose . . . . S. japonica

c. Seed merely pebbled . . . . S. nodosa

a. Seed saginoid (dorsal groove present: obliquely triangular; lateral surfaces drawn in) . . . d

d. Seed tan or light brown; surface smooth or tuberculate . . . e

e. Seeds tan; delicate reticulate ridge pattern present; frequently tuberculate (60%) . S. decumbens subsp. decumbens

e. Seeds light brown; never tuberculate, reticulate ridge pattern lacking . . . . . S. decumbens subsp. occidentalis

d. Seed brown; surface smooth to pebbled (sometimes papillose in S. apetala) . . . f.

f. Seeds with elongate ridge pattern (non-reticulate) . . . . S. nivalis

f. Seeds not ridged . . . . S. apetala
S. saginoides
S. procumbens
S. subulata
S. nodosa

Figure 4. SEM photographs of Sagina seeds, saginoid type. (a) S. saginoides, oblique dorsal view, showing dorsal groove and smooth seed surface; Sierra Nevada Range, California (Crow 1162, MSC). (b) S. procumbens, oblique lateral view, showing dorsal groove and smooth seed surface; Washington (Crow 1106, MSC). (c) S. subulata, lateral view, showing dorsal groove, elongate epidermal cells of lateral surface, smooth seed surface; Sweden (Weimarck s.n., 17 June 1943, DAO). (d) S. decumbens subsp. occidentalis, oblique lateral view, showing blunt interdigitating teeth of cog-like epidermal cells and pebbled seed surface; California (Howell 32536, CAS). All X 200.

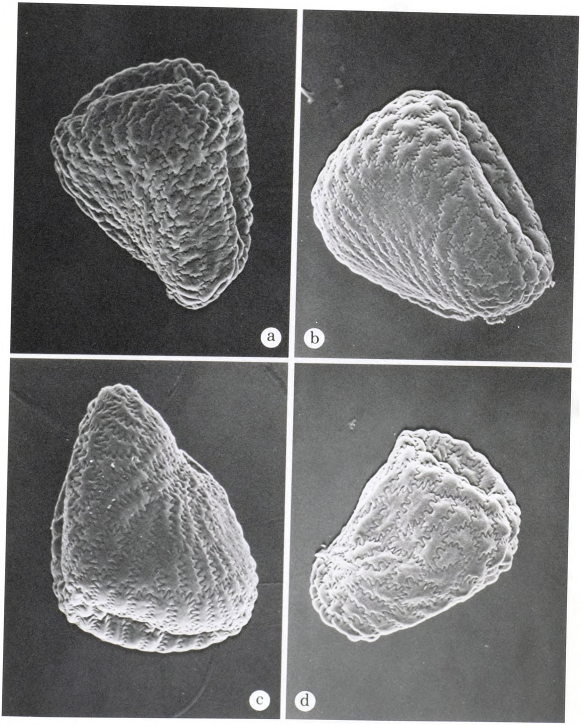


Figure 4

Figure 5. SEM photographs of *Sagina* seeds, saginoid type. (a) *S. decumbens* subsp. *decumbens*, dorsal view, showing dorsal groove and densely tuberculate seed surface, X 200; North Carolina (*Ahles 40187*, GH). (b) *S. decumbens* subsp. *decumbens*, detail of knobbed tuberculae located on ridges, X 1000; Florida (*Wiggins 19395*, DS). (c) *S. decumbens* subsp. *decumbens*, ventral view, showing less dense distribution of tuberculae borne on reticulate ridges, X 200; North Carolina (Biltmore Herbarium No. 1300, F). (d) *S. decumbens* subsp. *decumbens*, oblique lateral view, showing dorsal groove, non-tuberculate surface with reticulate ridge pattern present, cog-like epidermal cells obscure, X 200; Missouri (*Steyermark 8482*, MO).

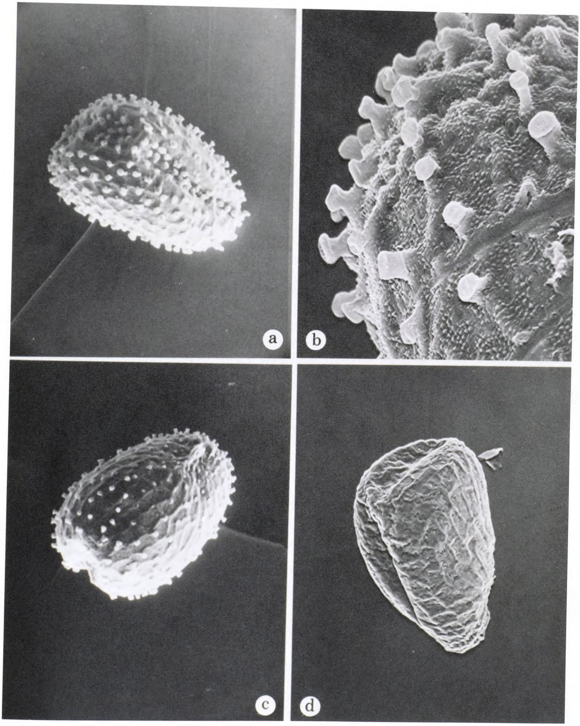


Figure 5

Figure 6. SEM photographs of Sagina seeds, saginoid type. (a) S. apetala, oblique lateral view, showing dorsal groove and mamillate papillae, X 200; California (Tracy 12200, DAO). (b) S. apetala, showing detail of mamillate papillae, X 1000 (same as 5a). (c) S. apetala, oblique dorsal view, showing dorsal groove and pebbled surface, X 200; California (Howell 29079, CAS). (d) S. maritima, oblique lateral view, showing dorsal groove, blunt interdigitating teeth, and smooth seed surface, X 200; Sweden (Asplund 757, NY).

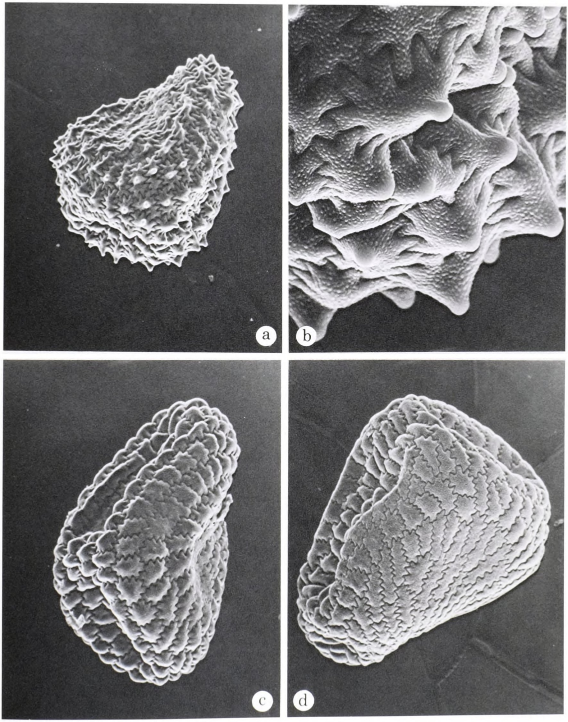


Figure 6

Figure 7. SEM photographs of Sagina seeds, saginoid type. (a) S. glabra, oblique lateral view, showing dorsal groove and slightly pebbled seed surface, X 200; France (Letacq s.n., COLO access. no. 174645). (b) S. caespitosa, oblique dorsal view, showing dorsal groove and elongate ridges of epidermal cells, X 200; Port Burwell, Hudson Straits, N. W. T. (Malte s.n., 25-28 July 1928, GH). (c) S. nivalis, oblique lateral view, showing dorsal groove and elongate ridges of epidermal cells, X 200; St. Paul Is., Bering Sea (Macoun s.n., 12 July 1897, F). (d) S. nivalis, detailed view of elongate ridges of epidermal cells X 1000; Baffin Is., N. W. T. (Calder 2131, DAO).

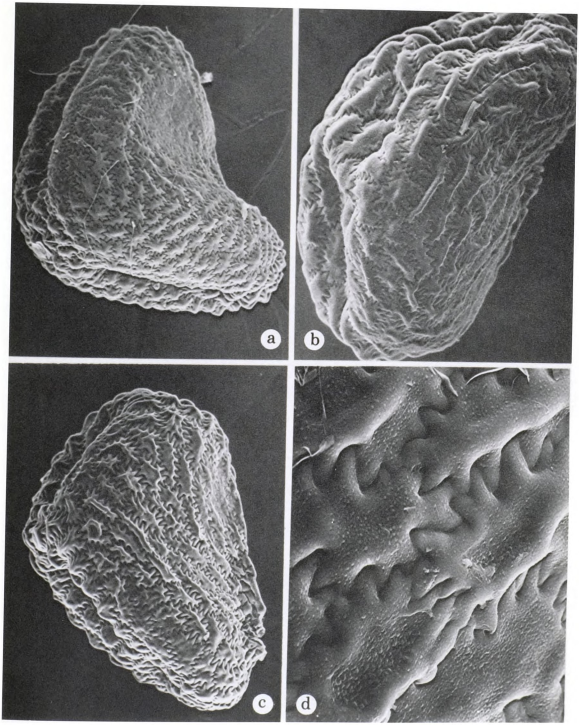


Figure 7

Figure 8. SEM photographs of Sagina seeds, intermediate between saginoid type and crassuloid type. (a) S. nodosa, lateral view, showing weakly developed dorsal groove and slightly pebbled surface, X 200; Lake Superior, Ontario (Crow 1272, MSC). (b) S. nodosa, lateral view, showing pebbled surface, X 200; Labrador Peninsula, Quebec (St. John s.n., 17 Sept. 1915, GH). (c) S. abyssinica, oblique lateral view, showing weakly developed dorsal groove and pebbled seed surface, X 200; Mt. Kenya, Africa (Hedberg 29.4.1959, UC). (d) S. abyssinica, detailed view, showing cog-line epidermal cells with acute interdigitating teeth and granular surface, X 1000; (same as 8c).

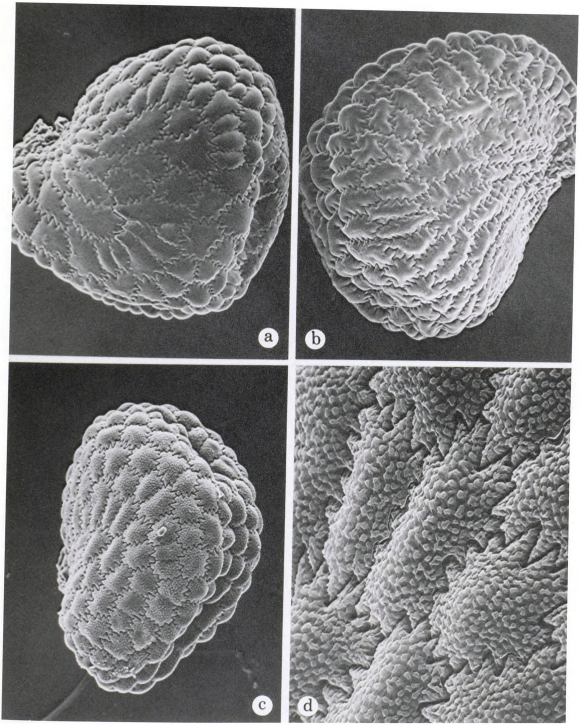


Figure 8

Figure 9. SEM photographs of Sagina seeds, crassuloid type. (a) S. maxima subsp. maxima, oblique lateral view, showing pebbled seed surface, X 200; Japan (Ichikawa 200240, upper left specimen, UC). (b) S. maxima subsp. crassicaulis, lateral view, showing smooth seed surface, X 200; Queen Charlotte Is., British Columbia (Calder and Taylor 36221, DAO). (c) S. paupuana, oblique dorsal view, showing smooth surface and lack of dorsal groove, X 200; New Guinea (Brass 30273, US). (d) S. subuletorum, lateral view, showing pebbled surface, X 200; Morocco (Font Quer s.n., 1928, UC).

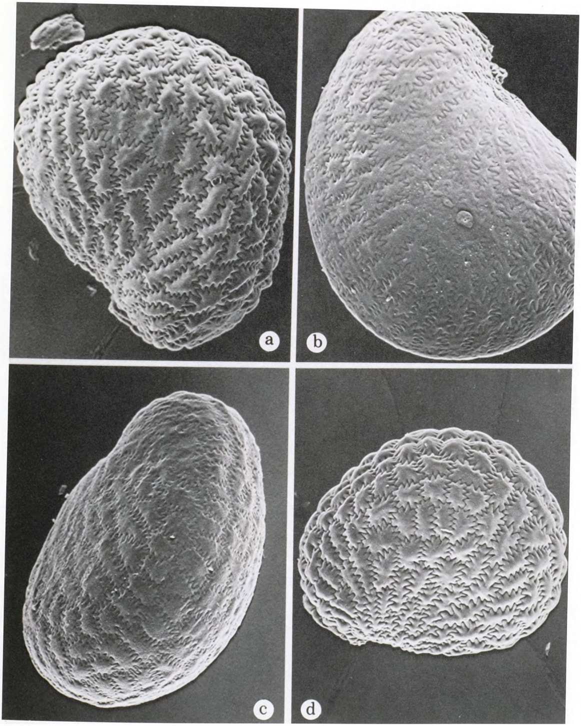


Figure 9

Figure 10. SEM photographs of <u>Sagina</u> seeds, crassuloid type. (a) <u>S. japonica</u>, lateral view, showing knobbed tuberculae, X 200; Japan (<u>Charette 1671</u>, US). (b) <u>S. japonica</u>, detailed view, showing knobbed tuberculae, X 1000 (same as 10a). (c) <u>S. japonica</u>, lateral view, showing rounded tuberculae, X 200 (<u>Ichikawa 200240</u>, lower right specimen, UC). (d) <u>S. japonica</u>, detailed view, showing rounded tuberculae, X 1000 (same as 10b).

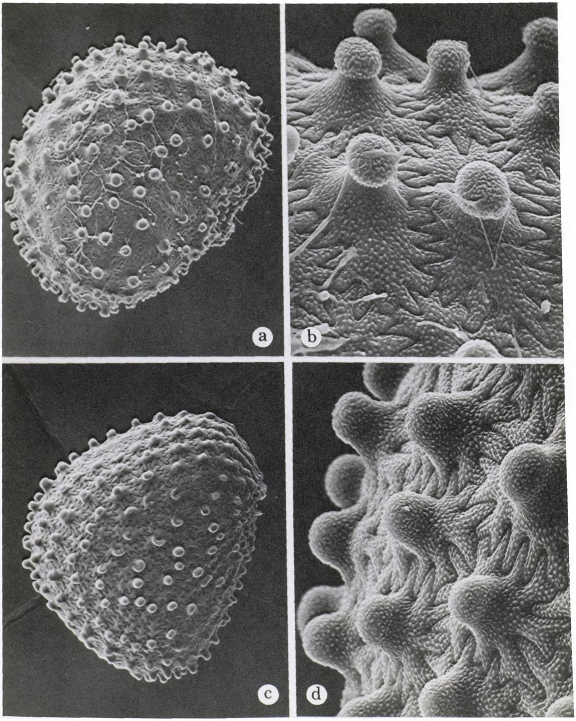


Figure 10

TAXONOMIC CONCEPTS

The species complexes of Sagina native to North America are largely allopatric. While sterility barriers are believed to be poor between taxa, isolation is effective by virtue of habitat preference and/or flowering time, combined with an inbreeding reproductive system which exhibits a trend from weakly outcrossing self-pollinating flowers to strongly inbreeding to ultimately cleistogamous flowers. Generic subdivision is based chiefly on seed morphology correlated with floral and vegetative morphology and geographical distribution. Most of the species appear to be polythetic and have been recognized on the basis of combinations of various characters. Taxa reflecting less distinction are treated at the subspecific level. These subspecies are geographically well defined and include considerable morphological variation. Integradation occurs in regions of geographical overlap. While plasticity in the American taxa is generally too great to permit meaningful varietal distinctions, the varietal rank might be appropriate to accommodate some of the diversity within certain subspecies in Europe.

CONSTANCY OF CHARACTERS

The constancy of characters expressed in the taxa of *Sagina* is important in determining the reliability of characteristics for delineating taxa. Since the taxa of *Sagina* are polythetic, presence of a particular characteristic or a combination of characters must be regarded as more reliable and indicative of a taxon than absence. The following characters are particularly noteworthy.

The saginoid-crassuloid seed type dichotomy has been found to be a very dependable character. The crassuloid seed type is considered primitive in the genus and only two species, *Sagina nodosa* and *S. abyssinica* express intermediacy in this character. The character has been especially useful in making sectional distinctions.

Leaf succulence is likewise sufficiently stable to be used as a character state for distinguishing section *Maxima* from section *Sagina*.

Presence or absence of pubescence at the base of the calyx and upper portion of the pedicel is reliable in some species. However, in *S. nodosa* and in *S. decumbens* subspp. *decumbens* and *occidentalis*, presence of pubescence is consistent neither within populations nor even on a single plant. In the North American populations of *S. caespitosa* the glandular character is sometimes only weakly expressed.

One character frequently used as distinctive in *Sagina saginoides*, *S. procumbens* and *S. subulata* is the reflexed nature of the pedicel on fruiting specimens. Actually the pedicels are recurved only during capsular development and become erect at the time of capsular dehiscence. This character is frequently not seen in herbarium specimens, but when present the character is reliable.

The character states of tetramerous versus pentamerous flower form have been regarded as very important not only in the delineation of taxa, but especially important in designating infrageneric categories. In several taxa, however, both tetramerous and pentamerous flowers may occur on a single plant. In each case, one or the other flower form will predominate, but caution must be exercised regarding the use of this as a key character. The character state of tetramerous versus pentamerous flowers is not useful at all for distinguishing the infrageneric categories recognized in this study.

FLORAL MORPHOLOGY

Inflorescence

The flowers of Sagina are borne singly and are terminal and axillary in position. Vivian (1942) has shown in an investigation of phyllotaxy in S. procumbens that this apparent floral arrangement is, in actuality, a modification of the typical caryophyllaceous cymose inflorescence, a uniparous scorpioid cyme.

Flowers

The flowers are quite small and generally inconspicuous. Both pentamerous and tetramerous flowers occur within the genus. While one type of flower may be consistent within a given taxon, several taxa frequently have both types of flowers occurring on the same plant (Figure 11a), with either the pentamerous or tetramerous flowers being predominant within the taxon. Gynodioecy has been observed in some European populations of S. procumbens, S. saginoides, S. nodosa and S. nivalis (Müller, 1883), however this state has not been observed in the North American plants. The trend in the genus is clearly toward selfing and ultimately cleistogamy.

Glandular hairs occur associated with the flowers in several taxa. The hairs are most densely concentrated at the calyx base and uppermost portion of the pedicel. They are uniseriate, arising from the epidermis and consist of 3 or 4 cells with a knobbed gland at the apex (Figure 12).

Figure 11. Photographs of flowers of Sagina nodosa.
(a) 4- and 5-merous flowers occurring on same plant.
(b) Flower showing nectariferous glands at the base of outer whorl of stamens (opposite sepals).

Figure 11

Figure 12. SEM photographs of *Sagina nodosa* pedicel showing glandular hairs (*C. A.* and *U. F. Weatherby 7090*, GH). (a) X 200. (b) X 500.

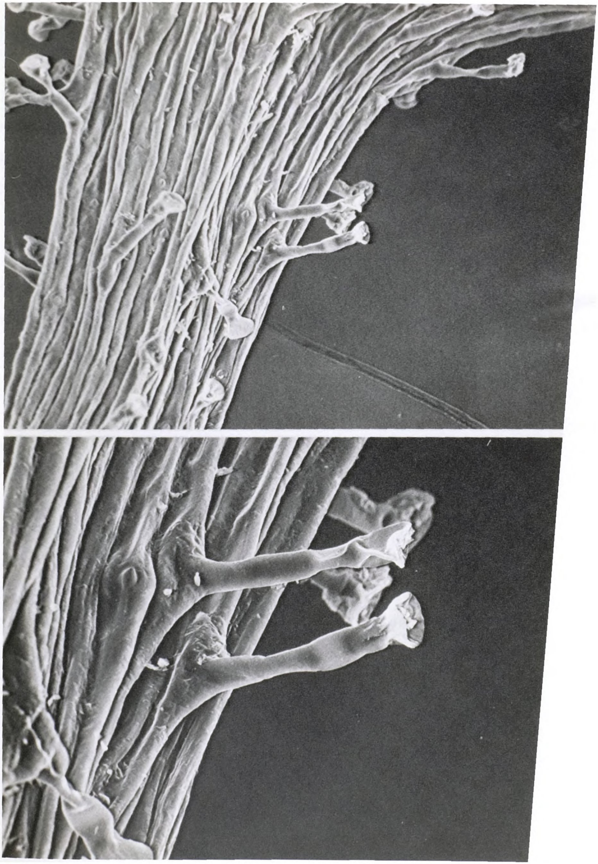


Figure 12

Calyx

The sepals are separate to the base. They are elliptical to orbicular and blunt at the apex. Rarely are the sepals acute and never is this characteristic of a given taxon. A narrow band of hyaline tissue occurs around the margins of the sepals and is generally whitish. When anthocyanins are abundant in the sepals the whole sepal may take on a purplish cast. Color more frequently is concentrated in the hyaline margin and sometimes only the tip takes on the distinctive purplish tinge. In bud the sepals are imbricate, cupped and frequently culcullate. Sepal size does not increase during capsular maturation.

Corolla

The petals alternate with the sepals, are thin, white, elliptical to orbicular in shape, have a short claw at the base and are typically blunt at the tip, but are occasionally emarginate. Development occurs late in the bud stage and in some taxa the petals remain poorly developed, vestigial or are aborted. In the annual taxa the petals are frequently caducous. In taxa where the petals are shorter than, equal to, or slightly exceeding the sepals, there is very little shrinkage and no withering. Petals which conspicuously exceed the sepals wither considerably following anthesis.

Androecium

The stamens occur in one or two whorls and are the same number as or twice that of the styles. Stamens of the outer whorl, opposite the sepals, are nectariferous at the base (Figure 11b). In cases where there is but one whorl, it is the outer, nectariferous whorl which is present. Meiosis and pollen grain maturation takes place very early in the bud stage, long before stamens take on a mature form. Anther dehiscence is longitudinal and extrorse. Individual cases of aborted stamens are not uncommon in the genus. Anther dehiscence more frequently occurs prior to floral anthesis and stamens are only very slightly exserted beyond the calyx and never exceed the stigmas. Filaments ultimately bend toward the stigmas, effecting self-pollination.

The pollen grains (Figure 13) are spherical, range between 18 μ and 36 μ in size (mean = 27.5 μ) and are periporate. The pores have a distinct annulus, are ca. 30 in number, and are evenly distributed. The tectum has indistinct perforations and is distinctly scabrate. (Terminology from Faegri and Iversen, 1964.)

Gynoecium

The ovary is 4- or 5-carpellate with formation of carpel walls arrested early in development, resulting in free-central placentation (Lister, 1884). Ovules are campylotropous. Coherent styles arise from a disc at the apex of the ovary. Elongation occurs just prior to or at anthesis, the styles separating and inner surfaces becoming papillate and stigmatic (Figure 14). Styles alternate with the sepals and are opposite the sutures of the capsules.

Figure 13. SEM photographs of *Sagina* pollen grains. (a) *S. nodosa*, X 1000 (*Crow 1291*, MSC). (b) *S. nodosa*, X 5000 (same as a). (c) *S. nivalis*, X 1000 (*Wynne-Edwards 9028*, CAN). (d) *S. nivalis*, X 5000 (same as c).

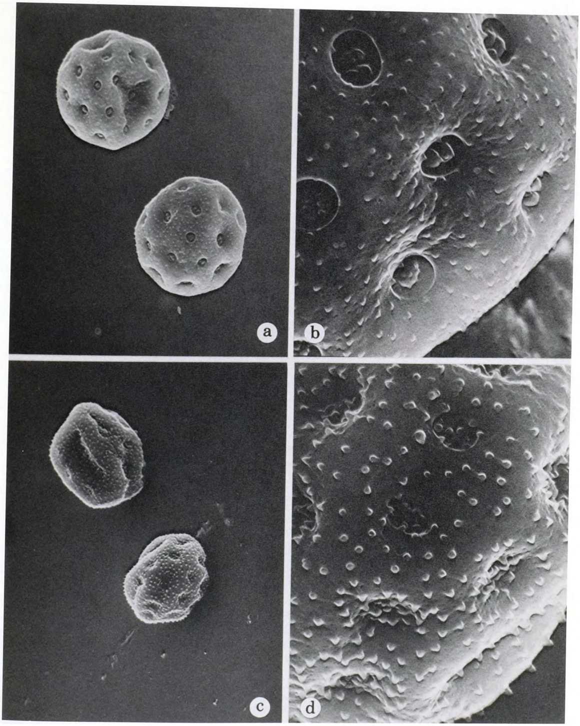


Figure 13

Figure 14. Papillate stigmas. Sagina maxima subsp. crassicaulis, Clatsop Co., Oregon (Crow 1111, MSC).

Figure 14

Fruit

The fruit is a capsule with the number of capsule valves equal to that of the styles and sepals. Sutures run from the apex to the base, dehiscence varying from one-fourth the capsule length to the entire length. The capsule remains green until late in the developmental stage, becoming tan or straw-colored upon maturity. The fruit type according to the fruit classification of Kaden and Kirpicznikov (1965) would be termed a Cerastiocarpum.

Seed

Two types of seeds occur and are diagnostic of sectional subdivisions of the genus (see section on seed morphology). The saginoid seed type is obliquely triangular, possesses a dorsal groove and has its lateral surfaces drawn inward (Figure 15a). The crassuloid seed type is more nearly reniform or globose, lacks a dorsal groove and its lateral surfaces remain full and plump (Figure 15b).

Figure 15. Seed types. (a) Saginoid, *Sagina saginoides*, Chelan Co., Washington (*Crow 1108*, MSC). (b) Crassuloid, *Sagina maxima* subsp. *crassicaulis*, Marin Co., California (*Crow 1180*, MSC). Both photographed under epi-illumination.

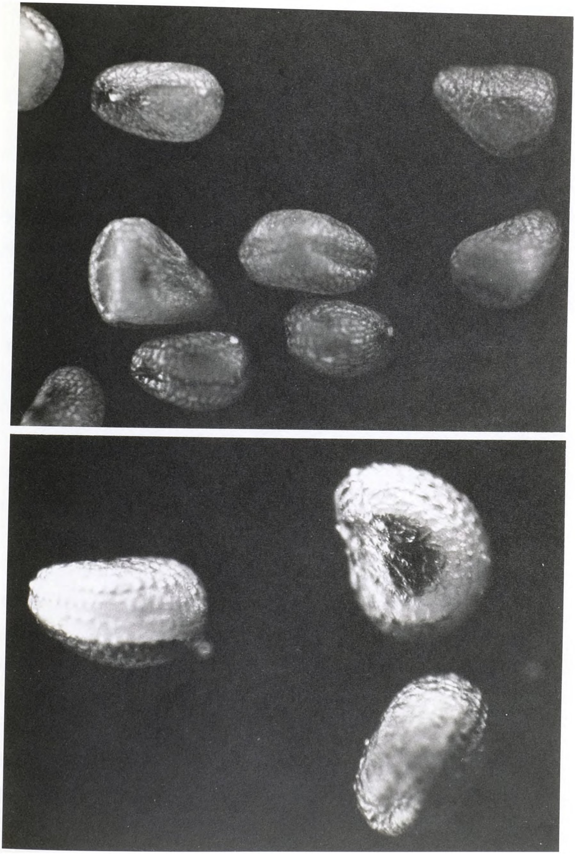


Figure 15

POLLINATION

The small, usually inconspicuous, whitish flowers of *Sagina* are all capable of self-fertilization. A trend, however, exhibiting a progression from outcrossing to selfing and culminating in cleistogamy can be observed within the genus.

The flowers in *Sagina* open under bright conditions. The stamens of the outer whorl are provided with nectaries at their bases and secrete a relatively adequate amount of nectar. Insect visitation is thus solicited, though somewhat feebly. Under dull weather conditions the flowers remain closed and self-pollination occurs.

There appears to be a strong correlation between petal size and tendency to inbreed, for those plants with the strongest tendency toward selfing and toward cleistogamy are those whose petals are reduced or lacking.

Sagina nodosa, the strongest outcrosser, is the largest flowered species, with petals being about twice the length of the sepals. The stamens occur in two whorls. The anthers of the outer, nectariferous whorl dehisce at anthesis, while the stigmatic surfaces remain unexposed. Later the stigmatic surfaces become exposed, receptive and cross-pollination is encouraged. In the end the sepals close, pushing the inner whorl of stamens, with its remaining pollen, onto the stigmas, and autogamy results (Wright, 1935).

A further step toward self-fertilization can be seen in _S. procumbens_. In this species the androecium is generally reduced to one whorl, the outer, nectariferous whorl. At anthesis the stigmas are receptive and curled toward the stamens. The filaments, in turn, are bent toward the stigmas and the anthers shed their pollen directly onto the stigmas. The nectaries are functional and a few small flies and bees have been reported as visitors (Knuth, 1908). However, the tendency is clearly toward self-pollination, for even in favorable weather the flowers frequently remain closed and effectively pollinate themselves.

In _Sagina apetala_, an annual whose petals are lacking or quickly caducous, pollination takes place quite regularly prior to the flower opening, if, indeed, the flower opens at all.

DISPERSAL

The tiny, light seeds of Sagina are well adapted to dispersal by wind. Under calm weather conditions dispersal is minimal and seeds remain in the vicinity of the parent plant. Capsule dehiscence is somewhat explosive. In species where dehiscence occurs the entire length of the sutures capsule dehiscence is somewhat explosive and seeds are scattered several inches. Raindrops appear to be an effective means of scattering seeds in those species where capsule dehiscence is less than half the length of the capsule. Brodie (1951) has observed this splash-cup dispersal mechanism in Sagina decumbens subsp. decumbens and has measured dispersal distances up to 18 inches.

Although dispersal is minimal on quiet days, when there is a high degree of air turbulence near the ground light seeds can be lifted to sufficient heights for long distance dispersal to take place (Ridley, 1930; Dahl, 1958; D. Löve, 1963). The seeds of Sagina are regarded as prime candidates for long distance dispersal (D. Löve, 1963) and are categorized as "dust diaspores" by Van der Pijl (1969).

HYBRIDIZATION IN SAGINA

For the most part the taxa of *Sagina* are inbreeders, sometimes to the extent of being cleistogamous. Although these self-pollinating taxa generally maintain their integrity, inbreeding functions as a leaky isolation barrier and there are occurrences of plants which are to some degree intermediate between taxa.

Interspecific crossability appears to be high in *Sagina* while the actual occurrence of hybridization is greatly reduced by the inbreeding system and by differing ecological preferences or blooming times.

Although crossing experiments are difficult to conduct with these small-flowered inbreeders, I was able to collect seed resulting from two interspecific crosses. These were *S. saginoides* x *S. procumbens* and *S. saginoides* x *S. apetala*. I was unable to germinate the seed resulting from either cross.

Voucher specimens (*P. M. Benoit 64*) on deposit in the herbarium of Stanford University (DS) and of the Department of Agriculture, Ottawa, Canada (DAO) document hybrids synthesized by crossing *Sagina procumbens* and *S. subulata*. The F_1 hybrids are phenotypically intermediate between the parental taxa.

Flora Europaea gives nomenclatural recognition to a long known natural hybrid between *S. procumbens* and *S. saginoides*. The hybrid,

S. x normaniana, which has been reported from the mountains of Scandinavia, Scotland and Austria, has reduced capsular development and seed set in the wild, but often produces well-developed capsules and good seed in cultivation (Clapham and Jardine, in Tutin et al., 1964).

Herbarium studies suggest that some hybridization occurs in the North American Saginas in regions where an overlap in distribution brings two taxa together.

The typically coastal, high Arctic Sagina nivalis reaches the fringes of its range along the Aleutian Islands where it sometimes occurs with populations of S. maxima subsp. maxima. Specimens occur which are phenotypically intermediate between the two taxa. Two such collections come from Umnak Island. In Johnson 930 and 1103 the specimens lean toward S. nivalis but weakly express the glandular character of S. maxima subsp. maxima.

Sagina nivalis also occurs disjunctly in high, alpine situations in Alberta, well within the normal range of the montane S. saginoides. Where both taxa occur together there are specimens which can be assigned to S. saginoides but express such characters of S. nivalis as purple sepal margins, inflated connate leaf bases, succulence of rosette leaves and an occasional 4-merous flower.

Several specimens from California appear to be intermediate between Sagina decumbens subsp. occidentalis and S. apetala, a closely related introduced European species. Although both species are strong inbreeders, it is possible that there is some interbreeding between the two. Habitat specificity and blooming time for the two taxa coincide. These specimens have both 4- and 5-merous flowers, possess petals characteristic of S. decumbens subsp. occidentalis and weakly exhibit the ciliate leaf character of S. apetala.

The ranges of Sagina maxima subsp. maxima and S. maxima subsp. crassicaulis come together on the Queen Charlotte Islands and on Vancouver Island. At these two locations there are numerous specimens which suggest introgression between the two taxa, especially in the range of pubescence on the pedicel and calyx base. Variation ranges from completely glabrous forms characteristic of subsp. crassicaulis to the very pubescent form typical of subsp. maxima. Introgression is much more complete between these two taxa as outcrossing is considerably more probable in this complex than in other complexes in the genus.

SPECIMENS EXAMINED

In this study measurements have been based on dried material using a rule with millimeter units. Measurements of seeds and stamens were made under 30X magnification.

In the citation of herbarium specimens abbreviations of institutions follow those of the fifth edition of Index Herbariorum (Lanjouw and Stafleu, 1964). The herbaria and their abbreviations are: National Museum of Canada (CAN); California Academy of Sciences (CAS); University of Colorado (COLO); Canada Department of Agriculture, Ottawa (DAO); Dudley Herbarium of Stanford University (DS); Chicago Natural History Museum (F); Gray Herbarium (GH); Jepson Herbarium of University of California (JEPS); University of Michigan (MICH); University of Minnesota (MIN); Missouri Botanical Garden (MO); University of Montana (MONTU); Michigan State University (MSC); New York Botanical Garden (NY); Oregon State University (OSC); Rocky Mountain Herbarium, University of Wyoming (RM); University of California (UC); National Museum, Smithsonian Institution (US); University of Wisconsin (WIS); Washington State University (WS); University of Washington (WTU).

The herbarium of the University of Waterloo, Waterloo, Ontario is not listed in Index Herbariorum. The abbreviation WTU is tentatively assigned to it.

TAXONOMIC TREATMENT

SAGINA Linnaeus

Sagina Linnaeus, Sp. Pl. 1: 128. 1753.

Alsinella Dillen. ex Hill, Brit. Herb. 225. 1756, in part.

Phaloe Dumortier, Fl. Belg., p. 110. 1827.

Spergella Reichenbach in Moessler, Handb. d. Gewachsk, ed. 2, 1: 65. 1827.

Low annual or perennial herbs; tufted, caespitose or matted. Stems ascending, decumbent or procumbent, horizontal stems becoming slightly woody in mat-forming species. Basal rosette or basal tuft of leaves present in perennial species, absent or early deciduous in annuals, rarely persisting. Secondary rosettes present in mat-forming species. Stems glabrous or glandular pubescent. Cauline leaves opposite, linear-filiform to subulate, scarious-connate at base; non-stipulate. Flowers small, whitish, terminal or axillary, 4- or 5-merous. Calyx base and upper pedicel glabrous or glandular pubescent. Sepals obtuse, margins scarious; veins obscure; sepals cupped and frequently cucullate in bud. Petals undivided, frequently absent or caducous in annual species. Stamens equal or twice the number of stigmas, in one or two whorls, outer whorl with nectaries at base. Styles the same number as the sepals and alternate with them, recurved at anthesis, inner surface stigmatic, papillose. Capsule many seeded (ca. 125), 4- or 5-valved, sutures running to base, valves opposite the sepals. Seeds (0.25-) 0.3 mm-0.5 (-0.6) mm long, obliquely triangular with dorsal groove or reniform to nearly globose with dorsal groove lacking, smooth, pebbled, papillate or tuberculate.

Ca. 15 species, chiefly of the cold temperate Northern Hemisphere; introduced in the Southern Hemisphere. Primary center of diversity--Eurasia; secondary center of diversity--Eastern Asia.

Type species: Sagina procumbens L., lectotype of Britton and Brown (1913); confirmed by Britton (1918), Hitchcock and Green (1929), and Phillips (1951).

Key to North American Species and Infraspecific Taxa of *Sagina*

a. Flowers with petals nearly twice the length of sepals, 3.0-4.5 mm long; leaves of upper main stem and of lateral branches subulate, 1 mm long, bearing axillary fascicles of minute, succulent leaves, giving a 'knotted' appearance . . . b

b. Stems glabrous, occasionally weakly pubescent at the nodes, pedicels and calyx bases glandular pubescent or glabrous . . . . *S. nodosa* var. *nodosa*

b. Stems, pedicels, calyx bases and frequently leaf margins glandular pubescent . . . . *S. nodosa* var. *pubescens*

a. Flowers with petals shorter than, equal to, or barely exceeding sepals, up to 2.5 mm long or absent; cauline leaves lacking axillary fascicles of minute succulent leaves . . . c

c. Flowers 5-merous; leaves succulent; seeds reniform or nearly globose, plump, lacking a dorsal groove . . . d

d. Seeds dark brown, distinctly tuberculate . . . *S. japonica*

d. Seeds reddish-brown, smooth or slightly pebbled . . . e

e. Calyx bases and upper portion of pedicel glandular pubescent . . . . *S. maxima* subsp. *maxima*

e. Plants entirely glabrous. .*S. maxima* subsp. *crassicaulis*

c. Flowers 4- or 5-merous; leaves not succulent, or if slightly succulent, then flowers predominantly 4-merous; seeds obliquely triangular, dorsal groove present . . . f

f. Plants annual; upper cauline leaves subulate, becoming shorter toward apex, lower cauline leaves linear to subulate . . . g

g. Flowers 4-merous; hyaline portion of leaf bases distinctly ciliate, especially of the upper cauline leaves; capsules equaling or barely exceeding sepals . . . . <u>S</u>. <u>apetala</u>

g. Flowers 5-merous, rarely 4-merous; leaf bases never ciliate . . . h

h. Seeds light tan, with delicate reticulate ridge pattern; surface smooth or tuberculate . . . . <u>S</u>. <u>decumbens</u> subsp. <u>decumbens</u>

h. Seeds light brown, never with reticulate ridge pattern; surface smooth to slightly pebbled . . . . <u>S</u>. <u>decumbens</u> subsp. <u>occidentalis</u>

f. Plants perennial; upper cauline leaves linear, linear-subulate or if subulate, then plants caespitose . . . i

i. Plants caespitose; stems short, cauline leaves subulate; sepal margins purple . . . j

j. Petals exceeding sepals, seldom equal, 2.5-3.0 mm long; flowers predominantly 5-merous; primary basal rosette lacking, several secondary rosettes of linear leaves often present . . . . <u>S</u>. <u>caespitosa</u>

j. Petals less than or equaling sepals, 1.5-2.0 mm long; flowers predominantly 4-merous; primary basal rosette of succulent, subulate leaves present . . . . <u>S</u>. <u>nivalis</u>

i. Plants ascending, spreading, procumbent or mat-forming, but not caespitose, or if caespitose in alpine, then leaves not subulate; leaves linear; sepal margins not purple . . . k

k. Flowers 4-merous, sometimes accompanied by 5-merous flowers; petals minute, 0.75-1.0 mm long, sometimes absent; sepals divergent at time of capsule dehiscence . . . . <u>S</u>. <u>procumbens</u>

k. Flowers 5-merous, rarely 4-merous; sepals appressed or at least loosely appressed at time of capsule dehiscence . . . l

l. Plants completely glabrous; leaf tips apiculate . . . . <u>S</u>. <u>saginoides</u>

l. Plants with leaves, stems, pedicels and calyx bases glandular pubescent; leaf tips aristate, arista long, equaling or exceeding leaf width . . . . <u>S</u>. <u>subulata</u>

TABLE 7. COMPARATIVE FEATURES OF *SAGINA* SECTIONS *SAGINA* AND *MAXIMA*

	Sect. *Sagina*	Sect. *Maxima*
Center of diversity	Eurasia	eastern Asia
Seed type	saginoid	crassuloid
Leaves	not fleshy (sometimes only slightly fleshy)	distinctly fleshy
Flowers	4- or 5-merous; morphology tends to favor inbreeding	5-merous; morphology tends to encourage outbreeding
Sepal length	1.5-2.5 (-3.0) mm	2.0-3.5 mm
Capsule length	1.5-3.0 (-4.0) mm	2.0-4.5 mm

Sagina sect. _Sagina_

Spergella (Reichb.) Koch, Syn. Fl. Germ. et Helv., p. 109. 1836, as section in _Spergula_.

Spergella (Reichb.) Koch, Syn. Fl. Germ. et Helv., ed 2, p. 117. 1843, as section in _Sagina_.

Saginella Koch, Syn. Fl. Germ. et Helv., ed. 2, p. 117. 1843, as section in _Sagina_.

Eusagina Williams, Jour. Bot. 34: 427. 1896, as subgenus.

Spergella (Reichb.) Williams, Jour. Bot. 34: 427. 1896, as subgenus.

Procumbentes Williams, Jour. Bot. 34: 427. 1896, as section.

Maritimae Williams, Jour. Bot. 34: 427. 1896, as section.

Procumbentes (Williams) Williams, Bot. Soc. & Exch. Club Br. Isl. 5: 191. 1918, as subsection.

Maritimae (Williams) Williams, Bot. Soc. & Exch. Club Br. Isl. 5: 192. 1918, as subsection.

Nodosae Moss, Cambr. Br. Fl. 3: 24. 1920, as series.

Subulatae Moss, Cambr. Br. Fl. 3: 24. 1920, as series.

Procumbentes Moss, Cambr. Br. Fl. 3: 24. 1920, as series.

Apetalae Moss, Cambr. Br. Fl. 3: 24. 1920, as series.

1. _Sagina nodosa_ (L.) Fenzl

Key to the varieties:

Stems glabrous, rarely with sparse glandular pubescence at base of nodes; pedicels and calyx bases glandular pubescent or glabrous . . . . 1a. var. _nodosa_

Stems, pedicels, calyx bases and frequently leaf margins bearing minute glandular hairs . . . . 1b. var. _pubescens_

1a. _Sagina nodosa_ (L.) Fenzl var. _nodosa_

Sagina nodosa (L.) Fenzl, Ver. Verbr. Alsin, tab. ad. p. 18. 1833. _Spergula nodosa_ L., Sp. Pl. 1: 440. 1753. _Alsine nodosa_ (L.) Crantz, Inst. 2: 408. 1766. _Phaloe nodosa_ (L.) Dumort., Fl. Belgica, p. 110. 1827. _Spergella nodosa_ (L.) Reichb., Fl. Germ. Excurs. p. 795. 1832. _Sagina nodosa_ (L.) E. Meyer, Elench. pl. boruss. p. 29. 1835. _Arenaria nodosa_ (L.) Wallr., Sched. Crit. 200, in obs. 1822. _Alsine nodosa_ (L.) Krause, in Sturms, Fl. Deutschl. 2 ed., 5: 34. 1901. Type: Not seen. "Habitat in Europae, frigidioris campis subhumidis."

Sagina nodosa f. _bulbillosa_ Polunin, Bull. Nat. Mus. Can. 92: 205. 1940. Type: _Polunin 2312_ (_Polunin 2315_ in original publication). Lake Harbour, Baffin Island. August 27, 1936. (CAN, holotype!; GH!, BM, OXF, isotypes.)

Perennial. Basal tufts of short compacted non-flowering branches bearing long linear leaves, ca. 15-30 mm long. Rosettes lacking. Main stems ascending to loosely spreading to prostrate, with none or few to many lateral branches bearing only subulate leaves, 1 mm long. Lower cauline leaves short-linear to subulate, tips apiculate to mucronate; axillary fascicles lacking. Upper cauline leaves subulate, 1.0-1.5 mm long; tips mucronate. Subulate cauline leaves of main stem and lateral branches with axillary fascicles of succulent subulate leaves, giving 'knotted' appearance. Stems glabrous or rarely weakly pubescent at nodes. Nodes frequently purplish. Pedicels glabrous or pubescent on upper portion. Flowers showy, protandrous, ca. 6-10 mm diameter, 5-merous or 5- and 4-merous. Calyx glabrous or glandular pubescent at base. Sepals elliptic, 2-3 mm long; tips frequently purplish, hyaline margins rarely purplish. Petals greatly exceeding sepals, rarely equaling or shorter than sepals; (2-) 3.0-4.5 (-5) mm long. Stamens 10 or 8, filaments 2.0-3.0 mm long, anthers 0.5 mm long. Styles long, 1.0-1.5 mm, upper half stigmatic on inner surface. Capsule valves thick, 3.0-4.0 mm long. Sepals remaining appressed after capsule dehiscence. Seeds dark brown, 0.5 mm, ovoid to reniform, a distinct notch present at hilum, dorsal groove present or absent, smooth to distinctly pebbled. Chromosome number: 2n = 44, 56. Figure 16.

Ecology and distribution: A shoreline plant becoming established in rock crevices, wet gravels and sands and in tufts of moss along rocky coasts from New England north to Newfoundland and infrequently to Baffin Island, along the St. Lawrence Seaway, on the shores of Hudson and James

Figure 16. Photographs of _Sagina nodosa_ var. _nodosa_. (a) Living specimen, Lake Superior, Ontario (_Crow 1292_). (b) Herbarium specimen, habit. Lake Superior, Ontario (_Voss 11319_, MICH).

Figure 16

Bay and Lake Superior and occasionally on lake shores westward to Lake Athabaska and Great Slave Lake. The taxon appears to be absent in the region of the Clay-belt of Ontario between James Bay and Lake Superior (Soper, 1963). Amphi-Atlantic. Flowering July and August. Figure 17.

Representative specimens: CANADA: ALBERTA: Sand Point, north shore of Lake Athabaska, 58°51'N., 110°50'W., Raup 701 (GH). Short distance east of Sand Point, north shore of Lake Athabaska, ca. 58°57'N., 110°49'W., Raup & Abbe 4484 (GH). MANITOBA: Cochran River, 58°02'N., 101°23'W., Baldwin 2118 (CAN). Muskey Island, Lake Winnipeg, Macoun s.n., 4 August 1884 (CAN). Vicinity of Churchill, 58°46'N., 94°10'W., Schofield & Crum 6896 (DS, MIN, WTU). Gillam, Churchill District, Schofield 2109 (WS). Pipestone Lake, 35 mi. north of Lake Winnipeg at entrance of Nelson River, Scoggan 3379 (CAN). York Factory, Scoggan 6165 (CAN, GH, MIN). NEW BRUNSWICK: CHARLOTTE CO.: Grand Manan Island, Churchill s.n., 5 August 1891 (GH); Whale Cove, Grand Manan Island, Weatherby & Weatherby 5581 (GH). CLOUCESTER CO.: Miscou Point, Miscou Island, Dore, Senn & Gorham 45.621 (DAO); Younghall, Fletcher 784 (CAN, DAO). RESTIBOUCHE CO.: Eel River, Chalmers s.n., September 1875 (CAN). NEWFOUNDLAND: Bonne Bay, near Winterhouse Brook, Fernald, Long & Fogg 1666 (GH, US). Cow Head, region north of St. Paul's Bay, Fernald & Wiegand 3341 (CAN). Flower Cove, Straits of Belle Isle, Fernald, Long & Dunbar 26650 (NY). Port Saunders Harbor, region of Ingornachoix Bay, Fernald & Wiegand 3343 (GH). St. Georges, region of Bay St. George, Fernald & Wiegand 3344 (F, GH). Blomidon Mts., region of Bay of Islands, Fernald & Wiegand 3342 (GH). Near Frenchman's Cove, Bay of Islands, Griscom s.n., 8 August 1920 (GH). Stephenville Crossing, Kennedy 438 (GH). Chimney Cove, Humber District, Rouleau 1320 (DAO). Daniel's Harbour, Rouleau 5115 (CAN, DAO, US). Englee, Savile 2664 (DAO). Port au Choix, Savile 3034 (DAO). St. Anthony, Cremailère Bay, Savile & Vaillancourt 2381 (DAO). Barred Island, Sornborger s.n., 20 August 1903 (CAN, GH). Fogo Island, Sornborger s.n., 7 August 1903 (CAS, GH, NY, US). Bard Harbor, St. John Bay, Wiegand, Gilbert & Hotchkiss 28159 (GH). NOVA SCOTIA: GUYSBOROUGH CO.: Canso, Fowler s.n., 7 August 1901 (US); Marie Joseph, Smith, Erskine, Collins & Schofield 611 (DAO). HALIFAX CO.: Halibut Cove, near Halifax, Dore, Senn & Gorham 45.513 (DAO). QUEENS CO.: Port Mouton, Graves, Long & Linder 21198 (GH). SHELBURN CO.: Villagedale, Fernald, Long & Linder 21197 (GH). NORTH-WEST TERRITORIES: DISTRICT OF FRANKLIN: Lake Harbour, Baffin Island, Polunin 2312 (CAN, GH). DISTRICT OF KEEWATIN: Coral Harbour, Southampton Island, 64°13'N., Beckett 404 (MIN). Baker Lake, south shore, ca. 64°07'N, 97°W., Porsild 6119 (CAN, US). DISTRICT OF MACKENZIE: Indian Lake, 64°17'N., 115°12W., Cody & McCanse 3395 (DAO). Norman Wells, Cody & Gutteridge 7469 (CAS, DAO, F, MICH, MIN, NY, US). Mackenzie River, opposite Ft. Simpson, Crickmay 39 (CAN). McTavish Arm, Great Bear Lake, ca.66°20'N., 119°30'W., Porsild & Porsild 5175 (CAN). Fairchild Pt., Great Slave Lake, 62°43'N., 109°10'W., Raup 705 (GH). Vicinity of Old Fort Reliance, Great Slave Lake, 62°47'N., 108°55'W., Raup 704 (GH). ONTARIO: Lake River, James Bay, 54°20'N., Dutilly & Lepage 16784 (CAN, GH). Severn River, Macoun 4912 (CAN). Between Limestone and White Seal Rapids, Severn River, Moir 1196

(CAN, MIN). Vicinity of mouth of the Severn River, Moir 1359 (CAN, MIN). Severn River at mouth of the Beaver River, Moir 266 (MIN). ALGOMA DISTRICT: Vrooman Island, in Lake Superior, Cowell 25 (DAO); vicinity of Michipicoten Harbor, Brulé Bay, Hosie, Harrison & Hughes 300 (DAO); 3 mi. southwest of Mica Bay, Lake Superior, Parmelee & Savile 3674 (DAO); peninsula on south side of Montreal River at Lake Superior, Parmelee & Savile 3588 (DAO); Lake Superior shore, north of Pte-auk-Mines, Soper & Purchase 9388 (CAN, MICH); Pancake Pt., Lake Superior, Taylor, Hosie, Fitzpatrick, Losee & Leslie 910 (CAN, GH); Old Woman Bay, Lake Superior, ca. 16 mi. southwest of Wawa, Voss 11319 (MICH). THUNDER BAY DISTRICT: Rossport, Lake Superior, Crow 1297 (MSC); Marin Island, Pigeon Bay, Lake Superior, Garton 1917 (DAO, GH, MIN, NY, RM); small islet opposite Black's Wharf, 20 mi. southwest of Nipigon, Lake Superior, Garton 6167 (DAO, MICH); Slate Islands, Lake Superior, Hosie, Losee & Bannan 589 (CAN, GH, UC); Michipicotin Island, Lake Superior, Macoun s.n., 24 July 1869 (CAN); 2 mi. west of Terrace Bay, Parmelee & Savile 3642 (DAO); Porphyry Island, Lake Superior, Taylor, Losee & Bannan 479 (GH); shore of Lake Superior at Heron Bay, ca. 6 mi. southeast of Marathon, Voss 10441 (MICH). PRINCE EDWARD ISLAND: KINGS CO.: between South Lake and the Gulf, near Bothwell, Fernald, Long & St. John 7446 (CAN, GH, NY, US). PRINCE CO.: Lower Sea Cow Pond, Fernald, Long & St. John 7443 (CAN, GH, WS). QUEENS CO.: Campbells Pond, Churchill s.n., 6 August 1901 (DAO, GH); Tracadie, Macoun s.n., 11 July 1888 (CAN); Dalvay, National Park, Erskine 1532 (DAO, NY). QUEBEC: Great Whale River, near mouth, east coast of Hudson Bay, Abbe & Abbe 3929 (CAN, MIN, US). Beaver River, east coast of James Bay, 53°25'N., 78°57'W., Dutilly & Lepage 32833 (DAO). Fort George, east coast of James Bay, 53°53'N., Dutilly & Lepage 12706 (GH). Koksoak River, Ungava basin, 57°40'-58°05'N., 68°25'-69°35'W., Dutilly & Lepage 14731 (GH). Near Lake Otelnuc, 56°01'N., 68°09'W., Dutilly & Lepage 39233 (DAO). ANTICOSTI ISLAND CO.: Cape Henry, Adams s.n., 6 August 1936 (DAO); West Point, Adams s.n., 31 July 1935 (DAO); Riv.-aux-Canards, Marie-Victorin 4209 (US); Salt Lake, Macoun 24033 (NY). BONAVENTURE CO.: Bonaventure River, Churchill 379 (MO); Carleton Point, Carleton, Collins & Fernald 66025 (CAN, GH, MICH, NY, US); Bonaventure, Ernest & LeBlanc 61-133 (DAO). GASPÉ-EST CO.: Grand Vallés, Clausen & Trapido 3054 (MIN, US); Grand Vallé River, Macoun s.n., 3 August 1882 (CAN); Bay of Gaspé, Riviere York, Marie-Victorin, Brunel, Rolland-Germain & Rousseau 17726 (GH). GASPÉ-OUEST CO.: Ste-Anne-des-Monts, Collins & Fernald 75 (CAN, GH, MIN, MSC, NY, UC, US); Manche d'Epee, Kelsey & Jordan 67 (CAN, GH). MAGDALEN ISLANDS CO.: Alright Island, Fernald, Long & St. John 7445 (CAN, GH, NY, US); Grindstone, Grindstone Island, Fernald, Long & St. John 7444 (GH); Ile du Hâvre-aux-Maisons, Marie-Victorin & Rolland-Germain 9875 (GH, NY, US, WS). MATANE CO.: Matane, mouth of Matane River, Forbes s.n., 3 August 1904 (CAN, GH); Riviere Blanche, on shore of St. Lawrence River, Forbes s.n. 3 August 1904 (NY). RIMOUSKI CO.: Cape Enragé, Bic, Fernald & Collins 1019 (GH); Pointe-au-Père, Raymond & Kucyniak 1665 (DAO); sud de la baie Orignal, Bic, Rousseau 26 953 (US). RIVIERE-DE-LOUP CO.: bank of St. Lawrence River, Cacouna, Fernald s.n., 8 August 1902 (GH, MIN); Trois-Pistoles, Mulligan & Beales 3209 (DAO).

SAGUENAY CO.: Middle island of St. Mary's Arch, north shore of Gulf of St. Lawrence, 59°38'W., Abbe 1152 (GH); Wolf Bay, Lewis 131997 (CAN); Natashquan, Marie-Victorin & Rolland-Germain 28 544 (CAN, CAS, GH, WIS); Seven Islands, Robinson 674 (CAN, GH, NY); Ile St. Génévième, Mingan Island, St. John 90418 (CAN). SASKATCHEWAN: South shore of Lake Athabaska, west of McFarlane River, vicinity of Yakow Lake, 59°12'N, 108°01'W, Argus 711-62 (DAO). Small island at base of Charlot Pt., Lake Athabaska, ca. 59°36'N., 109°13'W., Raup 6379 (CAN, DAO, GH, NY).

UNITED STATES: MAINE: YORK CO.: Kennebunk, J. W. C., Jr. [Chickering] s.n., 25 July 1877 (UC). WASHINGTON CO.: Cutler, Fernald s.n., 28 August 1902 (GH); Rogue Bluff, Knowlton s.n., 31 July 1916 (MO). MICHIGAN: KEWEENAW CO.: Rock Harbor, Isle Royale, Cooper 65 (MIN, US); Passage Island, Isle Royale, McFarlin 2449 (MICH); Grand Marais, Hermann 769 (MICH). MINNESOTA: COOK CO.: Clark Bay, Pigeon Point, Butters, Abbe & Abbe 385 (F, MIN, US); north shore of Morison Bay, Pigeon Point, Butters & Burns 738 (MIN); Suzie Island, Pigeon Point, Butters s.n., 2 September 1927 (MIN); island at entrance to Clark's Bay, Grand Portage, Rosendahl & Butters 6253 (MIN, UC). NEW HAMPSHIRE: ROCKINGHAM CO.: Isle of Shoals, Oakes & Robbins s.n., date unknown (NY).

Sagina nodosa is the most clearly defined species of the genus and its floral morphology apparently most nearly represents that of the ancestral type. Affinities of this species with the rest of the genus are discussed in the section on divergence.

The glandular and glabrous forms in var. nodosa are not separable as distinct taxa. Both forms are frequent throughout the greater portion of the geographical range and are not uncommonly found within a single population. The glandular form is slightly predominant and populations occurring in the interior region of Canada are almost entirely of the glandular type.

In populations along the shores of Lake Superior the pubescent forms sometimes occur with glandular hairs sparsely distributed on the stems, chiefly or solely at the base of the nodes, as well as on the pedicels and calyx.

Polunin (1940) described a form from Baffin Island, f. bulbillosa, which occurs totally without flowers and forms bulbils in the axils of the cauline leaves. The disarticulation of the tiny fascicles of leaves in late autumn is a normal mechanism of vegetative dispersal which reaches its greatest efficiency in the higher latitudes. The mechanism is not restricted to sterile plants and nomenclatural recognition of this condition is meaningless.

It appears that a typographical error was made in the citation of the holotype of Sagina nodosa f. bulbillosa in the original publication. The type specimen designated was Polunin 2315, but no specimen bearing this collection number can be found at the National Museum of Canada, depository designated for the holotype, or at the Gray Herbarium, depository designated for an isotype. The only specimens at either institution collected on Baffin Island bear the collection number Polunin 3212. The label data for these two sheets are identical to

Figure 17. Geographic distribution of *Sagina nodosa* var. *nodosa* in North America.

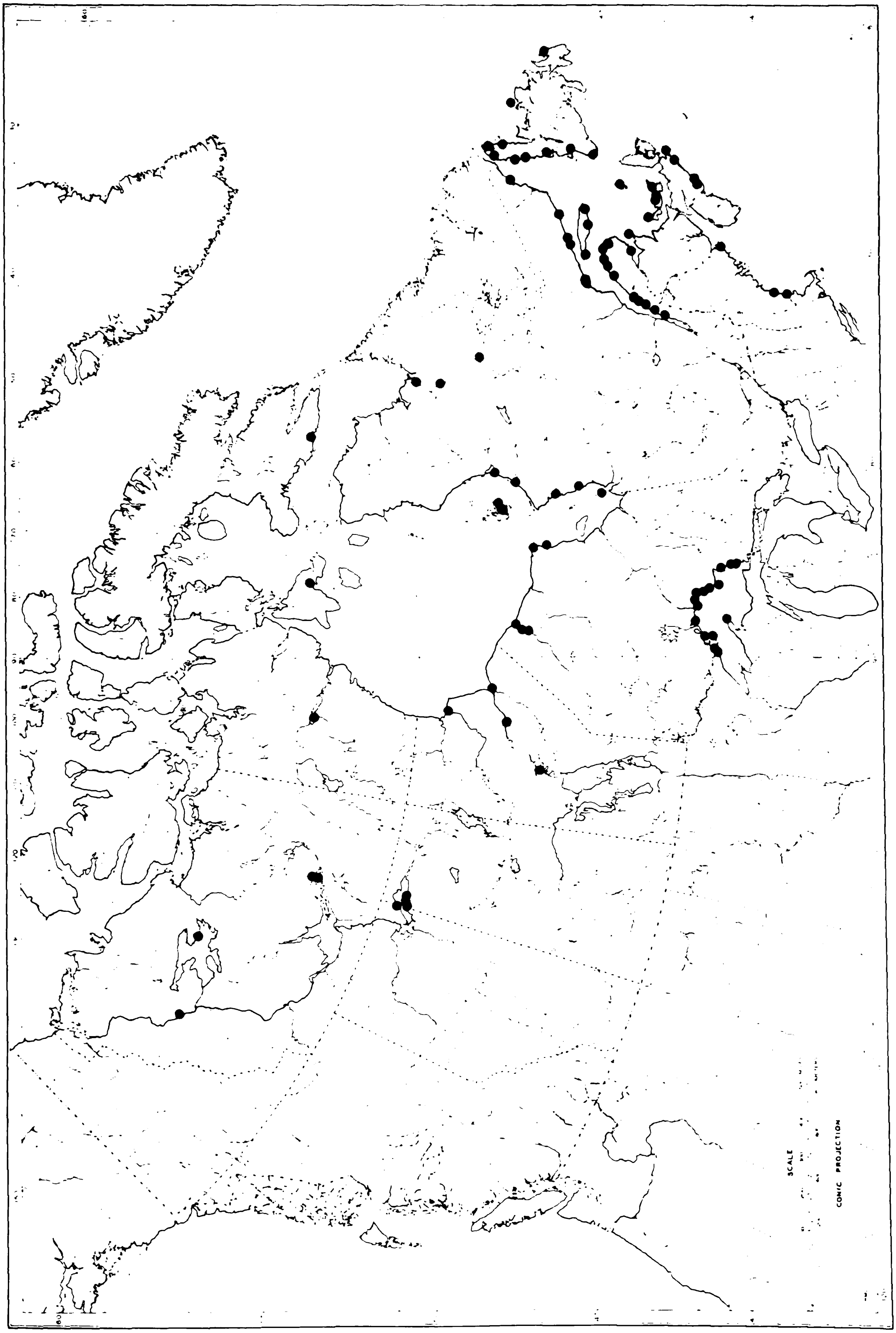


Figure 17

the data published for the type with the exception of the last digit of the collection number.

1b. Sagina nodosa var. pubescens (Bess.) Koch

Sagina nodosa var. pubescens (Bess.) Koch, Syn. Fl. Germ. et Helv. p. 117. 1843. Spergula glandulosa Bess., Prim. Fl. Galic. 1: 298. 1809. Spergula nodosa var. pubescens (Bess.) Mert. & Koch, Deutschl. Fl. p. 362. 1831. Spergella nodosa var. glandulosa (Bess.) Reichb., Fl. Germ. Excurs. p. 795. 1832. Sagina nodosa var. glandulosa (Bess.) Asherson, Fl. Brandenb. p. 97. 1860. Spergella glandulifera (Bess.) Shur, Enum. Pl. Transs. p. 109. 1866. Type: not seen. Original material: In sandy sites in wet meadows of hills. Lvov, Ukraine, U.S.S.R.

Perennial. Basal tufts of short compacted non-flowering branches bearing long linear leaves. Basal leaves ca. 15-30 mm long, usually bearing glandular hairs, especially on margins, sometimes glabrous. Rosettes lacking. Main stems ascending to loosely spreading to prostrate, with none or few to many lateral branches bearing only subulate leaves, 1 mm long. Lower cauline leaves short-linear to subulate, tips apiculate to mucronate; axillary fascicles lacking. Upper cauline leaves subulate, 1.0-1.5 mm long, tips mucronate. Subulate cauline leaves of main stem and lateral branches with axillary fascicles of succulent subulate leaves, giving 'knotted' appearance. Stems pubescent. Nodes frequently purplish. Pedicels pubescent on upper portion. Flowers showy, protandrous, ca. 6-10 mm in diameter, 5-merous or 5- and 4-merous. Calyx glandular pubescent at base. Sepals elliptic, 2-3 mm long, tips frequently purplish, hyaline margins rarely purplish. Petals greatly exceeding sepals, rarely equaling or shorter than sepals, (2-) 3.0-4.5 (-5) mm long. Stamens 10 or 8 filaments 2.0-3.0 mm long, anthers 0.5 mm long. Styles long, 1.0-1.5 mm, upper half stigmatic on inner surface. Capsule valves thick, 3.0-4.0 mm long. Sepals remaining appressed after capsule dehiscence. Seeds dark brown, smooth to distinctly pebbled, ovoid to reniform, a distinct notch present at hilum, dorsal groove present or absent, 0.5 mm long.

Ecology and distribution: Restricted to coasts, growing in moist crevices of rocks along seashore and on sea cliffs and in wet sand flats at river mouths. From Massachusetts to Nova Scotia, rare on Newfoundland and reported once from Anticosti Island and the Mingan Islands. Probably introduced. Eurasia. Flowering July and August. Figure 18.

Representative specimens. CANADA: NEW BRUNSWICK: CHARLOTTE CO.: Grand Manan, Churchill s.n., 5 August 1891 (F, MO); headland of New River beach, about 40 mi. east of St. Andrews, Klugh 579/29 (CAN); Herring Cove, Campobello Island, Malte 944/29 (CAN); Campobello Island, Smith s.n., 17 July-20 August 1888 (US); east side of Whale Cove, Grand Manan Island, Weatherby & Weatherby 5607 (US); west side of Whale Cove, Grand Manan Island, Weatherby & Weatherby 5484 (CAN, US). NEWFOUNDLAND: St. Georges, Bay St. George, Fernald & Wiegand 3344 (NY, US). New World Island, southern shore Notre Dame Bay, Fernald & Wiegand 5380 (GH).

Tilt Cove, northern shore Notre Dame Bay, Fernald & Wiegand 5381 (CAN, GH, NY). NOVA SCOTIA: ANAPOLIS CO.: Victoria Beach, Adams s.n., 31 July 1937 (DAO). DIGBY CO.: Culloden, Adams s.n., 28 August 1936 (DAO); Digby Neck, Bay of Fundy shore, Cox s.n., 28 July 1919 (DAO); Digby, Knight s.n., August 1879 (NY); Prim Point, near Digby, Harrison & Harrison s.n., 8 August 1913 (GH); Prim Point, Digby, Macoun 80870 (F); Brier Island, Smith, Roland, Collins, Erskine & Schofield 13 (DAO). HALIFAX CO.: West Lawrencetown, Bell & Erskine s.n., 21 July 1949 (DAO). QUEENE CO.: near mouth of Broad River, Fernald & Bissell 21195 (CAN, GH); central Port Mouton, Graves, Long & Linder 21198 (CAN, NY, US); Port Mouton, Roland s.n., 21 July 1938 (WIS). SHELBURN CO.: Round Bay, Prince & Atwood 1295 (WIS); southeast of Jones Harbour, East Sable, Smith, Clattenburg, Quinten & Chase 19667 (DAO). QUEBEC: ANTICOSTI ISLAND CO.: Salt Lake, Macoun s.n., 10 August 1883 (NY); peat bog at Salt Lake, Macoun 24033 (CAN, US). MATANE CO.: 15 mi. east of Mont Joli, Bassett & Crompton 4321 (DAO). SAGUENAY CO.: Ile à Charre, Mingan Islands, St. John 90417 (GH); Ile St. Généviève, Mingan Islands, St. John 90418 (GH).

ILES ST. PIERRE ET MIQUELON (France): Isthme de Langlade, Arsène 249 (GH).

UNITED STATES: MAINE: CUMBERLAND CO.: Western Brown Cow, Casco Bay, Chamberlain & Norton 1116 (US); Bailey's Island, Harpswell, Cushman 3968 (MIN). HANCOCK CO.: Seal Harbor, Mount Desert Island, Rand s.n., 21 July 1903 (UC). KNOX CO.: Matinicus Island, McAttee s.n., 4 November 1915 (US). LINCOLN CO.: Thrumcap Island, off Boothbay, Churchill s.n., 10 July 1903 (MIN, MO); Thread-of-Life Ledges, Bristol, Fassett 10375 (F, WIS); White Island, Fassett 2428 (WIS); Southport Fernald s.n., 4 August 1894 (GH, MIN); Pemaquid Pt., Hodgdon 5728 (DAO); Monhegan Island, Jenney, Churchill & Hill s.n., 2 July 1919 (MIN, MO). WASHINGTON CO.: Joe Dyer's Point, Baldwin Head, Walder 4054 (US). YORK CO.: York, Bicknell 4154 (NY); Cape Elizabeth, Blake s.n., 25 August 1857 (F, NY); York, Blake s.n., 10 August 1881 (DS, NY); Kennebunk, Chickering s.n., August 1875 (DS, US); Biddeford Pool, Clark s.n., 3 September 1955 (US); Cape Elizabeth, Fernald s.n., 23 July 1889 (F); Kennebunkport, Morong s.n., August 1878 (F). MASSACHUSETTS: ESSEX CO.: Manchester, Chamberlain s.n., date unknown, (NY); Cape Ann, 1 mi. north of Rockport, Churchill s.n., 8 July 1877 (GH); Rockport, Forbes s.n., 3 July 1904 (RM, UC); Rockport, Thatcher 9 (MIN); Glouchester, near, Long Beach, Williams s.n., 14 August 1898 (GH). NEW HAMPSHIRE: ROCKINGHAM CO.: Isle of Shoals, Canby s.n., August 1866 (UC, WS); Isle of Shoals, Oakes & Robbins s.n., date unknown (GH, NY, US).

In addition to the characteristic stem pubescence and frequent leaf pubescence of var. pubescens there is a tendency in this taxon for basal leaves to appear more ridged and the midveins more prominent in herbarium material. The wrinkled texture of these leaves suggests they are slightly more succulent than those of var. nodosa.

Some variation occurs in the amount and distribution of pubescence on the leaf surface in var. pubescens. In plants with a lesser amount of pubescence the glandular hairs are restricted chiefly to the

Figure 18. Geographic distribution of *Sagina nodosa* var. *pubescens* in North America.

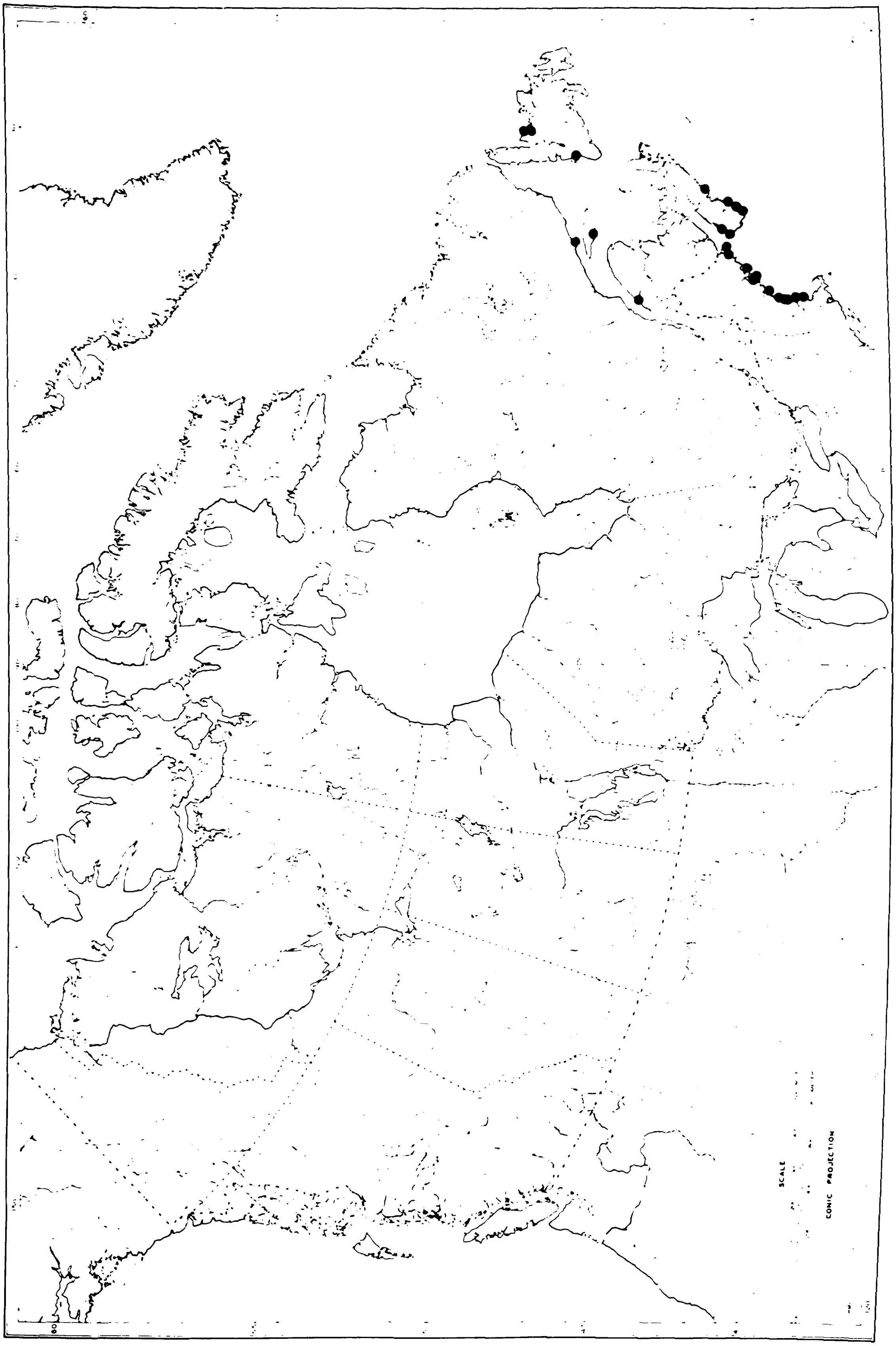


Figure 18

leaf margins. In more pubescent plants the trichomes are more frequent along the veins on the abaxial surface. The leaves may be glabrous.

Variety pubescens appears to be introduced in North America and is most firmly established along the Atlantic Coast at Digby, Nova Scotia and Franklin Co., Maine. There is little overlap with var. nodosa, which is rare south of Quebec Province. However, intergrades between the two taxa are apparent where populations of both taxa occur together.

2. Sagina saginoides (L.) Karst.

Sagina saginoides (L.) Karst., Deutsch. Fl. p. 539. 1880-1883. Spergula saginoides L., Sp. Pl. 1: 441. 1753. Alsine saginoides (L.) Crantz, Inst. 2: 408. 1766. Phaloe saginoides (L.) Dumort., Fl. Belgica, p. 110. 1827. Sagina Linnaei Presl, Rel. Haenk 2: 14. 1831. Nom. illeg. Spergella saginoides (L.) Reichb., Fl. Germ. Excurs., p. 794. 1832. Sagina spergella (L.) Fenzl, Ver. Verbr. Alsin., tab. ad. p. 18. 1833. Nom. illeg. Sagina saginoides (L.) Dalla Torre, Anteit. Beob. Alpenfl. p. 75 in Hartinger, Atlas der Alpenfl. 1882. Alsinella saginoides (L.) Greene, Fl. Fran. p. 125. 1891. Sagina saginoides (L.) Britton, Mem. Torrey Bot. Club 5: 151. 1894. Alsine Linnaei (Presl) Krause, in Sturms, Fl. Deutschl. 2 ed., 5: 35. 1901. Nom. illeg. Type: not seen. "Habitat in Gallia."

Sagina saginoides var. hesperia Fern., Rhodora 27: 131. 1925. Type: Crandall 89, 9500 ft., Chambers Lake, Colorado. (GH, holotype!)

Spergula saxatilis Wimm., Fl. Schles. p. 193. 1832. Sagina saxatilis (Wimm.) Wimm. Fl. Schles. p. 75. 1841. Spergella saxatilis (Wimm.) Schur, Enum. Pl. Transs. p. 109. 1866. Type: not seen. Original material: grass-covered rocky sites in mountains, near Waldenburg and Einsiedel, Silesia (Germany).

Spergella macrocarpa Reichb., Ic. Fl. Germ. 5: 26. 1841-1844. Sagina macrocarpa (Reichb.) Maly, Enum. Pl. Phan. p. 292. 1848. Sagina Linnaei var. macrocarpa (Reichb.) Beck, Fl. Nied.-Öst. p. 358. 1890. Nom. illeg. Sagina saginoides var. macrocarpa (Reichb.) Moss, in Jour. Bot. 52: 60. 1914. Type: Icones 4963.b. (W. lectotype.)

Sagina Baumgarteni Simonkai, Enum. F. Transs. p. 134. 1886. Type: not seen.

Perennial. Plants tufted, branches ascending or sometimes procumbent, becoming caespitose in alpine habitats. Entire plant glabrous. Rosettes of linear leaves frequently present, 9-45 mm in diameter, or replaced by a tuft of ascending linear leaves. Cauline leaves linear, sometimes linear-subulate in caespitose plants. Connate leaf bases not conspicuous, rarely appearing inflated and then so only in caespitose plants. Axillary fascicles of linear leaves frequently on procumbent stems. Flowers axillary or terminal. Pedicels generally long, filiform, mean length 14.5 mm, recurved during capsular development, becoming erect at maturity. Flowers 5-merous, very rarely 4-merous. Sepals elliptical, hyaline margins white, rarely purple in alpine specimens, 2.0-2.5 mm long. Stamens 10, or less frequently 5, filaments (1.0-) 1.5 mm long, anthers 0.25 mm long. Capsules 1.5-2 times the length of the sepals; capsule valves thin, 2.5-3.0 (-3.5) mm long, dehiscing to base. Sepals remaining appressed following capsule dehiscence. Seeds brown, obliquely triangular, with distinct dorsal groove, surface smooth to slightly pebbled, 0.3-0.4 mm long. Chromosome number: $2n = 22$. Figure 19.

Ecology and distribution: A montane species growing in the open or in light shade in wet places on lake margins, along streams and seepages in rock ledges and roadcuts, often in subalpine and alpine zones. From Alaska, south to Arizona and New Mexico. Its occurrence is rare in eastern North America. I have seen collections only from Richmond Gulf on Hudson Bay, the Shefferville area of the Labrador-Quebec Peninsula and on the Gaspé Peninsula, Quebec. Circumpolar. Flowering June to August. Figure 20.

Representative specimens: CANADA: ALBERTA: Bertha Lake, Waterton Lakes National Park, elev. 6000 ft., Breitung 16239 (NY). Near Cameron Lake, Waterton Lakes National Park, elev. 5450 ft., Breitung 16178a (NY). Malique Lake, near headwaters of the Saskatchewan and Athabasca Rivers, Brown 1176 (GH, MO, NY). Little Beehive Mt., vicinity of Lake Louise, Hunnewell 3529 (MIN). About 5 mi, east northeast of Bow Peak, Banff National Park, Hitchcock & Martin 7756 (COLO, DS, GH, MO, NY, OSC, RM, UC, WS, WTU). Crow's Nest Forest Reserve, Malte s.n., 10-24 August 1915 (CAN). Crow's Nest Pass, summit of Turtle Mt., Macoun 18290 (CAN). Mt. Edith Cavell, Jasper National Park, Scamman 3189 (GH). BRITISH COLUMBIA: Asulkan Valley, Glacier, Selkirk Mts., Brown 581 (GH, MO, US). About 8 mi. southeast of Barkerville,

Figure 19. Photographs of <u>Sagina saginoides</u>. (a) Habit. (b) Close-up of fruiting material.

Figure 19

elev. 5500 ft., Calder, Savile & Ferguson 14237 (DAO). North of Ft. St. James, Wolverine Lake, 55°41'N., 124°26'W., Calder, Savile & Ferguson 13645 (DAO). Between Baldy Mt. and Dunn Peak, ca. 7 1/2 mi. east northeast of Littlefort, ca. 51°27'N., 120°03'W., elev. 7100 ft., Calder, Parmelee & Taylor 19908 (DAO, UC). 8 mi. southeast of Nelson along road to Copper Mt., elev. 5400-5700 ft., Calder & Savile 10993 (DAO). Mt. Apex, southwest of Penticton, elev. 6800 ft., Calder & Savile 11731 (DAO). Mt. Thornhill, near Terrace, elev. 3800 ft., Calder, Savile & Ferguson 14871 (DAO). Mt. Sir Donald, Glacier, Fletcher 5 (NY). Selkirk Range, vicinity of Glacier, Hunnewell 4251 (MIN). Near Rogers Pass, Selkirk Mts., Heacock 4400 (GH, MIN, MO, NY, US). Victoria Lake, ca. 11 mi. west of Revelstoke, elev. 1785 ft., Hitchcock & Martin 7592 (DS, WTU). Battle Mt., Wells Gray Park, 50°N., 120°W., Ahti & Ahti 7003 (WTU). Chilliwack River, Macoun 34034 (CAN). Lake House, Skagit River, Macoun 79583 (CAN, NY). Upper Canyon Creek, Golden, Taylor 6727 (MICH). Sheep Mt., Elk River Valley, 34 mi. north of Natal, Weber 2347 (COLO, GH, UC, WS). VANCOUVER ISLAND: Below Mt. Burman, near Burman Lake, 49°37'N., 125°44'W., elev. 5000 ft., Calder & MacKay 32567 (DAO). Along Elk River, Strathcona Provincial Park, 49°46'N., 125°51'W., elev. 2800 ft., Calder & MacKay 31643 (DAO). Moat Lake, Forbidden Plateau, ca. 49°41'N., 125°24'W., elev. 4100 ft., Calder & MacKay 32280A (DAO). Mt. Arrowsmith, Anderson & Fletcher s.n., 7 August 1901 (DAO). Vicinity of Victoria, Macoun s.n., 23 May 1893 (MSC). DISTRICT OF MACKENZIE: Vicinity of Brintnell Lake, ca. 62°05'N., 127°35'W., Raup & Soper 9159 (GH). YUKON TERRITORY: Canol Rd., upper south fork of MacMillan River, opposite mile 280, Porsild & Breitung

11300 (CAN). Canol Rd., Rose-Lapie River Pass, mile 98-99, elev. 4000 ft., Porsild & Breitung 11900 (GH, UC, US). Canol Rd., slopes of Mt. Sheldon, opposite mile 222, elev. 6000 ft., Porsild & Breitung 11742 (CAN). Vicinity of Mackintosh, mile 1022 Alaska Highway, slopes of Mt. Decoeli, elev. 4000 ft., Schofield & Crum 8049 (CAN). QUEBEC: Fishing Lake Creek, Richmond Gulf, east coast of Hudson Bay, ca. 56°N., 76°W., Abbe, Abbe & Marr 4396 (CAN, DAO, MIN, US). Knob Lake, Schefferville area, Quebec-Labrador Peninsula, ca. 54°45'N., 66°40'W., Hustich & Kallio 752 (CAN). GASPÉ CO.: Mt. Albert, elev. 950 m, Collins & Fernald 74 (CAN, GH, MIN, MSC, NY, UC); 1 mi. above Marten River, River Ste-Anne-des-Monts, Collins & Fernald s.n., 3-17 August 1905 (GH).

UNITED STATES: ALASKA: Thompson Pass, Richardson Highway, Anderson 2777 (CAN). Unalaska, Anderson 4117 (GH). Falls Creek Mine, near Kenai Lake, Kenai Peninsula, 60°26'N., 149°17'W., Calder 6088 (CAS, DAO). Head of Resurrection Bay, Seward, Kenai Peninsula, 60°07'N., 149°25'W., Calder 7018 (DAO). Isabel Pass, mile 199 Richardson Highway, 63°32'N., 145°52'W., Cody & Webster 5824 (DAO). Tangle Lakes area, mountain east of Landmark Gap, Alaska Range, Gjaerevoll 1293 (CAN). Smith's Dry Lake, Attu Island, Aleutian Islands, Hardy 385 (GH). Juneau Ice Field, Heusser 212 (OSC). Mountains southeast of Texas Lake, 20 mi. northwest of Hyder, elev. 4600 ft., McCabe 8428 (UC). About 15 mi. due east of Berners Bay at Vaughan Lewis glacier, 25 mi. north of Juneau, Alaska, elev. 2800 ft., Miller 1745 (MSC). Peaceful Valley, Attu Island, Aleutian Islands, Soule 185 (WTU). Along Salmon River road 3 mi. north of Hyder, Whited 1208 1/2 (MO, WS). ARIZONA:

COCONINO CO.: San Francisco Mts., elev. 11500 ft., Knowlton 134 (US); Kaibab Basin, elev. 8200 ft., Merkle 586 (CAS); Little Park, North Rim Grand Canyon, elev. 8800 Ft., Merkle 601 (CAS). CALIFORNIA: ALPINE CO.: Carson Pass, elev. 8200 ft., Jepson 8116 (UC); 2 mi. west of Ebbet's Pass, elev. 8500 ft., Tracy 16642 (UC). AMADOR CO.: Silver Lake, elev. 8000 ft., Newell s.n., 24 August 1929 (CAS). BUTTE CO.: along Butte Creek, vicinity of Jonesville, Copeland s.n., 18 July 1931 (MIN, RM); Butte Meadows, Heller 14688 (DS, MO, US). CALAVERAS CO.: Big Meadows, Stanislaus National Forest, Crow 1175 (MSC); Dorrington, Jepson 10201 (UC). DEL NORTE CO.: High Prairie Creek, Jepson 9346 (JEPS). FRESNO CO.: Pine Ridge, elev. 5300 ft., Hall & Chandler 135 (MIN, NY, UC, US); Huntington Lake, elev. 6900 ft., Jepson 13057 (UC); Huckleberry Meadows, King's River region, elev. 6500 ft., Newlon 212 (UC). GLENN CO.: Sheetiron Mt., elev. 5950 ft., Bacigalupi 4677 (UC); 1/2 mi. on old road from Plaskett Meadows Ranger Station, Baker 10279 (UC). HUMBOLDT CO.: Trinity Summit, near Box Camp, elev. 5500 ft., Tracy 17918 (UC, US, WTU). INYO CO.: Lone Pine Creek Canyon, east slope of Sierra Nevada, elev. 6950 ft., Alexander & Kellogg 2907 (DS, UC, US); Sweetwater Creek, Sweetwater Mts., elev. 8200 ft., Munz 21172 (UC); Pine Canyon, east of Mount Muir, vicinity of Mt. Whitney, elev. 12200 ft., Sharsmith 3313 (UC). KERN CO.: about 1/2 mi. northeast of Evans Flat, Greenhorn Mts., elev. 5925-2950 ft., Smith 652 (UC); Bitter Creek, Twisselmann 12596 (CAS). LASSEN CO.: Martin Springs, Eagle Lake, Brown & Wieslander 45 (JEPS); Lassen Butte, Eastwood 1772 (CAS). MADERA CO.: Long Meadow, elev. 6800 ft., Hawkes 5204 (UC); near Garnet Lake, elev. 9700 Ft., Howell 16776 (CAS). MARIPOSA CO.: Summit of

Chowchilla Mt., Congdon s.n., 29 June 1885; Yosemite Valley, elev. 3900 ft., Hall 8879 (DS, US); near Wawona, elev. 4000 ft., Howell 431 (CAS); near Bridal Veil Creek, above Bridal Veil Falls, Yosemite Valley, elev. 4800 ft., Sharsmith 2175 (UC). MODOC CO.: East Creek, about 1 mi. east of Patterson Ranger Station, Warner Mts., elev. 7100 ft., Ferris & Lorraine 10630 (DS); 15 mi. southeast of Alturas, elev. 5500 ft., Hitchcock 6708 (NY, UC, WTU); mouth of Dry Creek at Parker Creek, Warner Mts., southeast of Alturas, Payne 791 (UC). MONO CO.: along California Rt. 120, 5 1/2 mi. west of Ranger Station, Inyo National Forest, elev. 8500 ft., Crow 1161 (MSC); Twin Lakes, west of Bridgeport, elev. 7400 ft., Ferris & Lorraine 10983 (DS); Tioga Crest, east of Saddlebag Lake, Tioga Pass region, elev. 11000 ft., Mason 11470 (UC); north slope of Excelsior Mt., near Summit Lake, elev. 10500 ft., Sharsmith 4145 (DS, GH, UC). NEVADA CO.: Lytton Creek, Norden, Jorgesen 501 (DS, WTU); Lake Van Norden, elev. 6900 ft., Raven 2436 (WS). PLACE CO.: Summit Valley, Howell 18582 (CAS). PLUMAS CO.: slopes across from the Devils Kitchen, Lassen Volcanic National Park, Gillett 846 (UC); Middle Fork Feather River, Rich Point, Jepson 10619a (UC). RIVERSIDE CO.: Deer Springs, San Jacinto Mts., elev. 9000 ft., Meyer 541 (UC); Strawberry Valley, San Jacinto Mts., elev. 5400 ft., Reed 2454 (UC). SAN BERNARDINO CO.: Big Bear Lake, San Bernardino Mts., Breitung 15504 (DAO); Dry Lake, San Bernardino Mts., Howell 23626 (CAS). SHASTA CO.: Brokeoff Meadows, Lassen Volcanic National Park, elev. 6300 ft., Gillett 112 (UC); Manzanita Lake, Lassen Volcanic National Park, elev. 5850 ft., Rose 45193 (CAS, GH). SISKIYOU CO.: Horse Camp springs, Mt. Shasta, elev. 8250 ft., Cooke 11474 (UC); Wagon Camp, Mt. Shasta, elev. 6000 ft., Crow 1206 (MSC); Compton's Prairie, Mt. Eddy, elev. 3800 ft., Heller 13267 (CAS, DS, MO, NY, US, WIS); South Fork of Samon River, 9 1/2 mi. above Cecilville, elev. 3500 ft., Wiggins 13445 (CAS, DS, NY, RM, US). TEHAMA CO.: South Yollo Bolly, Jepson s.n., 24 July 1897 (JEPS); north slope of North Yollo Bolly Peak, Munz 16679 (CAS, DS, NY). TRINITY CO.: Preacher Camp Grounds, 4 mi. west of Scott Ranch, Cantelow 1543 (CAS); South Fork Mt., Tracy 19055 (UC). TULARE CO.: headwaters of Freeman Creek, north slope of The Needles, Sequoia National Forest, Bacigalupi, Wiggins & Ferris 2569 (DS, WTU); Mineral King, Howell 17121 (CAS); South Fork of Kern River, Bakeoven Meadows, elev. 8100 ft., Howell 26886 (CAS). TUOLUMNE CO.: Mather, Keck 5318 (CAS, DS, US); Smoky Jack Meadows, above Glen Aulin, elev. 8600 ft., Sharsmith 4080 (CAN, GH, NY, UC); Iceberg Meadow along Clark Fork of the Stanislaus River, Wiggins 20193 (DS); Niagra Creek Public Camp, Sonora Pass Road, elev. 6550 ft., Wiggins 8975 (CAS). VENTURA CO.: Seymour Creek, Pierson s.n., in 1922(?) (US). COLORADO: BOULDER CO.: Green Lakes Valley, north of Kiowa Peak, elev. 11500-12000 ft., Weber & Dahl 8589 (COLO). CLEAR CREEK CO.: Berthoud Pass, near Idaho Springs, Degener & Peiler 16768 (RM); Cold Spring, Yankee Creek, above Brookvale, Churchill s.n., 22 June 1918 (MO); Pendleton Mt., above Leavenworth Gulch, Silver Plume region, elev. 11000 ft., Ewan 14472 (CAS); mountains about the headwaters of Clear Creek, valley near Empire, Patterson 173 (COLO, F, MICH, MIN, MO, MSC, UC, US); Mt. Evans, slope above Summit Lake, elev. 12800-13400 ft., Porsild & Weber 22869 (CAN); north slope Gray's Peak, elev. 12500 ft., Weber 5927 (COLO). CONEJOS CO.: west of

Platoro, near head of Adams Fork, elev. 11500 ft., Harrington 1719 (RM); just south of Platoro, elev. 9900 ft., Weber 7864 (CAS, COLO, DAO, MIN, RM, WS, WTU). COSTILLA CO.: slope of old Baldy Peak, 8 mi. from Fort Garland, elev. 9700 ft., Mattoon 179 (COLO); Buena Vista, Harper s.n., in 1886 (WIS). FREMONT CO.: Lake Creek, 3 mi. west of Hillside, Sangre de Cristo Mts., Erlanson 1416 (MICH). GILPIN CO.: Eldora to Baltimore, elev. 8500-9500 ft., Tweedy 5535 (RM, NY). GRAND CO.: East St. Louis Creek, Fraser Experimental Forest, southwest of Fraser, elev. 9500 ft., Weber 8616 (COLO, DAO, WTU); East Ten Lakes Park, elev. 11800 ft., Willard 61228 (COLO). GUNNISON CO.: along Spring Creek, 5 mi. north of Spring Creek campground, Gunnison National Forest, Crow 1146 (MSC); just west of Schofield Pass in Elko Park, 6 mi. northwest of Gothic, Crow 1147 (MSC); vicinity of Mt. Carbon, Kebbler Pass, Eggleston 5727 (US). LAKE CO.: Twin Lakes, Clements 421 (NY); Leadville, Trelease s.n., 8 July 1886 (MO). LA PLATA CO.: near La Plata, elev. 9000 ft., Baker, Earle & Tracy 675 (F, MIN, MO, NY, RM, US). La Plata Mts., elev. 11500 ft., Tweedy 430 (US). LARIMER CO.: Chamber's Lake, elev. 9500 ft., Crandall 79 (GH, NY); Beaver Creek, 50 mi. west of Fort Collins, elev. 9500-10000 ft., Crandall s.n., 19-20 July 1898 (RM); Cameron Pass, Osterhout 5024 (MO, MSC, RM); Loch Vale Trail, about 1/2 mi. north of The Loch, elev. 9900 ft., Willard 6027 (COLO); Trail Ridge, terrace south of Iceberg Lake, elev. 12000 ft., Willard 61131 (COLO). PARK CO.: vicinity of Georgia Pass, South Park, elev. 10500 ft., Walter 581 (COLO); trail from Platte Gulch to Wheeler Lake, ca. 5 mi. northwest of Alma, elev. 11500 ft., Weber 8747 (COLO, DAO, MIN, WTU); Duck Lake, Zobel s.n., 18 July 1934 (MO). ROUTT CO.: mountains east of Streamboat Springs, Osterhout 2685 (RM); trail from Columbine to summit of Hahn's Peak, elev. 8400-10800 ft., Weber 6913 (COLO). SAN JUAN CO.: 1/2 mi. south of South Mineral Campground, elev. 10200 ft., Douglass 54-427 (COLO); Needle Mt., Tenmile Basin, ca. 18 mi. southeast of Silverton, elev. 12800 ft., Michener 830 (COLO). SUMMIT CO.: near Breckenridge, elev. 9800 ft., Mackenzie 234 (MO, NY, RM, WIS); south side Monte Cristo Creek, just north of Hoosier Pass, elev. 11000 ft., Weber, Rollins & Livingston 6495 (COLO). IDAHO: BLAINE CO.: 14 mi. north of Ketchum, Wood River, Christ 15818 (NY); Boulder Creek Canyon, Sawtooth Mts., elev. 8000 ft., Thompson 14142 1/2 (WTU). BOISE CO.: headwaters of S. Fork Payette River above Sacajawea Hot Springs, 3 mi. north of Elk Lake, Sawtooth Primitive Area, Hitchcock & Muhlick 9861 (NY, WTU). BOUNDARY CO.: Continental Mt., Christ 1697 (NY); north slope of Mt. Rootnaah, Daubenmire 44379 (WS). CUSTER CO.: Stanley Basin, near Cape Horn Ranger Station, Christ 9683 (NY); on banks of Yankee Fork, near Custer, Christ 11345 (NY); North Fork Big Lost River, 9 mi. west of Wild Horse Ranger Station, Christ 16003 (NY); Ryan Peak, Boulder Mts., elev. 9000 ft., Hitchcock & Muhlick 10638 (WTU). FRANKLIN CO.: Bear River Range, Franklin Basin, Maguire 21627 (NY). FREEMONT CO.: Red Rock Pass, Christ 5767 (NY). IDAHO CO.: Callender, west of Orogrande, Christ 11623 (NY); west side of Seven Devils Divide, Seven Devils Mts., Christ 12493 (NY, US). LEMHI CO.: South Fork Camas Creek near Sleeping Deer Mt., 4 mi. northwest of Challis, Hitchcock & Muhlick 11345 (WTU). SHOSHONE CO.: near Sohons Pass, region of the Coeur

D'Alene Mts., elev. 1500 m, Leiberg 1425 (GH, NY, US). TETON CO.: Game Creek, Victor, Christ 5145 (NY). Victor, Merrill & Wilcox 893 (GH, NY, RM, US). VALLEY CO.: valley of Monumental Creek, near old town of Roosevelt, 21 mi. east of Stibnite, Christ & Ward 1464 (NY). MONTANA: DEER LODGE CO.: 4 mi. west of Storm Lake, Anaconda Mts., Hitchcock & Muhlick 14868 (NY, WIS, WS, WTU). FLATHEAD CO.: vicinity of Lake McDonald, 4 mi. north of Belton, Holzinger 31 (US); near White-fish divide on Yakinikak Creek, Mooar 10736 (MSC); vicinity of Lake McDermott, elev. 1450-1740 m, Glacier National Park, Standley 15640 (US). MISSOULA CO.: near Lagoon Lake, above Glacier Lake, Mission Mts. Primitive Area, elev. 6500 ft., Crow 918 (MSC); near headwaters of the South Fork of the Jocko River, 21 mi. northeast of Missoula, elev. 5700 ft., Thomas 11243 (DS). GALLATIN CO.: Spanish Basin, elev. 6500 ft., Rydberg & Bessey 4034 (CAN, NY). GLACIER CO.: Many Glacier, Glacier National Park, Jones 5329 (GH); Hidden Lake Overlook, Logan Pass, Glacier National Park, Harvey 7024 (MONTU); vicinity of Going-to-the-Sun Chalets on St. Mary Lake, Glacier National Park, elev. 1350 m, Standley 17124 (US). LINCOLN CO.: Big Cherry Creek, east of Libby, Harvey 2703 (MONTU). PARK CO.: Big Muddy Creek, near Wilsall, Suksdorf 372 (WS); Cooke Guard Station, about 2 mi. east of Cooke City, elev. 8000 ft., Witt 1780 (CAS, COLO, DAO, MIN, NY, UC, WIS, WS, WTU). RAVALLI CO.: Watchtower Creek Trail, Bitterroot Mts., elev. 5600 ft., Lackschewitz & Fageraas 633 (MONTU). SWEET GRASS CO.: Sweet Grass Canyon, Crazy Mts., elev. 6000-7000 ft., Flodman 447 (MO, NY); along East Fork Boulder River, 3 mi. south of Rainbow Lakes, Hitchcock 16490

(WTU). Montana, county uncertain, Long Baldy, Little Belt Mts., elev. 7000-8000 ft., Flodman 446 (NY, MO); Belt Mts., Williams 493 (MIN). NEVADA: DOUGLAS CO.: 2 mi. east of junction of Kingsbury & Clear Creek Grades, Train 3178 (UC). ELKO CO.: Jarbidge River, 2 mi. south of Jarbidge, Baker 8636A (WTU). ESMERALD CO.: Chiatovitch Creek, Duran 2801 (UC). HUMBOLDT CO.: valley of Lawance Creek, Santa Rosa Mts., elev. 6000 ft., Archer 246 (MICH). NYE CO.: North Twin River, Toyabe Mts., Linsdale & Linsdale 658 (CAS). ORMSBY CO.: head of Fall Creek, elev. 2460 m, Baker 1332 (GH, MO, MSC, NY, UC, US). WASHOE CO.: Galena Creek, 8 mi. west of Reno Hot Springs, elev. 6100 ft., Archer 5469 (UC); Third Creek, near Mt. Rose, elev. 8500 ft., Howell 14055 (CAS, WTU). NEW MEXICO: RIO ARRIBA CO.: vicinity of Brazos Canyon, Standley & Bollman 11043 (US). SAN MIGUEL CO.: Winsor's Ranch, Pecos River National Forest, elev. 8400 ft., Standley 4170 (GH, MO, NY, US). SANTA FE CO.: Santa Clara Canyon, Marcelline 1911 (F). OREGON: BAKER CO.: Hudson Creek, R44E, T6S, sec. 9., Head 1594 (OSC). CROOK CO.: vicinity of Laidlaw, Whited 3216 1/2 (US). DESCHUTES CO.: Paulina Lake, Howell 7076 (CAS); Diller Glacier, Three Sisters Mts. elev. 7500 ft., Van-Vechten 248 (WTU). GRANT CO.: Dixie Mt., Blue Mts., Henderson 5536 (CAS, GH); Strawberry Mt., Blue Mts., elev. 8000 ft., Maquire & Holmgren 26843 (GH, NY). HARNEY CO.: White Horse Mts., Griffiths & Morris 464 (US); Steens Mts., 12 1/2 mi. east & 9 1/4 mi. south of Frenchglen, Hansen 877 (OSC). HOOD RIVER CO.: White River, S. Mt. Hood; 10 mi. southeast of Mt. Hood, Lloyd s.n., July 1894 (NY). JACKSON CO.: northern slopes of Mt. Asland, Rossbach 599 (DS). JOSEPHINE CO.:

near Bolan Lake, Siskiyou Mts., Hitchcock & Martin 5238 (DS, NY, UC, WS, WTU); 4 mi. southeast of Oregon Caves, Siskiyou Mts., Peck 8288 (GH); Grayback Area, Siskiyou Mts., Whittacker s.n., 24 July 1949 (WS). KLAMATH CO.: Kerr Notch, Crater Lake National Park, Baker 7127 (WTU); Crater Lake, Hawkins s.n., 30 July 1917 (WIS); 15 mi. north of Fort Klamath, Peck 9367 (DS, GH, MO, NY). LAKE CO.: Cogswell Creek, 8 mi. south of Lakeview, Peck 15564 (DS, WTU). LANE CO.: Scott Lake, McKenzie Pass, Jones 5769 (WTU); west of North Sister, elev. 6500 ft., VanVechten 221 (OSC). UMATILLA CO.: 2 mi. north of Tollgate, Blue Mts., elev. 5000 ft., Crow 1235 (MSC). UNION CO.: Indian Creek, Blue Mts., Darlington 146 (CAS). WALLOWA CO.: Lake Wallowa, Powder River Mts., Ferris & Dulthie 1387 (DS); Mirror Lake, Wallowa Mts., 7550 ft., Mason 1957 (OSC); Imnaha Canyon, 24 mi. above Imnaha, Peck 18379 (DS, NY, WTU). WASCO CO.: 15 Mile Meadow, Mt. Hood National Forest, elev. 4500 ft., Jones 4135 (GH, UC, WTU). UTAH: BEAVER CO.: Big Flat Ranger Station, Tushar Mts., Eggleston 10461 (US); vicinity of Big John Flats, Beaver River headwaters, elev. 9000-10000 ft., Maguire 19834 (GH, WTU). BOX ELDER CO.: Dunn Canyon, Raft River Range, elev. 6500 ft., Maguire & Hclmgren 22176 (GH, NY, UC, US). CACHE CO.: mountains near Logan, Shear s.n., 9 August 1895 (NY). DAGGETT CO.: Green Lakes, elev. 7500 ft., Hermann 4824 (MO). DUCHESNE CO.: Moon Lake, Ashley Forest, elev. 8100 ft., Harrison & Larsen 7704 (MO); Krebs Basin, above Chain Lake, Mt. Emmons, elev. 11300 ft., Hermann 4938 (MO). ELKO CO.: Verdi Lake, Ruby Mts., elev. 10450 ft., Mills & Beach 1575 (UC). GRAND CO.: north base of Haystack Mt., La Sal Mts., elev. 9300 ft., Maguire, Richards, Maguire & Hammond 17965 (CAN, WTU). JUAB CO.: Granite Creek, Deep Creek Range, elev. 7000 ft., Maguire & Holmgren 21865 (GH, NY, UC, US, WTU). PIUTE CO.: Tate Mine, near Maryville, Jones 5855 (MSC, NY, RM, UC). RICH CO.: Laketown, elev. 6300 ft., Harrison & Larsen 7956 (MO). SALT LAKE CO.: Silver Lake, Big Cottonwood Canyon, Clemens s.n., 30 September 1909 (RM, UC). SAN JUAN CO.: southeast part of La Sal Mts., elev. 10000 ft., Goldman & Hitchcock 1473 (MO); Abajo Mts., elev. 3000-3300 m, Rydberg & Garrett 9746 (NY, US). SANPETE CO.: vicinity of Clayton Peak, Wasatch Mts., elev. 9000 ft., Stokes s.n., 12-26 August 1903 (MO). SEVIER CO.: Fish Creek Canyon, Garrett 2596 (NY). SUMMIT CO.: Mill Creek, southwest base of Mt. Elizabeth, Uinta Mts., elev. 8500 ft., Hermann 5897 (MO, RM); Burntfork Creek, below Thompson Creek, elev. 7500 ft., Jensen s.n., 24 July 1942 (UC, WTU); South Blanchard Lake, Henry's Fork Basin, Kings Peaks-Gilbert Peak region, Uinta Mts., elev. 11100 ft., Maguire, Hobson & Maguire 14616 (WTU). UINTAH CO.: Paradise Park, Uinta Basin, elev. 10000 ft., Graham 10056 (GH, MO); east slopes of Leidy Peak, Uinta Mts., elev. 10000 ft., Maguire 17669 (WTU). UTAH CO.: American Fork Canyon, elev. 8000 ft., Jones 1362 (CAS, F, MICH, MSC, NY, UC, US, WS, WTU). WAYNE CO.: Blind Lake, Aquarius Plateau, elev. 10000 ft., Dixon 758 (F); Fremont Reservoir, head of Fremont River, elev. 8500 ft., Dixon 549 (F). WASHINGTON: ASOTIN CO.: Blue Mts., Jones 1876 (WS). CLALLAM CO.: east face of Obstruction Point, elev. 5600 ft., Meyer 1258 (MO). CHELAN CO.: northeast side of Snow Lake, Stuart Range, Wenatchee Mts., southwest of Leavenworth, elev. 5000 ft., Crow 1108

(MSC). COLUMBIA CO.: Indian Corral, Blue Mts., Carlington 146 (WS). JEFFERSON CO.: Mt. Olympus, elev. 5000 ft., Flett 3043 (WTU); Skokomish River, Olympic Mts., Piper s.n., August 1895. KLICKITAT CO.: Bingen, Suksdorf s.n., 18 April 1895 (WS). OKANOGAN CO.: head of Middle Fork of Pasayten River, north of Harts Pass, Ownbey & Meyer 2312 (DS, MO, NY, UC, WS, WTU); Salmon Creek, near Conconully, Thompson 6967 (MIN). PEND OREILLE CO.: near Gypsy Meadow, elev. 4800 ft., Layser 918 (WS). PIERCE CO.: Nisqually Bridge, Mt. Rainier, elev. 3900 ft., Jones 9917 (GH, NY); road to Sunrise glacier, Mt. Rainier, Crow, 1236 (MSC); trail above White River Campground, Inter Fork of White River, Mt. Rainier, elev. 4500 ft., Raven 8963 (CAS); "Ellerbach," Mt. Adams, Suksdorf 334 (WS). WHATCOM CO.: Winchester Mt., elev. 4500 ft., St. John 8964 (WS); Bagley Lake, near Mt. Baker Lodge, elev. 4300 ft., Thompson 5700 (DS, MO, WTU); below glacier on Heliotrop Ridge, Mt. Baker, elev. 7500 ft., Thompson 11253 (US, WTU). YAKIMA CO.: Wodan's Vale, Mt. Adams, elev. 2000 m, Suksdorf 6829 (COLO, DS, NY, UC, WS, WTU). WYOMING: ALBANY CO.: Medicine Bow, above Nash Forks, off route 130 near Centennial, Churchill s.n., 13 July 1958 (MSC); Centennial, Nelson 7728 (GH, MIN, MO, NY, RM, US); Trail Creek, near Sand Lake, Medicine Bow Range, elev. 9700 ft., Porter & Porter 7927 (DS, UC, WTU). CARBON CO.: South Spring Creek, Hayden Forest, Eggleston 11277 (US); Battle Lake Mt., Nelson 4241 (RM). FREMONT CO.: Brooks Lake, near Dubois, Churchill s.n., 18 July 1958 (MSC). LINCOLN CO.: near junction of Box Canyon Creek and Grey's River, elev. 7800 ft., Goodman 5133 (RM). PARK CO.: Beartooth Pass, Beartooth Range, elev. 9200 ft., Porsild, Johnson

& Darling 22753 (CAN); Old Faithful, Hawkins 580d (US); Canyon Junction, Langdon 160 (OSC); Yellowstone Lake, Rydberg & Bessey 4037 (NY). TETON CO.: Teton Creek, Targhee National Forest, 11 mi. east of Driggs, Anderson 415 (NY); Teton Pass, Merrill 340 (US); "Jackson Hole," vicinity of Jackson Lake, near Moran, elev. 7500-3500 ft., Yuncker 5290 (F, NY); vicinity of Holback Canyon, elev. 7500 ft., Williams & Pierson 735 (CAS, GH, MO, NY, RM). Wyoming, county unknown, vicinity of Big Horn Mts., Williams s.n., July-August 1897 (RM).

In reorganizing the specimens of *Sagina* in the Gray Herbarium, Fernald (1925) noted that the typical phase of *S. saginoides* of the Arctic and Eurasia occurred locally throughout the North American range of the species, but that most of the material of western America was found having sepals and capsules of shorter length than the typical. This American extreme he described as var. *hesperia*.

The Eurasian specimens exhibit considerable variability, the range for sepal and capsule length being continuous (sepals 2.0-3.0 mm long; capsules 2.5-5.0 mm long). Frequently plants of lower elevations tend to be more robust, producing slightly larger flowers, while plants of higher elevations are generally smaller. The more robust, larger flowered plants, with capsules up to 5.0 mm long were first recognized at the specific level as *Spergella macrocarpa* Reichb., and later at the varietal level as *Sagina saginoides* var. *macrocarpa* (Reichb.) Moss. Moss (1914) admits that the discontinuity between the two varieties is trifling, but continues to recognize two varieties in *S. saginoides*

Figure 20. Geographic distribution of <u>Sagina saginoides</u> in North America.

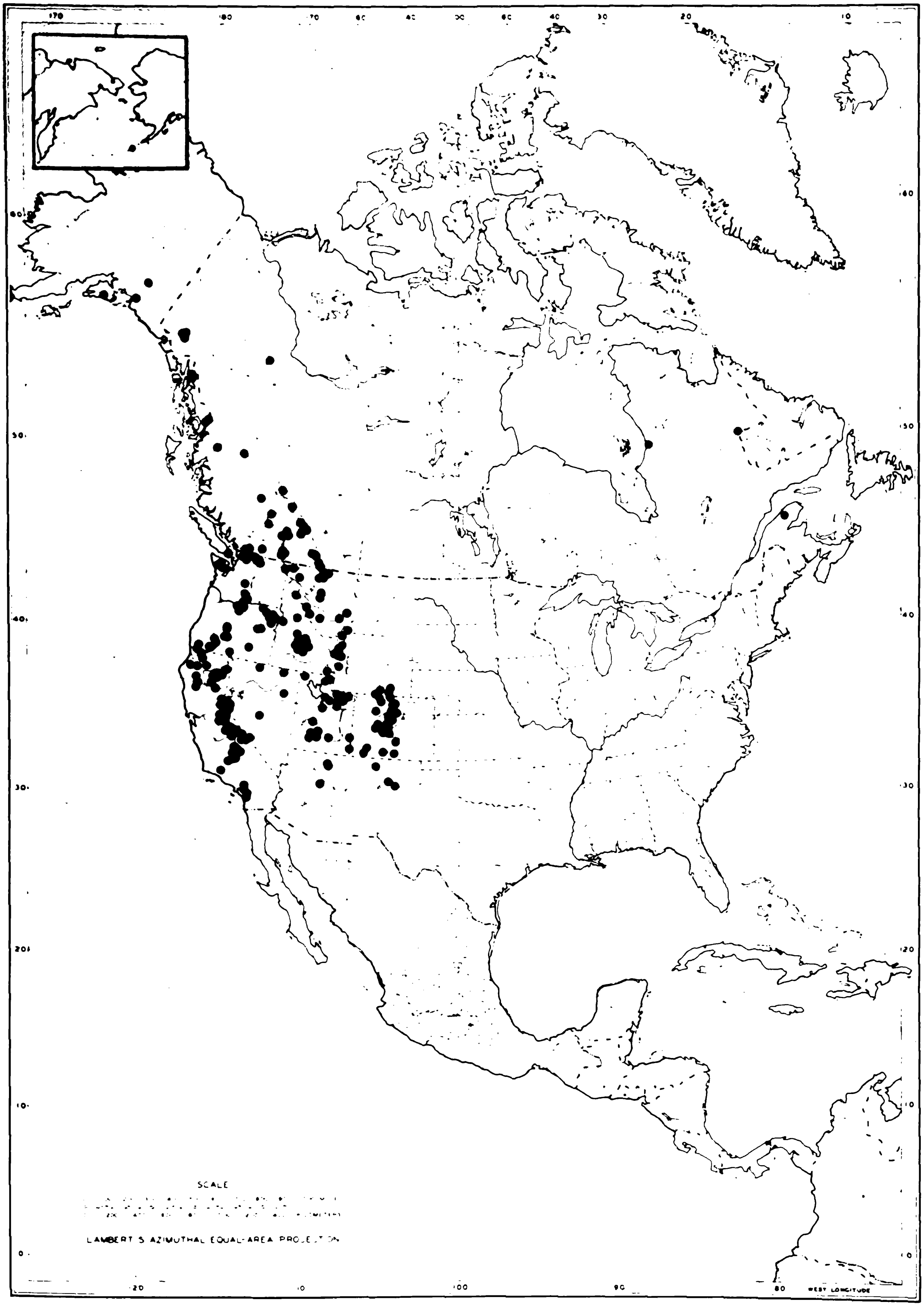


Figure 20

North

(Moss, 1920). The treatment in Flora Europaea (Clapham and Jardin, in Tutin et al., 1964) notes that the larger flowered plants cannot be clearly separated as a taxon distinct from typical S. saginoides.

Discontinuity in this variable species appears to be lacking between those plants which were regarded as var. macrocarpa and those which were regarded as var. hesperia. I am therefore not recognizing infraspecific categories in the species.

Earlier collections of Reichenbach, which were housed at the Zwinger Museum in Dresden, Germany, were destroyed by fire in May 1849 (Stafleu, 1967). However, the original plates of his Icones Florae Germanicae et Helveticae are preserved at Vienna (W). I therefore designate Icones 4963.b. as the lectotype of Spergella macrocarpa Reichb.

3. Sagina procumbens L.

Sagina procumbens L., Sp. Pl. 1: 128. 1753. Alsine procumbens (L.) Crantz, Inst. 2: 404. 1766. Sagina pentamera Rouy & Foucaud, Fl. France 3: 286. 1896. Nom. nud. Alsine procumbens (L.) Krause, in Sturms, Fl. Deutschl. 2 ed., 5: 36. 1901. Type: not seen. "Habitat in Europae, pascuis sterilibus uliginosis aridis."

Sagina procumbens var. compacta Lange, Meddel. Groenl. 3: 242. 1887. Type: not seen. Original material: Igaliko, Greenland. Collected by Vahl?

Sagina muscosa Jord., Pugill. Pl. Nov. p. 32. 1852. Type: not seen. Original material: on mossy cliffs of woodlands and in subalpine meadows of mountains, Gerbier de Jones and Mont Pila, near Lyon, France.

Perennial. Plants totally glabrous. Stems ascending or, more frequently, procumbent. Rosettes of linear leaves frequent in younger plants, 9-35 (-55) mm in diameter. Procumbent stems with axillary fascicles giving rise to secondary tufts or, less frequently, secondary rosettes, rooting at the nodes. Cauline leaves linear, lower leaves 4-15 mm long, becoming shorter toward the apex, upper leaves 2.5-6.0 mm long. Leaf margins entire, rarely with minute glandular cilia. Leaf tips apiculate to aristate. Connate leaf bases not conspicuous, never forming an inflated cup. Pedicels generally long, filiform, recurved during capsule development, becoming erect at maturity. Flowers 4-merous, occasionally 4- and 5-merous. Pedicels long, filiform. Sepals elliptical to orbicular, 1.5-2.0 (-2.5) mm long, hyaline margins white, never purple tinged. Petals 4 or fewer or sometimes absent, minute, 0.75-1.0 (-1.5) mm long, orbicular to elliptical, clawed. Stamens 4, occasionally 8, filaments 1.0-1.5 mm long, anthers 0.25 mm long. Capsules slightly exceeding sepals. Capsule valves thin, (1.5-) 2.0-2.5 (-3.0) mm long. Sepals appressed during capsular development, divergent following dehiscence. Seeds brown, obliquely triangular, with a distinct dorsal groove, (0.3-) 0.4 (-0.5) mm long. Chromosome number: $2\underline{n} = 22$. Figures 21 and 22.

Ecology and distribution: A weedy species, growing in wet or damp gravelly or sandy soils along roadsides, sidewalk cracks, and margins of paths or lawns. Also frequent along pond and lake margins, coastal rocks and sands and sea cliffs. The species is sometimes

Figure 21. Photographs of Sagina procumbens. (a) Flowers showing cupped sepals and papillate stigmas (emasculated), Watcom Co., Washington (Crow 1238, MSC). (b) Adventitious roots produced on procumbent stem of weedy plant in growth chamber.

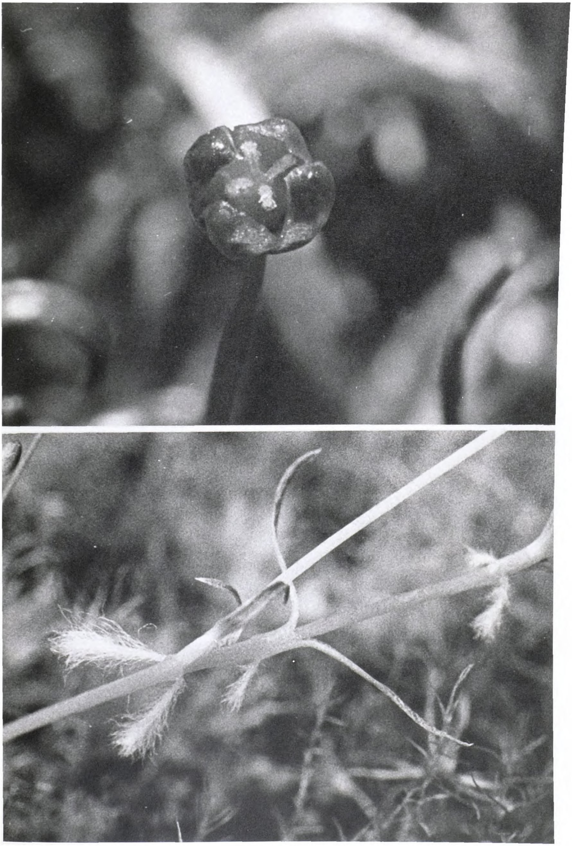


Figure 21

Figure 22. Photographs of Sagina procumbens. (a) Habit, Bolton Pass, Quebec (Marie-Victorin, Rolland-Germaine, Raymond and Rouleau 56363, GH). (b) Habit, St. John's Avalon Peninsula, Newfoundland (Bassett 541, DAO).

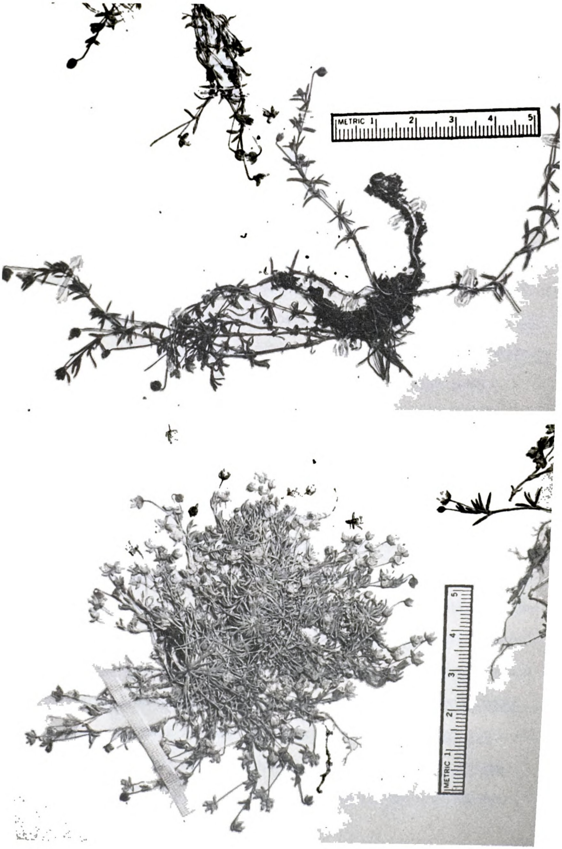


Figure 22

cultivated as a ground cover. In eastern North American from Newfoundland, west to New York and eastern Pennsylvania, and the southwest shore of Lake Superior. In western North America, from the San Francisco area north to Washington and infrequently northward to the Queen Charlotte Islands, and the Aleutian Islands. Single collections are known from Detroit, Michigan; Columbus, Ohio; Pulaski Co., Arkansas; Missouri (no specific locality cited); and Marysvale, Utah. Occasionally at high elevations in Mexico and Central America. Also introduced in eastern Asia and the Southern Hemisphere. Native to Eurasia. Flowering May to September. Figure 23.

Representative specimens: CANADA: BRITISH COLUMBIA: Saltspring Island (Straight of Georgia), Ashlee s.n., in 1959 (DAO). Between Prince Rupert and Galloway Rapids, Calder, Savile & Ferguson 13208 (DAO). Near east end of Summit Lake on road from Nakusp to New Denver, Calder & Savile 10010 (DAO, NY). Vancouver, Eastham 9906 (UC). Road to Silver King Mine, Nelson, Eastham 10050 (UC). New Westminster, Henry 9139 (RM). Langley Prairie, Groh s.n., 26 July 1939 (DAO). Hecate Island, MaCabe 7134 (UC). East shore of Kootnay Lake, 15 mi. south of Boswell, Senn & Frankton 5868 (DAO). Queen Charlotte Islands: Summit, between Gillatt Arm of Cumshewa Inlet and Peel Inlet, Moresby Island, Calder & Taylor 35173 (DAO); approximately 3 mi. from east end of Skidegate Lake along Copper Creek, Moresby Island, Calder & Taylor 36077 (DAO). Vancouver Island: Vicinity of Victoria, Macoun s.n., 23 May 1893; Quarantine Lake, about 20 mi. west of Victoria, McCabe 5647 (UC); Nanimo, Malte s.n., 30 June 1914 (CAN); Duncans-Cowichan

Lake road, Rosendahl 1758 (GH, NY, UC, US). NEW BRUNSWICK: CHARLOTTE CO.: Deer Island, Chrysler 6295 (GH); Mill Cove, Campobello Island, Malte 971/29 (CAN, GH); Digidiquash, about 20 mi. northeast of St. Andrews, Malte 648/29 (CAN); west side of Whale Cove, Grand Manan Island, Weatherby & Weatherby 5492 (CAN, MO, US). GLOUCHESTER CO.: Grande Anse, Blake 5533 (CAS, GH, NY, US, WTU); Caraquet, Dore, Senn & Gorham 45.593A (DAO). KENT CO.: Bass River, Fowler s.n., August 1875 (WIS). KINGS CO.: Sussex, Svenson & Fassett 2000 (GH). NORTH-UMBERLAND CO.: Little Branch, Miramichi, Fowler s.n., 24 August 1894 (F, US, WIS). RESTIGOUCHE CO.: Eel River, near Dalhousie, Malte 456 (CAN). SUNBURY CO.: Oromocho River at Fredericton Junction, Roberts & Bateman 64-2069 (DAO). WESTMORLAND CO.: Shediac, Hubbard s.n., 7 July 1914 (GH); about 15 mi. northeast of Sackville, Scoggan 12243 (CAN). YORK CO.: Fredericton, Scoggan 11867 (CAN). LABRADOR: Perquet Island, 51°26'N., Allen 66 (GH, NY). Red Islands, near Turnavik, 53°48'N., 56°46'W., Bishop 285 (CAN, US). Forteau, on Strait of Belle Isle, Donly s.n., ca. 20 August 1964 (DAO). NEWFOUNDLAND: Gander, Bassett 483 (DAO, MO). St. John's, Avalon Peninsula, Bassett 541 (DAO). Ferryland, Brooks s.n., 20 July 1937 (GH, MO). Tompkins, Edgerton & Pease s.n., 4 July 1939 (GH). Birchy Cove, Curling, Bay of Islands, Fernald & Wiegand 3334 (CAN, GH, NY). Cow Head, north of St. Paul's Bay, Fernald & Wiegand 3335 (GH). Deer Pond Brook, highlands of St. John, northwestern Newfoundland, Fernald & Long 28154 (GH). Dildo Run, southern shores of Notre Dame Bay, Fernald & Wiegand 5378 (F, GH, MO). Glenwood, valley of Gander River, Fernald & Wiegand 4376 (GH, US).

Grand Bruit, district of Burgeo and La Poile, Fernald, Long & Fogg 247 (GH). Grand Falls, Fernald & Wiegand 4375 (GH). Port Saunders, region of Ingorachoix Bay, Fernald & Wiegand 3336 (GH). Sacred Island, Straits of Belle Isle, Fernald & Long 28150 (GH). Ship Cove, Sacred Bay, Fernald, Wiegand & Long 28152 (GH). Tilt Cove, northern shores of Notre Dame Bay, Fernald & Wiegand 5379 (NY, RM, UC). Bell Island, near Topsail, Conception Bay, Howe & Lang 1308 (NY). Channel, Howe & Lang 932 (NY). Frenchman's Cove, Bay of Islands, Mackenzie & Griscom 10263 (GH, US). St. John's, Robinson & Schrenk 218 (CAN, DAO, F, GH, MIN, MO, NY, US). Hughes Brook, Humber District, Rouleau 1662 (CAN, DAO, NY, US). Hughes Brook, Humber District, Rouleau 1662 (CAN, DAO, NY, US). East Port, Bonavista Bay, Smith, Smith & Squires 303 (DAO). Fogo Island, Sornborger s.n., 7 August 1903 (CAN, GH, NY, US). Terra Nova National Park, Stirrett 1244 (DAO). NOVA SCOTIA: CAPE BRETON CO.: Sydney, Cape Breton Island, Barnhart 832 (NY); N. W. Cove, Sactari Island, Smith, Schofield, Sampson & Bent 5351 (DAO). COLCHESTER CO.: Lynn, Dore 45.1095 (DAO); west of Folley Lake, Fassett 19040 (GH, WIS); Londonderry Bridge, Great Village River, Smith, Curry & Clattenburg 19184 (DAO). CUMBERLAND CO.: cliffs near Moose River, about 8 mi. east of Parrsboro, Scoggan 13820 (CAN). DIGBY CO.: Brier Island, Smith, Roland, Collins, Erskine & Schofield 126 (DAO). GUYSBOROUGH CO.: Cansco, Fowler 25191 (WIS); Boyleston, Hamilton 18294 (CAN, US); Cook's Cover, Perry, Wetmore, Hicks & Prince 10229 (GH); Guysborough, Rousseau 35324 (CAN, US). HALIFAX CO.: Halibut Cove, near Halifax, Dore, Senn & Gorham 45.521 (DAO). INVERNESS CO.: near Pleasant Bay, Cape Breton Island, Pease

26634 (GH); Cheticamp River, Cape Breton Island, Smith, Schofield, Taylor, Webster & Slipp 7799 (DAO); near Margaree Forks, Cape Breton Island, Smith, Taylor, Webster & Slipp 6228 (DAO); West Mabou Harbour, Smith, Schofield, Sampson & Bent 4178 (DAO). KINGS CO.: Hall Harbor, Fassett 19049 (WIS); Scott Bay, Prince & Atwood 1064 (DAO); Black River, Zinch 224 (DAO). LUNENBURG CO.: Chester, Pease 26655 (GH); near Petite Riviere, Greene Bay, Zinch 700 (DAO). PICTOU CO.: Pictou, Robinson 209 (NY). SHELBURNE CO.: on the island, Barrington Passage, Macoun 80869 (CAN, MO). VICTORIA CO.: Aspy Bay, Cape Breton Island, Churchill s.n., 25 July 1909 (MIN); Baddeck, Cape Breton Island, Macoun 19031 (CAN, GH); Money Rocks, St. Paul Island, Perry & Roscoe 194 (CAN, GH, MO, NY, US); Ciboux Island, Smith, Schofield, Taylor, Webster, Slipp & Bentley 10932 (CAN, DAO). YARMOUTH CO.: Jassy Lake, Lake Annis, Bean, White & Linden 21193 (GH, NY, US); Wedgeport, Klawe 1080 (GH); Yarmouth, Macoun 80868 (CAN). Sable Island: 43°59'N., 59°47'W., St. John 1226 (CAN, GH, NY, US). PRINCE EDWARD ISLAND: Tracadie Beach, Churchill s.n., 23 July 1901 (GH, MO. Brackley Beach, Dore & Gorham 45.245 (DAO). Near Bonshaw, Erskine & Dore 1105 (DAO, NY). Rocky Point, Fernald & St. John 7438 (WS). Charlottetown, Groh s.n., 18 July 1932 (DAO). Souris, Malte s.n., 29 August 1924 (CAN). Near Park Corner, Smith 230 (DAO). QUEBEC: ANTICOSTI ISLAND CO.: Pointe de l'est, Marie-Victorin, Rolland-Germain & Louis-Marie 21 642 (GH). BONAVENTURE CO.: Port Daniel, Lepage 13542 (DAO); New Carlisle, Williams & Fernald 69140 (CAN). BROME CO.: Bolton Pass, Marie-Victorin, Rolland-Germain, Raymond & Rouleau 56363 (GH). GASPÉ-EST CO.: Bonaventure Island, Fernald &

Collins 1020 (GH); cliffs between Cape Rosier and Cape Gaspé, Johansen s.n., 12 August 1922 (CAN); Perce, Marie-Victorin & Rolland-Germain 49 462 (DAO, MICH); Riviere Ause-Aux-Canards, Marie-Victorin, Rolland-Germain & Jacques 44 527 (DAO, UC); Coin du Banc, Scoggan 515 (CAN). LEVIS CO.: Point Garneau, Cinq-Mars & Cayouette s.n., 15 September 1954 (DAO). MAGDALINE ISLANDS CO.: Grindstone, Grindstone Island, Fernald, Bartram, Long & St. John 7439 (GH); Grand Ruisseau, Ile-aux-Meules, Grandtner, Lamieux & Rousseau 8191 (DAO); Brion Island, St. John 1875 (GH, US). MATANE CO.: Sandy Bay, St. Lawrence River, Fernald & Pease 25041 (GH); Riviere Blanche, Forbes 1494 (CAN, DS, GH). RIMOUSKI CO.: Cap a'l'Original, Bic, Clausen & Trapido 2827 (MIN, UC); St.-Fabien-sur-mer, Lepage 15843 (DAO). RIVIERE-DE-LOUP CO.: Trois-Pistoles, Lepage 15325 (DAO). SANGUENAY CO.: Blanc Sablon, Straits of Belle Isle, Fernald, Wiegand & Long 28156 (GH); Ile des Perroquets, Archipel de Blanca Sablon, St. John s.n., 28 July 1915 (CAN, GH). TEMISCOUATA CO.: Saint-Hongré, Blouin, Carrier, Lemiaux & Richard 7373 (DAO); Ile Aux Basque, Marie-Victorin, Rolland-Germain & Jacques 33 032 (GH, RM). WOLFE CO.: Notre-Dame de Ham, Canton d'Ham Nord, Hamel & Brisson 15399 (CAN); Riviere Saumon, canton de Lingwick, Hamel & Brisson 14790 (UC).

ILES SAINT-PIERRE (France): Savoyard, Le Hors s.n., 16 August 1950 (DAO); Vigie, Le Hors s.n., 21 September 1931 (DAO).

MEXICO: MEXICO: Vertiente sw del Ixtaccíhuatl, La Joya, elev. 3850 m, Rzedowski 21578 (MICH); Vertiente nw del Ixtaccíhuatl, en la región de Peñas Cuatas, La Ciénega, Rzedowski 21813 (MICH).

UNITED STATES: ALASKA: Haines (Chilkoot Inlet, Lynn Canal, n. of Juneau), Anderson 6047 (CAN). Unalaska (Aleutian Islands), Eyerdam 2273 (CAN, CAS, DS, NY, UC, US). Girdwood (Cook Inlet, Turnagain Arm, se. of Anchorage), Hultén, s.n., 1 July 1961 (US). Sand Point, Shumagin Islands, Riggs s.n., 31 July 1913 (US). Vicinity of Massacre Bay, Peaceful Valley, Attu Island (Aleutian Islands), VanSchaack 499a (US). ARKANSAS: PULASKI CO.: without definite locality, Hasse s.n., May 1886 (MONTU). CALIFORNIA: AMANDA CO.: weed in University of California Botanical Garden, Berkeley, Crow 1179 (MSC). DEL NORTE CO.: 1 mi. south of Crescent City, Abrams & Bacigalupi 8393 (DS); along road in redwoods north of Crescent City, Eastwood 12299 (CAS); Laguna Creek, 5 mi. north of Regna, Tracy 5872 (UC). HUMBOLDT CO.: Stone Lagoon, Humboldt Coast, Jepson 9337 (JEPS); Freshwater Creek near Wrangletown, Tracy 5338 (CAS, UC, WTU). MARIN CO.: Shell Beach, Howell 20929 (CAS); Inverness Ridge, Pt. Reyes Peninsula, about 3 mi. northward from town of Inverness, Thomas 10413 (DS). MENDOCINO CO.: Highway 1, Caspar, Nobs & Smith 1149 (CAS). SAN FRANCISCO CO.: Golden Gate Park on cross park boulevard, San Francisco, Howell 32571 (CAS, MSC); crevices of sidewalk on 9th Ave. near Fulton Street, San Francisco, Rubtzoff 2449 (CAS, MSC). SAN MATEO CO.: ravine north of Seal Cove, Dudley s.n., 16 March 1900 (DS). SANTA CLARA CO.: weed in Stanford Experimental Garden, Stanford University, Stanford, Thomas 8725 (DS). CONNECTICUT: FAIRFIELD CO.: Fairfield, Johnson s.n., 30 June 1890 (NY); Trumbull s.n., 10 June 1893 (MIN). HARTFORD CO.: Southington, Bissell s.n., 17 June 1900 (GH); crest of Avon Mt., 1/4 mi. south of Farmington

Ave., Farmington Twp., Churchill s.n., 10 July 1952 (MSC); South Glastonbury, Wilson 75 (RM). LITCHFIELD CO.: Norfolk, Redfield 13062 (MO). NEW HAVEN CO.: North Guilford, Bartlett s.n., 22 June 1906 (GH); Waterbury, DuBois s.n., August 1889 (UC); Milford, Eames 1494 (MIN); Mt. Carmel, Stafford s.n., 16 June 1885 (US). NEW LONDON CO.: Mumford's Point, Groton, Graves s.n., 6 June 1903 (GH); Taftville, Setchell s.n., 28 June 1884 (UC); Franklin, Woodward s.n., 30 August 1914 (GH). TOLLAND CO.: Hop River, Andover, Seymour 17643 (WIS). WINDHAM CO.: Connecticut River, Westminster, Blanchard 70 (GH). DELAWARE: NEW CASTLE CO.: Wilmington, Tatnall s.n., 21 May 1930 (GH). IDAHO: KOOTENAI CO.: Hayden Lake, Baker 14882 (WTU). MAINE: CUMBERLAND CO.: Portland, Garber s.n., 29 August 1874 (F). FRANKLIN CO.: South Chesterville, Eaton 17001 (WIS). HANCOCK CO.: vicinity of Blue Hill, Maxon 11036 (US); Seal Harbor, Mount Desert Island, Williams s.n., 15 July 1897 (GH). KENNEBEC CO.: Chesterville, Chamberlain, Knowlton & Eaton s.n., 18 July 1902 (GH); South Litchfield, Fassett 18292 (WIS). KNOX CO.: Union, Cole 973 (US); Washington, Steyermark 4209 (F). LINCOLN CO.: Ocean Point, Fassett 15442 (WIS); Rams Island, Boothbay, Fassett 3580 (WIS); Monhegan Island, Jenney, Churchill & Hill s.n., 3 July 1919 (MO); Medomak, Steyermark s.n., August 1928 (F). SAGADAHOC CO.: Bowdoinham, Fassett 2850 (WIS). YORK CO.: York, Blake s.n., 23 July 1863 (NY); Fryeburg, Harvey 140 (US); South Berwick, True 1141 (US). WASHINGTON CO.: Cutler, Kennedy, Williams, Collins & Fernald s.n., 2 July 1902. MARYLAND: BALTIMORE CO.: Baltimore, Jones s.n., 25 May 1904 (F). MASSACHUSETTS: BARNSTABLE CO.: Woods Hole, Bacon 95

(MSC); South Orleans, Murdoch 2056 (F); Nashawena, Elizabeth Islands, Northrop s.n., July-August 1901 (NY). BERKSHIRE CO.: Stockbridge, Britton s.n., 28-31 July 1901 (NY); Great Barrington, Leavenworth s.n., in 1820 (MSC). BRISTOL CO.: New Bedford, Greene s.n., date unknown (WIS). DUKES CO.: Gay Head, Martha's Vineyard, Seymour 1201 (GH, NY, US). ESSEX CO.: Newburyport, Fernald s.n., 2 October 1902 (GH); Forbes 17194 (MIN, WIS); Nahant, Russell s.n., August 1863 (GH). FRANKLIN CO.: Mt. Toby, Harris s.n., 30 June 1877 (MIN); Charlemont, Hunnewell 10659 (GH); Buckland, Seymour 3812 (WIS). HAMPDEN CO.: Granville, Seymour 121 (GH, MO); Mt. Shatterack, Montgomery, Seymour 8121 (DAO, WIS). HAMPSHIRE CO.: Middlefield Valley of Westfield River, Fernald & Long 9480 (GH); Huntington, Robinson 776 (GH); MIDDLESEX CO.: Merrimac River, Lowell, Beattie s.n., 21 May 1930 (RM); Ashland, Morong s.n., 19 June 1878 (F, NY); Waltham, Seymour & Seymour s.n., 4 July 1911 (CAS, MSC, WIS). NANTUCKET CO.: Brant Point road, Nantucket Island, Bicknell s.n., 20 June 1908 (NY); "Ram Pasture," Nantucket Island, MacKeever 417 (NY). PLYMOUTH CO.: Middleboro, Murdoch 596 (F). SUFFOLK CO.: Cambridge, Beal s.n., date unknown (MSC); Revere, Clark s.n., in 1873 (MSC). WORCESTER CO.: Lancaster, Seymour s.n., 5 July 1944 (WIS); Douglas, Weatherby D2197 (US). MICHIGAN: HOUGHTON CO.: Douglas Houghton Falls, Lake Linden, Farwell 6595 (MICH); 1.5 mi. east of Laurium, Hermann 7692 (MSC, NY); Otter Lake, Hyypio 409 (MSC). KEWEENAW CO.: Allouez, Hermann 7797 (DS, F, MICH, MO, NY, US, WS); Agate Harbor, Hermann 7797 (NY, RM, UC). MARQUETTE CO.: Champion, Hill s.n., 10 July 1889 (GH, NY). WAYNE CO.: golf links, Detroit, Piper s.n., 8 June 1922 (US). MINNESOTA: ST. LOUIS CO.: Duluth, Lakela 2561 (MIN, NY, UC, WS). MONTANA: LINCOLN CO.: Stanley Creek base of Stanely Mt., elev. 760 m, Harvey 5492 (MONTU). NEW HAMPSHIRE: CHESHIRE CO.: Alstead, Seymour & Seymour s.n., 27 June 1913 (WIS). GRAFTON CO.: road near confluence of Batchelders Brook and Bakers River, Warren Twp., Churchill s.n., 11 July 1939 (MSC); Holdeness, Faxon s.n., 7 June 1886 (GH); Lebanon, Kennedy s.n., 25 September 1894 (GH). HILLSBOROUGH CO.: Peterborough, Batchelder s.n., 3 September 1928 (MO). ROCKINGHAM CO.: Isles of Shoals, Canby s.n., August 1866 (WS); North Hampton, Eaton s.n., June 1896 (GH). STRATTFORD CO.: Dover, Hodgdon 4679 (WIS). NEW JERSEY: OCEAN CO.: Beach Haven Terrace, Long Beach Island, Long 3798 (GH). PASSAIC CO.: Hewitt, Mackenzie 2850 (MO). NEW YORK: ALBANY CO.: Albany, House 28498 (NY); Loudonville, House 30942 (NY). BRONX CO.: Bronx, Moldenke 20157 (CAN). FRANKLIN CO.: Adirondack Hatchery, Saranac Inn, Muenscher & Maguire 1113 (F, MO). FULTON CO.: Nick Stone Golf Course, Caroga Lake, Fassett 10374 (WIS). ONADAGA CO.: near Jamesville, House s.n., 1 August 1903 (NY). ONEIDA CO.: Utica, Harberer 129 (GH, NY). RENSSELAER CO.: Troy, Hall s.n., 1828-1834 (F). RICHMOND CO.: Richmond Valley, Staten Island, E. G. Britton s.n., 24 June 1894 (NY, GH); Giffords, Staten Island, N. L. Britton s.n., 21 May 1889 (NY). ROCKLAND CO.: Clarkestown Twp., Lehr 1020 (NY). SARATOGA CO.: Saratoga Springs, House 27928 (GH, NY). SUFFOLK CO.: Wading River, Long Island, Miller 327 (UC); Southampton, Long Island, Piper s.n., 12 August 1921 (US); Northville, Long Island, Young s.n., June 1873 (US). TOMPKINS CO.: Ithaca, Eames 9870 (GH, MO). WESCHESTER CO.: Tarrytown, Barnhart 1446 (NY). OHIO: PICKAWAY CO.: Tarlton, Bartley 1526 (NY, US). OREGON: CLATSOP CO.: Cannon Beach, Thompson 12746 (MO, NY, WS, WTU). COOS CO.: Fossil Point, Coos Bay, Abrams & Benson 10577 (DS). CURRY CO.: 4 mi. north of Brookings, VanDeventer s.n., 23 April, 1963 (CAS); The Heads, Port Orford, Peck 9062 (GH, MO, NY). KLAMATH CO.: north end of Lake-of-the-Woods, Peck 16598 (DS). LAND CO.: just south of Heceta Head lighthouse, Cronquist 6112 (GH, NY, UC, WTU); Cleawox Lake, Detling 2989 (UC). LINCOLN CO.: Yachats, Cooke 10717 (OSC); 1/4 mi. south of Yaquina Bay, Lawrence 1562 (DS, OSC, US). MULTNOMAH CO.: Portland, Piper s.n., June 1921 (US); Albina, Suksdorf 1744 (WS). TILLAMOOK CO.: Garibaldi, Erickson s.n., 15 July 1954 (OSC). Oregon, no specific locality, Elihu Hall s.n. in 1871 (CAN). PENNSYLVANIA: BERKS CO.: Reading, Fisher s.n., 23 August 1905 (MICH). CUMBERLAND CO.: Newville, Wahl, Wherry, Hammond, Stafford & Tanger 6624 (GH). LACKAWANA CO.: Scranton, Glowenke 6861 (GH). LEHIGH CO.: Bethleham, Lochman, s.n., 6 August 1891; Allentown, Schaeffer 56239 (US). MONROE CO.: Pocono Manor, Wherry s.n., 18 June 1945 (DAO). MONTGOMERY CO.: Philadelphia, Parker s.n., 2 July 1865 (F); Philadelphia, Witte s.n., 7 July 1934 (RM, NY). RHODE ISLAND: NEWPORT CO.: Newport, Tweedy s.n., June 1881 (DS). PROVIDENCE CO.: Providence, Collins s.n., 30 May 1891. WASHINGTON CO.: Block Island, Watson s.n., June 1885 (GH); Middletown, Williams s.n., 4 July 1909 (GH). Rhode Island, no specific locality, George Thurber s.n., in 1846 (GH). UTAH: PIUTE CO.: Tate Mine, Marysvale, elev. 9000 ft., Jones 5855 (MO). VERMONT: CALDONIA CO.: Peacham, Blanchard

s.n., 31 July 1884 (UC, US); Groton, Seymour 18328 (WIS). ORANGE CO.: Newbury, Jesup & Sargent s.n., 29 July 1891 (GH). WASHINGTON CO.: Walden and Cabot, Burbank, Grout & Eggleston s.n., 4 July 1894 (NY). WINDHAM CO.: Newfane, Grout s.n., 2 July 1895 (F). WINDSOR CO.: Rochester, Dutton s.n., 10 July 1914 (GH, MICH, MO). WASHINGTON: CLALLAM CO.: Elcoha River, Olympic Peninsula, Jones 3522. CHELAN CO.: head of Poison Creek, north side of Lake Chelan, Ward 700 (CAS, WS, WTU). CLATSOP CO.: Cornet Bay, Whidbey Island, Smith 1720 (UC). KING CO.: Kirkland Lake, Eyerdam 1686 (DAO); Redmond, Frye s.n., 24 October 1908 (WTU); Seattle, Rigg s.n., May 1908; near Renton, Thompson 8956 (MO, WTU). KITTITAS CO.: Table Mt., Wenatchee Mts., elev. 4500 ft., Thompson 9743 (WTU); Snoqualmie Pass, Wiegand 840 (F). KITSAP CO.: Colby, Warren 276 (WS, WTU). KLICKITAT CO.: Bingen, Suksdorf 5013 (WS). PACIFIC CO.: Ilwaco, Abrams 11272 (DS). SAN JUAN CO.: Long Island, Muenscher & Muenscher 15979 (MIN). SKAGIT CO.: Bear Creek, T36N, R8E, sec. 10, Mt. Baker National Forest, Crow 1241 (MSC). SNOHOMISH CO.: Everett, Minch s.n., 23 July 1928 (WS). WAHKIAKUM CO.: Cathlamet, Foster s.n., 10 May 1907 (WS). WHATCOM CO.: Little Sandy Creek, Baker Lake, T37N, R8E, sec. 12, Crow 1238 (MSC); Birch Bay, Muencher 7786 (UC, WS); Kendall, Muenscher 10184 (DS, WTU); Bellingham, Thomas 9967 (DS). WISCONSIN: IRON CO.: Hurley, Fassett 9541 (WIS).

A few specimens from the coast of Labrador and of the St. Lawrence seaway have been recognized as *S. procumbens* var. *compacta* Lange. These plants appear to be depauperate, environmentally induced growth forms. Dr. J. K. Morton (personal communication) has likewise

Figure 23. Geographic distribution of _Sagina procumbens_ in North America.

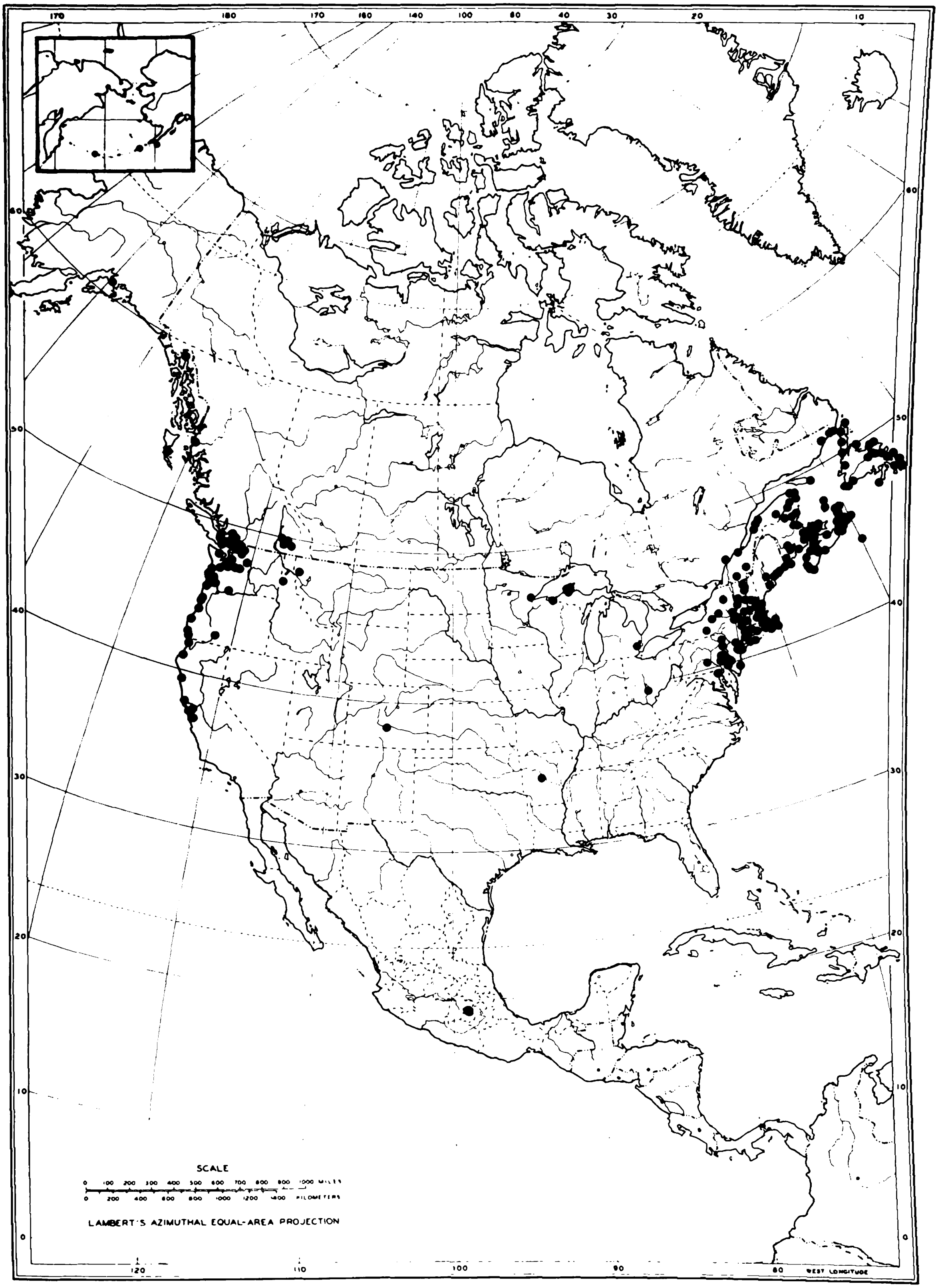


Figure 23

n North

questioned the validity of this taxon. His field observations in a dune situation indicate that there seemed to be a cline from the very compact form ("good" var. compacta) growing away from the shore and becoming more normal toward the shore. Morton collected seed and vouchers from both extremes and grew the plants under cool greenhouse conditions. Plants grown from the compact form appear as normal S. procumbens. We agree that var. compacta should be considered no more than a growth form.

4. Sagina subulata (Sw.) Presl

Sagina subulata (Sw.) Presl, Fl. Sic. p. 158. 1826. Spergula subulata Sw., Sven, Vet, Acad. Handl. Stockh. p. 45. 1789. Phaloe subulata (Sw.) Dumort., Fl. Belgica p. 110. 1827. Spergella subulata (Sw.) Reichb., Fl. Germ. Excurs. p. 794. 1832. Sagina subulata (Sw.) Wimm., Fl. Schles. p. 76. 1841. Alsine subulata Krause, in Sturms, Fl. Deutschl. 2 ed. 5: 34. 1901. Type: not seen. Original material: near Alingsas, Sweden.

Sagina Revelieria Jord. & Flourr., Brev. Pl. Nov. fasc. i. p. 11. 1866. Type: not seen. Original material: Corsica Mountains, Quenza, Corsica, France.

Perennial. Plants tufted, caespitose, frequently forming dense mats. Horizontal stems becoming slightly woody with extensive mat formation. Branches short, with short internodes, ascending or decumbent, often not exceeding basal leaves. Stems densely glandular pubescent or less frequently glabrous. Leaves densely glandular

pubescent or with glandular hairs restricted to the margins, and then often minutely glandular ciliate, rarely glabrous. Leaves with long aristae, 0.5-0.75 mm long. Basal tufts of leaves linear, 3.0-12 mm long, curled inward. Cauline leaves linear-subulate, 3.0-10 mm long. Connate leaf bases scarious, forming a conspicuous cup. Flowers axillary or terminal, usually solitary. Pedicels long, filiform, mean length 22.5 mm, erect during capsular development. Pedicels densely to weakly pubescent. Flowers 5-merous, rarely 4- and 5-merous. Sepals elliptical, 1.5-2.0 mm long, the hyaline margins white. Petals elliptical, 1.5-2.0 mm long, shorter than or equaling sepals. Stamens 10, filaments (1.0-) 1.5 mm long, anthers 0.25 mm long. Capsules slightly exceeding sepals. Capsule valves thin, 2.0-3.0 (-3.5) mm long, dehiscing to base. Sepals remaining appressed following capsule dehiscence. Seeds brown, obliquely triangular, with dorsal groove, a distinct notch at hilum, surface smooth, 0.4 (-0.5) mm long. Chromosome number: $2n = 18$, 22. Figure 24.

Ecology and distribution: In wet gravelly sands of stream margins. Introduced from Eurasia and known only from Harney Co., Oregon, Bedford Co., Virginia and La Laguna, Baja California. Native to Eurasia. Flowering June to August.

Representative specimens: MEXICO: BAJA CALIFORNIA: Sierra de la Laguna, Brandegee s.n., 22 January 1890 (UC). Sierra de la Laguna, Brandegee s.n., 27 March 1892 (GH, UC). Sierra de la Laguna, Brandegee s.n., 4 October 1899 (GH, NY, UC). Cape Region, La Laguna, elev. 6000 ft., Thomas 7885 (CAS, DS, GH, MICH, US).

Figure 24. Photographs of Sagina subulata. (a) Habit, Sweden (Särnquist s.n., 20 June 1948, DAO). (b) Close-up of aristae, photographed under epi-illumination, Sweden (Bagge s.n., 16 June 1890, UC).

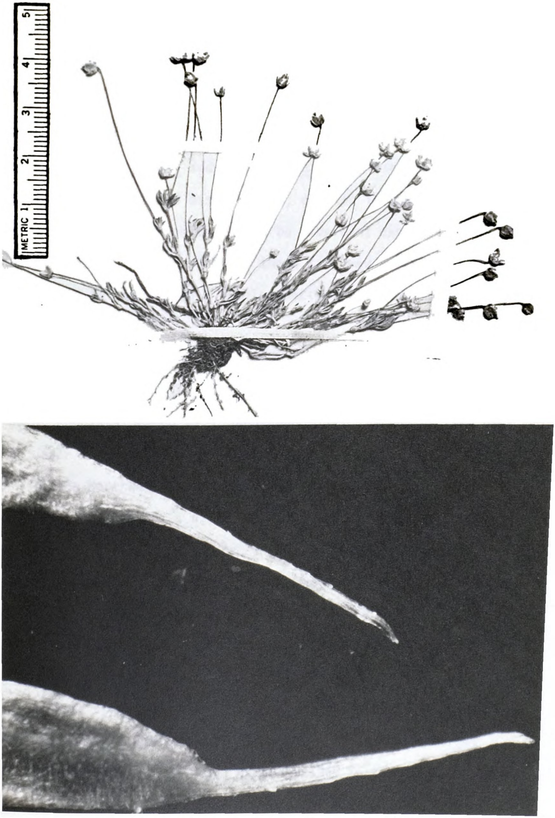


Figure 24

UNITED STATES: OREGON: BARNEY CO.: Steens Mt., Faegri s.n., 25 July 1965 (OSC); Dino Creek, Steens Mt., Train s.n., 30 July 1935 (US) and 31 July 1935 (MIN). VIRGINIA: BEDFORD CO.: specific locality unknown, Curtiss s.n., 20 May 1872 (MO).

Sagina subulata is an extremely variable, wide ranging species of Eurasia. Sagina glabra and S. pilifera, two closely allied European montane taxa of restricted distribution, overlap in numerous characteristics with S. subulata and appear to be divergent expressions of this variable species. Further study of these taxa may reveal that this complex should be considered a single species with three infraspecific taxa.

I have seen but a single specimen from eastern North America which is referable to Sagina subulata. Plants treated by Torrey and Gray as S. subulata belong to S. decumbens subsp. decumbens (see discussion under that taxon).

In the Northwest, three specimens (Train s.n., July 30, 1935 and July 31, 1935; Faegri s.n., July 25, 1965) have been collected in the alpine zone of Steens Mt., Harney Co., Oregon which exhibit glandular pubescence. The Train specimens are extremely pubescent while the Faegri specimen is weakly glandular, with foliar pubescence restricted to leaf margins. Introduction of this population of S. subulata into this remote area is without explanation.

Another isolated population of S. subulata occurs at the tip of Baja California. Specimens collected by T. S. Brandegee during the period 1890-1899 and by J. H. Thomas in 1959 in the mountains at

La Laguna (ca. 5,500 ft. elevation) occur in the region of an abandoned ranch which had been operated in the 1800's (Goldman, 1951). Introduction of this population took place during the period that the ranch was actively worked.

A mat-producing form of this taxon is widely used as a ground cover and is available from Nurserymen under the names "Scottish Moss" and "Corsican Pearlwort." Living plants observed in the W. J. Beal Botanical Garden, Michigan State University, were noted to flower profusely but with no subsequent capsular development. Herbarium specimens from several localities in the western United States likewise show little capsular development. The cultivar propagates easily by vegetative means, but is not found readily escaping cultivation. The cultivar differs from the native European mat-producing form by being glabrous, except for the minutely glandular-ciliate leaf margins. The cultivated form originated in the Corse Mountains, Corsica, France (Vilmorin, 1894).

5. Sagina nivalis (Lindbl.) Fries

Sagina nivalis (Lindbl.) Fries, Nov. Fl. Suec. Mant. 3: 31. 1842. Spergula saginoides var. nivalis Lindbl., in Physiogr. Sällsk. Tidskr. p. 328. 1838. Type: not seen. Original material: region of Kongsvold near Doores, Norway, 24 September 1837.

Sagina intermedia Fenzl, in Ledeb., Fl. Ross. 1: 339. 1842. Type: not seen. Original material: region of Tschuktschorum along bays of St. Laurent, Russia.

Perennial. Caespitose, forming low cushions. Basal rosette of succulent, subulate leaves, tips apiculate. Flowering stems numerous, radiating from axils of basal rosette leaves. Stems slender, sometimes purple tinged. Cauline leaves subulate, with connate leaf bases forming shallow scarious cup, often purplish, becoming shorter toward stem apex. Pedicels long, filiform, glabrous. Flowers 4-merous or 4- and 5-merous. Sepals 1.5-2.0 mm long, nearly orbicular to elliptical, rounded at tip, glabrous, frequently purplish, hyaline margins nearly always purple, sometimes only at tip. Petals equaling to slightly shorter than sepals, 1.5-2.0 mm long. Stamens 8 or 10, filaments 1.5 mm long, anthers 0.25 mm long. Capsules 4- or 5-valved, 2.0-3.0 mm long, dehiscing to base. Capsule valves thick. Sepals remaining appressed following capsule dehiscence. Seeds brown, obliquely triangular, with dorsal groove, distinctly notched at hilum, lateral surfaces frequently with elongate ridges, dorsal surface appearing smooth to pebbled, 0.5 mm long. Chromosome number: $2n = 84, 88$. Figure 25.

Ecology and distribution: Growing on sandy or gravelly beaches, coastal rocks, alluvial plains, fresh glacial moraines and low, swampy tundra and in alpine areas. Widely distributed in the Arctic Archipelago, Alaska, Hudson-James Bay region and the coast of Labrador. Disjunct population in Alberta. Flowering July and August. Figure 26.

Representative specimens: CANADA: ALBERTA: Medicine Lake, Jasper National Park, Scamman 2527 (GH). Mt. Edith Cavell, Angel Glacier, Jasper National Park, Scamman 2446 (GH), mixed collection. LABRADOR: Chateau, 51°49'N. Allen s.n., 8 August 1882 (F, NY).

Figure 25. Photographs of _Sagina nivalis_. (a) Habit, Axel Heiberg Is., N. W. T. (_Hegg_ and _Beschel 10857_, GH). (b) Habit, Attu Is., Aleutians (_Jordal_ and _Miller 3077-A_, MICH).

Figure 25

Nunaksuk Island, Bishop 285b (GH). Crater Lake vicinity, ca. 52 mi. west southwest of Hebron, 58°02'N., 64°02'W., Gillett 8938 (DAO, US). Makkovik, 55°N., Hustich 68 (CAN). Cutthroat Harbour, south of Cape Mugford, 57°30'N., 62°W., Porsild 189 (CAN). Hebron, Sornborger 207 (GH). Battle Harbour, Waghorne 4901 (CAN). Okkak, near Cutthroat Tickle, 57°40'N., 62°W., Wynn-Edwards 7476 (CAN). NORTHWEST TERRITORIES: DISTRICT OF FRANKLIN: Northwest Middle Fiord, Axel Heiberg Island, Beschel 13118 (CAN). Mould Bay, Prince Patrick Island, 76°14'N., 118°59'W., Bruggemann 361 (DAO, NY, UC). Frobisher Bay, Baffin Island, 63°45'N., 68°32'W., Calder 2085 (DAO, US). Erik Harbour, Baffin Island, 72°40'N., 76°30'W., Coombs 31 (DAO). Head of Inugsuin Fiord, Baffin Island, Hainault 3634 (CAN). Ferguson Lake, Victoria Island, 69°25'N., 105°15'W., Jones 29a (DAO). Clyde, Baffin Island, Martin 23 (DAO). Beekman Peninsula, southeast Baffin Island, ca. 63°25'N., 64°75'W., McLaren 103 (CAN). Pangnirtung, Baffin Island, Polunin 1168 (US). Arctic Bay, Baffin Island, Polunin 2555 (CAN). Banks Island, near northeast corner, ca. 73°24'N., 117°W., Porsild 17677 (CAN). Bernard Island on northwest coast of Banks Island, Porsild 17747 (CAN). Resolute Bay, Cornwallis Island, Porsild 21672 (CAN). Head of Minto Inlet, Victoria Island, Porsild 17388 (CAN). Botany Bay, Kangerdluak Fiord, Ekalugad Fiord region, Baffin Island, Webber 1302 (CAN). Isortoq Fiord, Baffin Island, Webber 382 (CAN). Isortoq River at Lewis Glacier, Webber 140 (CAN). Cumberland Sound, opposite Pangnirtung, Baffin Island, Wynne-Edwards 9364 (CAN). Cape Searle, Padloping, ca. 67°10'N., 62°30'W., Wynne-Edwards 9147 (CAN). DISTRICT OF KEEWATIN: Cape Jones, Baldwin, Hustich, Kucyniak & Tuomikoski 664 (CAN). Smith Island, east coast of Hudson Bay, Baldwin 1824 (CAN, GH). Coral Harbour, South Hampton Island, Calder, Savile & Kukkonen 24228 (DAO). Whale Point, northwest coast Hudson Bay, Comer s.n., August 1894 (GH). Fullerton, Hudson Bay, 63°57'N., Macoun 79091 (CAN, GH). Port Burwell, Hudson Strait, 60°22'N., 64°50'W., Malte s.n., 25-28 July 1928 (CAN, GH). Mistake Bay, 62°05'N., 93°06'W., Porsild 5664 (CAN). Yathkyed or Hikolikdjuak Lake on the Kazan River, 62°30'-63°N., 97°-98°30'W., Porsild 5795 (CAN). Chesterfield Inlet, 1 mi. north of settlement, 63°21'N., 90°42'W., Saville & Watts 1266 (DAO, MO, WTU). DISTRICT OF MACKENZIE: O'Grady Lake, Mackenzie Mts., 63°00'N., 129°02'W., Cody 16416 (DAO). Bathurst Inlet, west side, Keisall & McEwen 190 (CAN). Atkinson Point, Arctic Coast, ca. 70°N., 131°20'W., Porsild & Porsild 2601 (CAN). Cape Dalhousie, Arctic Coast, ca. 70°20'N., 129°55'W., Porsild & Porsild 2747 (CAN). 6 mi. east of Kittigazuit, Arctic Coast, ca. 69°20'N., 133°W., Porsild & Porsild 2482 (CAN). Shingle Point, Arctic Coast, ca. 69°N., 137°30'W., Porsild 7099 (CAN). QUEBEC: Richmond Gulf, Cairn Island, east coast of Hudson Bay, ca. 56°15'N., 76°30'W., Abbe, Abbe & Marr 4399 (MIN). Stromness Harbor, Fort George, James Bay, 53°56'N., Dutilly & Lepage 12740 (GH). YUKON TERRITORY: Mayo Landing, Broadfoot 5 (DAO). Canol Rd., Mile 95, upper Rose River valley, Porsild & Breitung 10368 (CAN).

UNITED STATES: ALASKA: Mendenhall, Anderson 434 (NY). Wainwright, Anderson 4364 (UC). Lowell Creek Canyon, Seward, Kenai Peninsula, Calder 5898 (DAO). Snow River delta, Kenai Lake, Kenai Peninsula, 60°19'N., 149°21'W., Calder 6573 (DAO). Head of Katmai River, Katmai

National Monument, Cahalane 518 (US). Ca. 40 mi. east of Cape Lisburne, 4 mi. inland along Pitmegea River, Cantlon & Gillis 57-2453 (MSC). Okpilak River, 69°23'N., 144°04'W., Cantlon & Gillis 57-2287 (MSC, US). Glacier Bay, Cooper 222 (US). Columbia Bay, Prince William Sound, Cooper 315 (F, MIN). Muir Inlet, Glacier Bay, Coville & Kearney 630 (US). Port Vita, Raspberry Island, Kodiak group, Eyerdam 5137 (CAS, DAO, MIN). Sable Pass, Mt. McKinley National Park, Frohne 54-256 (DS). Tangle Lakes area, east of Landmark Gap, Alaska Range, Gjaerevoll 1324 (CAN). Mead River village, Northern Coastal Plain, Hultén s.n., 5-8 August 1960 (US). Uyak, Kodiak Island, Jepson 391 (US, UC). Olga Bay, Kodiak Island, Looff & Looff 1027 (GH). Dexter Creek, Nome, Seward Peninsula, Porsild & Porsild 1340 (CAN). Pastolik, Norton Sound, Porsild & Porsild 985 (GH). Unalaklet, Norton Sound, Porsild & Porsild 1148 (CAN). Port Clarence, Teller, Seward Peninsula, Porsild & Porsild 1432 (CAN). Paxon, Alaska Range, Porsild & Porsild 574 (CAN). Point Hope, Scamman 6390 (CH). Meade River, 1 mi. southeast of Atkasuk, Stone 300 (DS, RM). Iko Bay, vicinity of Point Barrow, Thompson 1395 (DS, US). Columbia Glacier, Heather Island, 60°N., 147°W., Viereck & Viereck 2312 (COLO). Nanivak, 7 mi. southwest of Point Barrow, Wiggins 12604 (DS, GH, UC, US, WTU). Point Barrow, Wiggins 12946 (DS, GH, UC, WTU). Near Walakpa triangulation target, southwest of Barrow Village, Wiggins 12511A (DS). Cape Thompson, 68°05'N., 165°40'W., Wood & Wood 511 (CAN). ALLEUTIAN ISLANDS: Amchitka Island, Erdman 578 (COLO). Amlia Island, Eyerdam 1244 (CAS, DS, GH). Nunivak Island, Haley s.n., 1 July 1927 (CAS). Attu Island, Hardy 385 (GH, MIN, WTU). Attu Island, Howard 30 (US). Umnak Island, Nikolski, Hultén 7041 (CAS). Unalaska,

Figure 26. Geographic distribution of Sagina nivalis in North America.

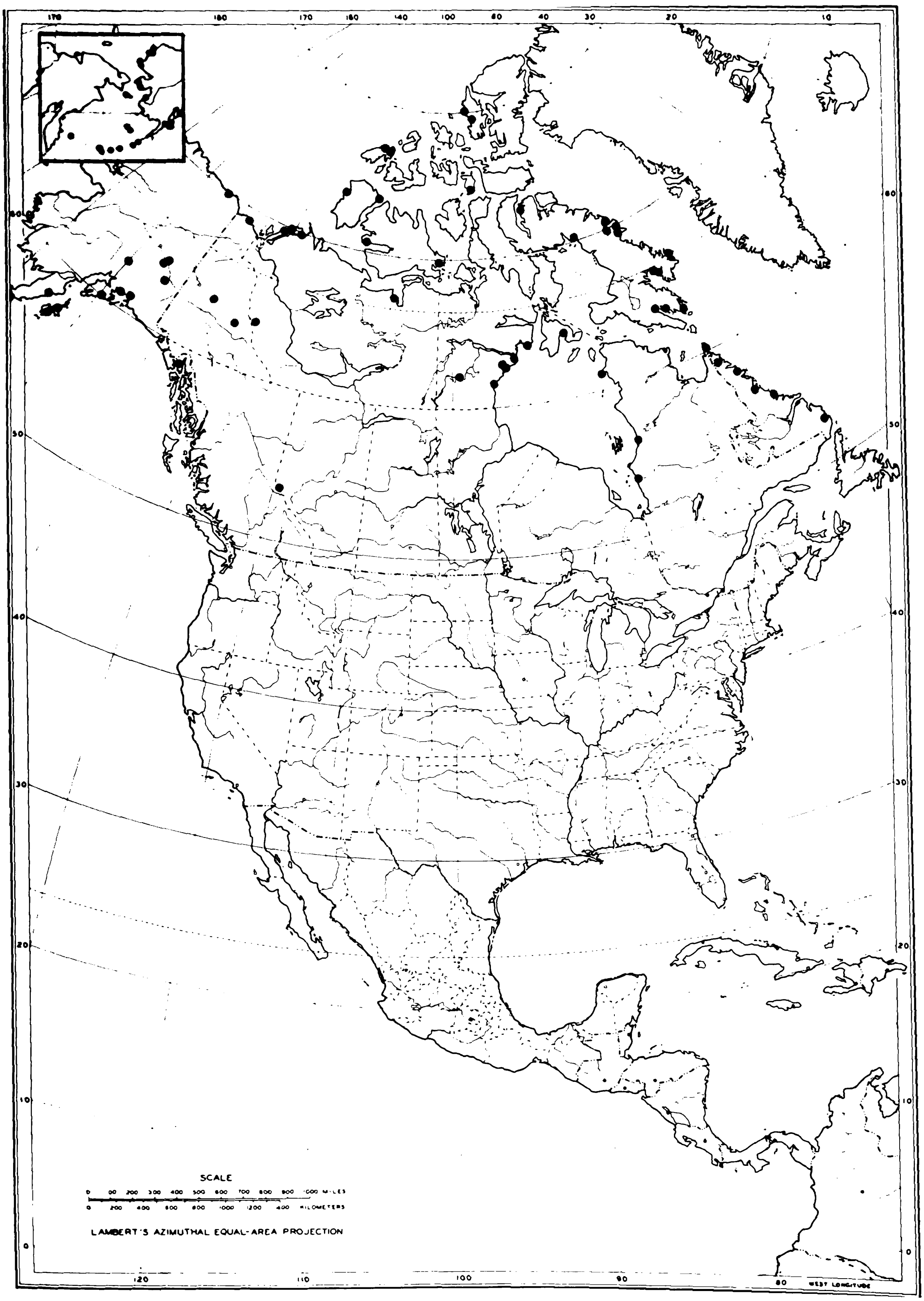

SCALE
LAMBERT'S AZIMUTHAL EQUAL-AREA PROJECTION
WEST LONGITUDE

Figure 26

Hultén 6708b (US). Ananuliak Island, Umnak, 5 mi. of Nikolski, Johnson 290 (WIS). Adak Island, Jordal 2621-A (MICH, US). Atka Island, Oliver & Oliver 55 (MICH, US). BERING SEA: Pribilof Islands, St. George Island, Johnston s.n., 5 May 1920 (CAS). Pribilof Islands, St. Paul Island, Macoun s.n., 28 July 1891 (GH, MO, NY, US). St. Lawrence Island, Gambell, Anderson 5185 (CAN).

Sagina nivalis occurs disjunction in Alberta. I have seen only two specimens from Alberta which represent "good" S. nivalis (Scamman 2446 and 2527). This population is mixed with S. saginoides. There are several specimens from Banff and Jasper National Parks which appear intermediate between S. nivalis and S. saginoides.

There are several specimens from alpine habitats in Colorado, Utah and Wyoming which are suggestive of S. nivalis. These specimens are densely caespitose and the sepal margins are distinctly purple. These 5-merous specimens, however, belong to S. saginoides.

6. Sagina caespitosa (J. Vahl) Lange

Sagina caespitosa (J. Vahl) Lange, Consp. Fl. Groenl., Meddel. Groenl. 1: 22. 1880. Arenaria caespitosa J. Vahl, Icon. Fl. Danica. 18: 4. 1840. Sagina nivalis var. caespitosa (J. Vahl) Boiv., Nat. Can. 93: 583-646. Type: not seen. Original material: growing in wet clayey and sandy gravel filled places, ca. 60 ft. above sea level, especially in bays of Greenland from Godthaab to Upernavik, and occurs from 64° to 72° 48'.

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Figure 28.

Rep
Peninsula,
Ikordlearsu

Perennial. Caespitose, forming small mats or cushions. Basal rosette of leaves lacking; secondary rosettes usually present, leaves linear to linear-subulate. Flowering stems numerous, ascending to radiating, frequently purple tinged. Cauline leaves subulate, becoming shorter toward apex, midvein frequently conspicuous; connate leaf bases forming shallow scarious cup, often purplish. Pedicels long, filiform, glandular pubescent, rarely glabrous (in North American plants). Flowers 5-merous or 5- and 4-merous. Sepals 2.0-2.5 mm long, broadly ovate to lanceolate, tips obtuse to somewhat acute, hyaline margins usually purple tinged, at least at the tip. Calyx base glandular pubescent or glabrous. Petals 2.5-3.0 mm long, exceeding, seldom equaling, sepals. Stamens 10 or 8, filaments 1.5-2.0 mm long, anthers 0.25-0.3 mm long. Capsules 5- or 4-valved, 3.0-3.5 mm long, dehiscing to base. Capsule valves thick. Sepals remaining appressed following capsule dehiscence. Seeds brown, obliquely triangular, with dorsal groove, distinctly notched at hilum, lateral surfaces frequently with elongate ridges, dorsal surface appearing smooth to pebbled, 0.5 mm long. Chromosome number: $2n = 88$. Figure 27.

Ecology and distribution: In wet sands and gravels of shorelines and stream margins, wet mossy places, and dry rocky barrens and gravelly hillocks. Northeast Arctic, south to northern Manitoba, James Bay and northern Labrador. Amphi-Atlantic. Flowering July and August. Figure 28.

Representative specimens: CANADA: LABRADOR: Cape Mugford Peninsula, Kaumajet Mts., 57°50'N., 62°50'W., Abbe 269 (GH). East Bay, Ikordlearsuk, Torngate region, 59°57'N., 64°24'W., Abbe & Odell 270 (GH).

Figure 27. Photographs of _Sagina caespitosa_. (a) Habit. (b) Close-up showing pubescence on calyx base and pedicel. Both Baralzon Lake, Manitoba (_Scoggan_ and _Baldwin_ _8206_, CAN).

Figure 27

MANITOBA: Baralzon Lake, 60°00'N., 98°10'W., Scoggan & Baldwin 8206 (CAN, MIN). NORTHWEST TERRITORIES: DISTRICT OF FRANKLIN: Inugsuin Fiord, Baffin Island, ca. 70°N., 68°30'W., Hainault 3836 (CAN). Beekman Peninsula, southeast Baffin Island, ca. 63°20'N., 64°50'W., McLaren 142 (CAN). Pangnirtung, Baffin Island, Polunin 1568 (WIS). Point Brewster, Frobisher Bay, Baffin Island, Potter 8237 (GH). Resolution Island, Frobisher Bay, Baffin Island, Potter 8238 (GH). Tolnes Road, Baffin Island, 66°27'N., Seidenfaden 1281 (NY). Isortoq Fiord, Baffin Island, ca. 70°N., 77°W., Webber 407 (CAN). DISTRICT OF KEEWATIN: Cape Jones, Baldwin, Hustich, Kucyniak & Tuomikoski 681a (CAN). Kaminak Lake, 62°N., 95°W., Güssow 114a (DAO). Port Burwell, Hudson Strait, 60°22'N., 64°50'W., Malte s.n., 25-28 July 1928 (CAN, GH). Baker Lake, north shore, 64°30'N., 97°W., Porsild 6094 (CAN). Kazan River, 62°30'-63°N., 97°-98°30'W., Porsild 5798 (CAN). QUEBEC: Fort Chimo area, 58°07'N., 68°23'W., Calder 2662 (DAO). Fort George, James Bay, 53°53'N., Dutilly & Ernest 12500 (GH). Korok River, east side of Ungava Bay, 42 mi. inland from Korok Bay, 58°35'N., 64°15'-66°W., Rousseau 1111 (DAO).

The material of North America and western Greenland differs from European plants of this taxon in having glandular trichomes on the upper portion of the pedicels and on the calyx bases. The European plants are totally glabrous. Amount of glandular pubescence in the North American material is variable. Weakly glandular forms are frequent and occasionally glabrous specimens are encountered. Plants of the glandular pubescent form examined possessed an average of 70% glandular flowers while 30% of the flowers were glabrous. Separate

Figure 28. Geographical distribution of Sagina caespitosa in North America.

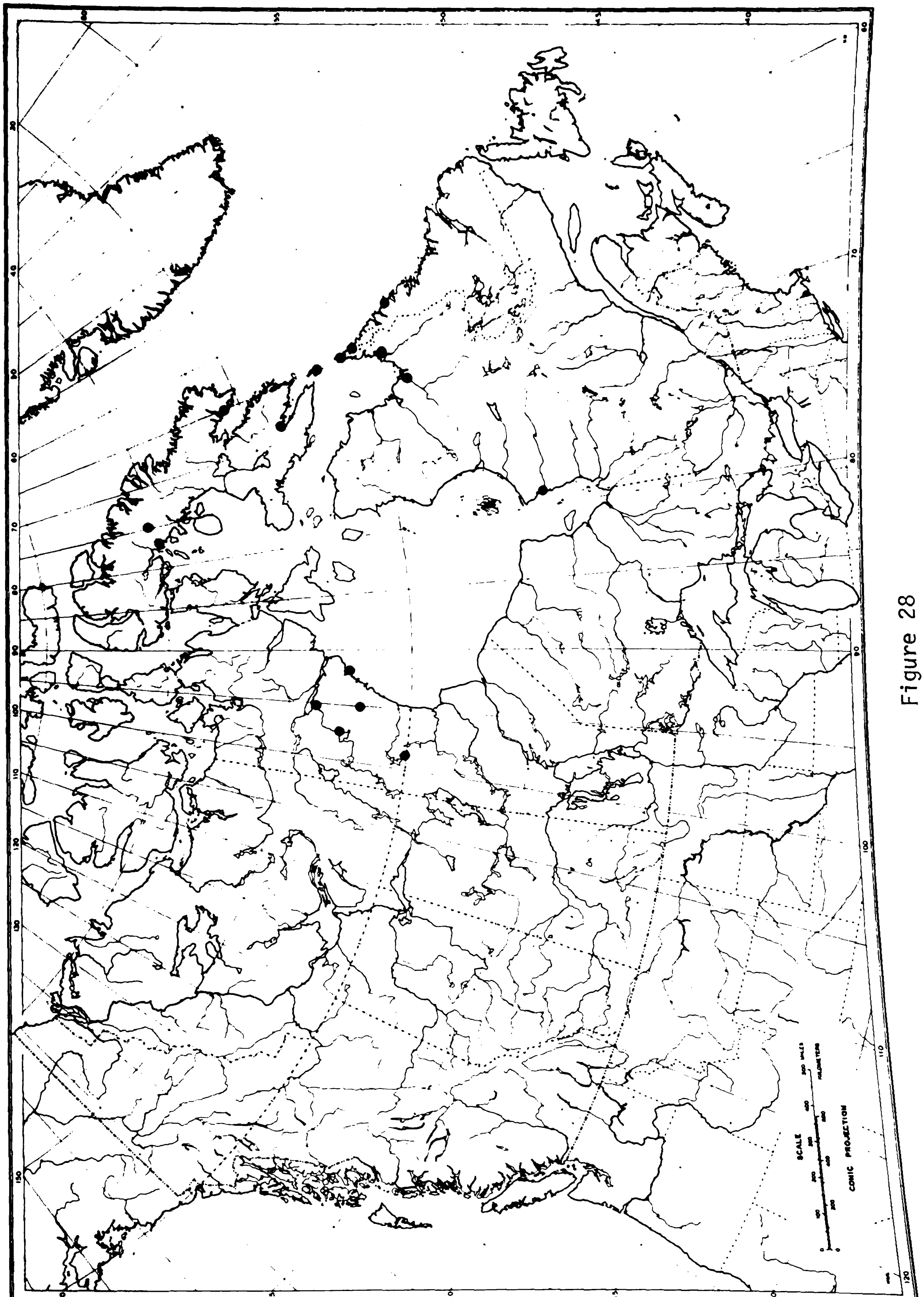

Figure 28

nomenclatural recognition of European and North American material seems unnecessary.

7. Sagina decumbens (Ell.) T. & G.

Key to the subspecies:

Seeds light tan, with delicate reticulate ridge pattern; surface smooth or tuberculate . . . 7a. subsp. decumbens

Seed light brown, never with reticulate ridge pattern; surface smooth to slightly pebbled . . . 7b. subsp. occidentalis

7a. Sagina decumbens (Ell.) T. & G. subsp. decumbens

Sagina decumbens (Ell.) T. & G., Fl. N. Am. 1: 77. 1838. Spergula decumbens Ell., Sketch 1: 523. 1821. Type: unknown.

Sagina subulata var. Smithii Gray, Manual 5 ed. p. 95. 1867. Type: C. E. Smith s.n., June 1865, sandy road in the pine woods, at the mouth of Great Egg Harbor, New Jersey (GH, lectotype!).

Annual with slender taproot. Branches slender, ascending or decumbent. Basal rosette of leaves lacking or early deciduous. Lower cauline leaves linear, 4-22 mm long, leaf bases connate, typically with conspicuous hyaline margins, connate portion not generally appearing inflated, apices apiculate. Anthocyanins frequently giving stems and connate leaf bases a purplish tinge. Upper cauline leaves becoming subulate toward apex, 1.5-5 mm long at tip, apiculate. Pedicels filiform, glabrous or glandular pubescent. Flowers 5-merous, rarely 4-merous. Calyx base glabrous or glandular pubescent, often sparsely so.

Sepals ovate, hyaline margin conspicuous, margins or apex frequently purple. Sepals (1.0-) 1.5-2.0 (-3.0) mm long. Petals elliptical, slightly exceeding sepals at anthesis, equal or shorter than sepals during capsule development, (0.75-) 1.0-2.0 (-2.25) mm long. Stamens 10 or fewer, filaments (1.0-) 1.5 mm long, anthers 0.25 mm long, dehiscing less than half the length of the capsule. Sepals remaining appressed after capsule dehiscence. Seeds light tan, obliquely triangular, with dorsal groove, surface smooth or tuberculate, with delicate reticulate ridge pattern (sometimes obscure), (0.25-) 0.3-1.4 mm long. Chromosome number $2\underline{n} = 36$. Figure 29.

Ecology and distribution: In moist or dryish sandy places, frequently at field margins, open pine woods, paths, roadsides, sidewalk cracks and lawns. Southeastern half of the United States, from Connecticut and southern New Jersey, west to southern Ohio, southern Indiana, Illinois, Missouri and southeastern Kansas, south to northern Florida and eastern Texas. Disjunct populations in Arizona, Alberta and New Brunswick. Sagina decumbens subsp. decumbens is chiefly a Coastal Plain and Piedmont taxon. It appears to have extended its range westward with civilization, particularly into Kansas, Oklahoma, northeast Texas, Arizona, Alberta and Saskatchewan. Flowering April to June. Figure 30.

Representative specimens: CANADA: ALBERTA: east of Hand Hills, Macoun s.n., 8 August 1879 (CAN, DAO). Buffalo Plains, Macoun s.n., 10 August 1879 (US). SASKATCHEWAN: hillsides, Farewell Creek, Cypress Hills, Macoun s.n., 27 June 1895 (CAN).

Figure 29. Photographs of *Sagina decumbens* subsp. *decumbens*. (a) Habit. (b) Close-up showing glandular pubescence. Horry Co., South Carolina (*Weatherby* & *Griscom* 16524, US).

Figure 29

UNITED STATES: ALABAMA: CULLMAN CO.: Cullman, Mohr s.n., 1 April 1884 (US). ESCAMBIA CO.: Atmore, Blanton 201 (DAO, F, GH, MICH). LEE CO.: Auburn, Earle & Baker s.n., 18 April 1898 (F, NY, RM, US). MOBILE CO.: Mobile, Mohr s.n., 24 March 1861 (US). ARIZONA: mountains between Miami and Superior (border of Pinal and Gila Counties), Nelson & Nelson 1907 (CAS, GH, MO, NY, RM, UC, US). PIMA CO.: Rincon Range Station, Darrow s.n., 11 April 1937 (CAS). ARKANSAS: BRENTON CO.: Decatur, Plank s.n., April 1899 (NY). BRADLEY CO.: Warren, Demaree 21484 (GH). CLAY CO.: Corning, Letterman s.n., May 1884 (MO). FRANKLIN CO.: Mulberry River, Cass, Fassett 17439 (WIS). GREENE CO.: specific locality unknown, Eggert s.n., 29 April 1893 (MO). HEMPSTEAD CO.: Fulton, Bush 2434 (MO). INDEPENDENCE CO.: Newark, Eggert s.n., 23 April 1896 (MO). NEVADA CO.: Prescott, Bush 533 (MO). PULASKI CO.: Little Rock, Demaree 22725 (MO). WASHINGTON CO.: Savoy, Fassett 17440 (WIS); Brentwood, Palmer 8206 (NY). CONNECTICUT: FAIRFIELD CO.: Fairfield, Eames s.n.. 19 June 1898 (GH). NEW HAVEN CO.: Milford, Eames s.n., 7 June 1898 (GH). DELAWARE: KENT CO.: Choptank Mills, Tatnall 2130 (GH). SUSSEX CO.: Millsboro, Commons s.n., 23 May 1876 (GH); Bethany Beach, Tatnall 3321 (GH). DISTRICT OF COLUMBIA: Washington, Morong s.n., 22 May 1877 (NY). FLORIDA: ALACHUA CO.: Gainsville, Wiggins 19394 (NY). BAY CO.: Lynn Haven, Banker 3671 (NY). DUVAL CO.: near Jacksonville, Curtiss 6353 (DS, GH, MIN, MO, NY, UC, US). GILCHRIST CO.: 9 mi. south of Bell, Wiggins 19493 (DS). HILLSBOROUGH CO.: no specific locality, Fredholm 6314 (GH, MIN). JACKSON CO.: Marianna Caverns State Park, Godfrey 55331 (GH, NY). LEON CO.: near Tallahassee, Rugel s.n., April 1843 (MO). LIBERTY CO.: Apalachicola River swamp south of Bristol, Small, DeWinkeler & Mosier 11263 (NY). ST. JOHNS CO.: St. Augustine, Leeds s.n., 4 March 1893 (F). GEORGIA: BARTOW CO.: 2 1/4 mi. northwest of Acworth, 7 1/2 mi. southeast of Centerville, Duncan 8041 (MO). CALHOUN CO.: Edison, Collom s.n., 18 April 1953 (MO). CHATHAM CO.: Tybee Island, Harper 2175 (GH, MO, US). CLARKE CO.: 3 mi. west of Winterville, Cronquist 4237 (GH, NY, US); Athens, Harper s.n., 20 June 1900 (NY). DEKALB CO.: Decatur, Crow 1925 (MSC); Stone Mountain State Park, Crow 1919 (MSC). GLYNN CO.: 5 mi. west of Brunswick, Cronquist 4913 (US). GWINNETT CO.: Yellow River near McGuire's Mill, Small s.n., 7 May 1895 (F, NY). MACON CO.: near Macon, Mohr s.n., April 1915 (US). RABUN CO.: canyon at Tallulah Falls, Small s.n., 20 April 1893 (F). RICHMOND CO.: Augusta, Crow 1926 (MSC). WILKES CO.: just east of Dry Fork of Long Creek, between Washington and Lexington, Cronquist 4229 (GH, MICH, MO, NY, UC, US). ILLINOIS: CHAMPAIGN CO.: Urbana, Jones 19605 (DAO). JACKSON CO.: Giant City State Park, Fassett 21467 (WIS). JOHNSON CO.: Round Bluff, south of Goresville, Bailey 2194 (MIN); Vienna, Winterringer 6281 (F). PEORIA CO.: Peoria, Chase 10374 (F). PULASKI CO.: Wetang, Vasey s.n., no date (F, NY). UNION CO.: Cobden, Earle 693 (NY). INDIANA: BROWN CO.: Nashville, Lyon s.n., 22 May 1930 (MICH). CLARK CO.: Charlestown, Baird s.n., 2 June 1877 (MICH). JEFFERSON CO.: Hanover, Barnes 17 (WIS). POSEY CO.: Mt. Vernon, Deam 56156 (GH). SPENCER CO.: Rockport, collector and date unknown (GH). KANSAS: CHEROKEE CO.: specific locality unknown, Hitchcock 628 (GH, MO, NY, RM, US); 2 mi. northwest of

Baster Springs, McGregor 15337 (US). KENTUCKY: LYON CO.: Kuttawa, Eggleston 4641 (MIN, NY). LOUISIANA: EAST BATON ROUGE PARISH: Baton Rouge, Brown 860 (NY). IBERIA PARISH: Weeks Island, Thieret 16999 (US). IBERVILLE PARISH: Plaquemine, Barnhart 2822 (NY). LAFAYETTE PARISH: Lafayette, Thieret 10333 (DAO). LA SALLE PARISH: Catahoula Lake, 3 mi. southeast of Nebo, Ewan 19066 (GH). PLAQUEMINES PARISH: Point la Hache, Langlois s.n., April 1883 (NY, UC). RAPIDES PARISH: Bluffs of Red River, vicinity of Alexandria, Ball 411 (MO, NY, US). ST. MARTIN PARISH: St. Martinville, Langlois s.n., 15 March 1892 (MICH, MIN). ST. TAMMANY PARISH: vicinity of Covington, Arsène 11978 (US). MARYLAND: TALBOT CO.: 2 1/4 mi. southwest of Longwoods, Earle 4062 (GH). WORCESTER CO.: 10 mi. southeast of Salisbury, Tatnall 1773 (WS). MISSISSIPPI: CARROLL CO.: North Carrollton, Clute 35 (F, NY). FORREST CO.: southeast of Hattiesburg, Cooley, Pease & Ray 3243 (GH). JACKSON CO.: Biloxi, Tracy 5040 (F, MICH, MO, MSC, NY). LEE CO.: Natchez Trace Parkway, McDougall 1804 (US). PEARL RIVER CO.: 3 mi. north of Picayune, Rose 8046 (CAS). WARREN CO.: Snyder's Bluff, Cooley 3336 (GH). MISSOURI: BARRY CO.: Eagle Rock, Bush 507 (MO). BOLLINGER CO.: 5 mi. west of Grassy, Steyermark 18982 (MO). BOONE CO.: 4 mi. southeast of Ashland, Drones 1910 (CAS, GH). BUTLER CO.: Neelyville, Bush 36 (MIN); 5 mi. southwest of Qulin, Steyermark 26655 (F). CARTER CO.: Grandin, Bush 340 (MO). CEDAR CO.: 3 mi. north of Stockton, Steyermark 18655 (MO). CHRISTIAN CO.: Chadwick, Bush 4441A (MO). DALLAS CO.: between Plad and Buffalo, Steyermark 18691 (MO). DOUGLAS CO.: along north fork of White River between Roosevelt and Richville, Steyermark 19156 (MO). DUNKIN CO.: about 5 mi. northwest of Campbell, Steyermark

398 (MO). FRANKLIN CO.: Pacific, Eggert s.n., 23 May 1882 (MO, NY, US). GREENE CO.: specific locality unknown, Blankinship s.n., 23 April 1888 (MO). HENRY CO.: 3 mi. northeast of Finey, Steyermark 18774 (MO). JEFFERSON CO.: Hasse s.n., 24 May 1887 (MO). LACLEDE CO.: north of Hazel Green, Steyermark 8075 (MIN). LAWRENCE CO.: east of Chesapeak, Steyermark 4519 (MO). MAC DONALD CO.: specific locality unknown, Bush s.n., 24 April 1891 (MO). MILLER CO.: 4 mi. south of Bogville Dam, Steyermark 18798 (MO). OREGON CO.: 4 mi. south of Koshkonong, Steyermark 18970 (MO). OSAGE CO.: east of Linn, Steyermark 18709 (MO). PHELPS CO.: 4 mi. southeast of St. James, Steyermark 22188 (F). POLK CO.: north of Burns, Steyermark 18665 (MO). PULASKI CO.: 1 mi. west of Jerome, Steyermark 4600 (MO). REYNOLDS CO.: south of Ellington, Steyermark 7944 (MO). ST. FRANCOIS CO.: Bismark, Russell s.n., 15 April 1898 (MO). ST. LOUIS CO.: Forest Park (in St. Louis), Steyermark 1728 (F). SCOTT CO.: 2 mi. south of Benton, Steyermark 10256 (MO). SHANNON CO.: Montier, Bush 54 (MO). TEXAS CO.: along Jack's Fork of Current River, 3 mi. south of Arroll, Steyermark 18588 (MO). WAYNE CO.: south of Greenville, Anderson s.n., 31 May 1939 (MO). NEW JERSEY: ATLANTIC CO.: Pleasant Mills, Gross s.n., 12 May 1884 (NY); Atlantic City, Redfield 4180 (MO); Somer's Pt., Smith s.n., June 1865 (MO, NY). BERGEN CO.: near Hewitts, Britton s.n., 29 June 1886 (NY). BURLINGTON CO.: Atsion, Canby s.n., August 1863 (NY). CAMDEN CO.: Camden, Parker, s.n., 4 July 1866 (MO). CAPE MAY CO.: Cold Springs, Brown 5236 (GH). OCEAN CO.: Forked River, Churchill s.n., 27 May 1891 (GH); Surf City, Long 3821 (GH). NEW YORK: NASSAU CO.: Rockaway,

Schrenk s.n., 30 May 1879 (MICH). SUFFOLK CO.: Stony Brook, Miller s.n., 25 May 1877 (GH); Wading River, Miller s.n., 22 May 1874 (F). NORTH CAROLINA: BUNCOMBE CO.: Asheville, Hayne 2766 (F). CARTERET CO.: Beaufort, Morton 2198 (US). BRUNSWICK CO.: Smith Island, Morton 2118 (US). NEW HANOVER CO.: near Wilmington, Canby s.n., May 1867 (MICH, NY). NORTHAMPTON CO.: Garysburg, Ahles 38345 (DAO). ORANGE CO.: Chapel Hill, Carlton 38 (MIN). PITT CO.: Gardnerville, Radford 32534 (NY). ROBESON CO.: Lumberton, Knowlton s.n., 9 April 1924 (GH). ROWAN CO.: vicinity of Heilio's Mill, Small & Heller s.n., 4-9 June 1891 (WTU). WAKE CO.: Raleigh, Godfrey, s.n., 8 April 1937 (GH). OHIO: LAWRENCE CO.: Ironton, Werner s.n., 27 May 1892. OKLAHOMA: CARTER CO.: 6 mi. northwest of Ardmore, Nelson, Nelson, Goodman & Waterfall 5696 (RM). COMANCHE CO.: vicinity of Fort Sill, Clemens 11576 (MO). CRAIG CO.: Vinita, Indian Territory, Carleton 12 (NY, US). CLEVELAND CO.: 2 mi. east of Norman, Bruner s.n., 15 April 1924 (MO, RM). MARSHALL CO.: near Lake Texoma, Goodman 5806 (GH, US). MURRAY CO.: Crusher Spur, Stevens 52 (DS, MIN, MO, NY, US). PONTOTOC CO.: 4-5 mi. east of Ada, Robbins 2339 (UC). PENNSYLVANIA: BUCKS CO.: Doylestown, Pond s.n., 27 May 1885 (US). LANCASTER CO.: Safe Harbor, Porter s.n., 15 May 1861 (NY). PHILADELPHIA CO.: ballast ground, Philadelphia, Parker s.n., 30 May 1865 (NY). SOUTH CAROLINA: ALLENDALE CO.: Fairfax, Ahles 10616 (COLO). BEAUFORT CO.: Beaufort, Churchill 379 (MO). CHARLESTON CO.: Charleston, Smith s.n., April 1865 (GH). DORCHESTER CO.: Summerville, Hunnewell 8139 (MIN). EDGEFIELD CO.: north of Edgefield, Steyermark 63373 (F). HORRY CO.: 2 mi. south of Myrtle Beach, Clausen

& Trapido 3748 (NY); Longwood Landing, Weatherby & Griscom 16524 (NY, US). KERSHAW CO.: Lynches River, 7 mi. south of Jefferson, Redford 9068 (WTU). TENNESSEE: DECATUR CO.: specific locality unknown, Ames s.n., July 1865 (MICH). FRANKLIN CO.: north of Estill Springs, Svenson 9993 (GH). GRUNDY CO.: Goose Pond, near Pelham, Svenson 7618 (GH). GRUNDY CO.: Goose Pond, near Pelham, Svenson 7618 (GH). KNOX CO.: Knoxville, Ruth 4310 (MO). OBION CO.: near Samburg, Eyles 7801 (GH). ROAN CO.: Harriman, McMorine s.n., 22 April 1893 (DAO). SHELBY CO.: near Memphis, Palmer 17447 (MO). TEXAS: BASTROP CO.: Alum Creek, south of Bastrop State Pines Park, Tharp, Warnock & Barkley 16T011 (F, UC). BELL CO.: near Belton, Wolff 374 (US). BURNET CO.: 3 mi. south of Bertram, Johnson 6158 (DS). COLORADO CO.: Columbia, Bush 96 (MIN). DALLAS CO.: Dallas, Reverchon s.n., April 1876 (MO, NY). DENTON CO.: 4 1/2 mi. north of Grapevine, Whitehouse 17970 (MICH). FAYETTE CO.: specific locality unknown, Wurzlow s.n., in 1891 (F). FANNIN CO.: Bonham, Milligan s.n., April 1892 (US). GALVESTON CO.: Galveston, Lindheimer s.n., April 1863 (MO). GONZALES CO.: Ottine Swamp, Cory 18133 (GH). HARRIS CO.: Houston, Bush 27 (MO). KLEBERG CO.: Kingsville, Rees 37 (NY). LIBERTY CO.: Liberty, Palmer 7733 (MIN). MATAGORDA CO.: Matagorda, Palmer 4253 (MO). MONTGOMERY CO.: near Conroe, Palmer 33339 (GH). TARRANT CO.: near Handley, Ruth 452 (F, NY, US, WIS). TRAVIS CO.: Austin, Tharp s.n., 19 March 1932 (CAS, GH, MICH, NY, UC, WTU). VAN ZANDT CO.: west of Canton, Correll & Correll 35679 (UC). WALKER CO.: specific locality unknown, Warner 64 (GH, US). WOODS CO.: Mineola, Reverchon, s.n., 22 April, no year (MO). VERMONT:

WINDHAM CO.: Brattleboro, Grout s.n., 25 July 1895 (GH). VIRGINIA: BEDFORD CO.: specific locality unknown, Curtiss s.n., 20 May 1872 (F, MO). DINWIDDE CO.: near Burgess Station, Fernald & Long 9917 (GH). GREENSVILLE CO.: 1 mi. south of Emporia, Fernald & Long 7016 (NY, US). HAMPTON CO.: Hampton, Chickering s.n., 15 May 1877 (NY). NANSEMOND CO.: Norfolk, Earll s.n., 14 May 1880 (US). PRINCES ANNE CO.: False Cape, Fernald, Griscom & Long 4636 (NY). PITTSYLVANIA CO.: Dansville, Small & Heller 230 (DAO, F, GH, MIN, MO, US). HENRICO CO.: Richmond, Churchill s.n., 11 May 1894 (GH). SMYTH CO.: south fork of Holston River near Add Wolf, Small s.n., 15 June 1902 (F). YORK CO.: Yorktown, Thomas 2694 (DS). SOUTHAMPTON CO.: Franklin, collector unknown, May 1867 (GH).

There is considerable variation in pubescence in this taxon. Pubescent forms predominate over glabrous forms 3:1 with no geographical segregation of the character. Within the pubescent forms there is a complete range from just a few flowers with glandular hairs to all flowers on a single plant bearing glandular trichomes.

Presence of the tuberculate seed character is likewise variable and without geographical segregation. While only smooth seeds or tuberculate seeds may be present in a single population, frequent occurrences of mixtures of the two seed types are encountered. The frequency of the tuberculate seed type is ca. 60 percent.

The nomenclature has been somewhat confusing in subsp. *decumbens*. In *A Flora of North America* Torrey and Gray (1938) correctly transferred *Spergula decumbens* Ell. to *Sagina*. In the same work they included

Figure 30. Geographical distribution of *Sagina decumbens* subsp. *decumbens*.

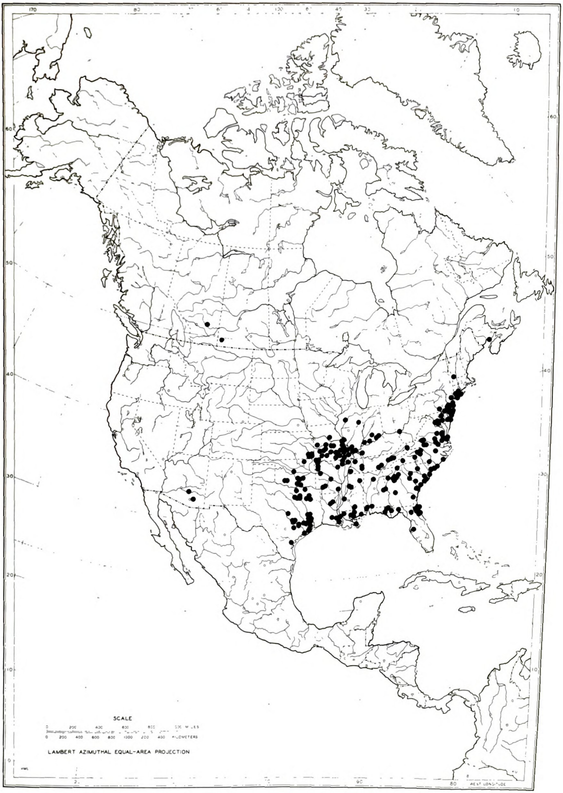

Figure 30

Sagina subulata based on a collection cited as "Rocky Mountains, Drummond" (p. 178) and simultaneously made the transfer of Spergula subulata Swartz to Sagina. The description provided for this taxon more nearly applies to Sagina decumbens subsp. decumbens and is not descriptive of any of the Saginas native to the Rocky Mountains.

In Gray's Manual ed. 2 (1856) the name Sagina decumbens is replaced by the name Sagina Elliottii Fenzl with Spergula decumbens Ell. indicated as the synonym. The binomial Sagina Elliottii was never validly published, either by Fenzl or by Gray.

In the 5th edition of Gray's Manual (1867) Sagina decumbens is treated as S. subulata, Wimmer being recognized as the author of the transfer, and Sagina Elliottii is cited in synonymy. Gray also described a new variety of the taxon, Sagina subulata var. Smithii in that edition.

In Gray's Manual ed. 6, revised by Watson and Coulter (1899), the binomial Sagina decumbens is correctly used for the taxon. Although var. Smithii is included, a nomenclatural transfer to Sagina decumbens was never actually made.

This slender, nearly apetalous variety described by Gray does not warrant recognition as a distinct taxon. Gray's variety represents an extreme in the range of variability of subsp. decumbens exhibiting a tendency toward a habit which is more slender, with much branched filiform stems and a greater frequency of 4-merous flowers which produce fewer-seeded capsules. The range of variability is continuous and it seems best to consider the material a single taxon.

No single specimen was cited with the original description to typify var. Smithii. Of the four collections studied by Gray, all glued to a single sheet, only one specimen bears the notation "no petals" in Gray's handwriting. I therefore designate this specimen, C. E. Smith s.n., June 1865, sandy road in the pine woods, at the mouth of Great Egg Harbor, New Jersey (GH), as the lectotype of Sagina subulata var. Smithii.

7b. Sagina decumbens subsp. occidentalis (Wats.) Crow, comb. nov.

Sagina occidentalis Wats., Proc. Am. Acad. 10: 344. 1875.
Alsinella occidentalis (Wats.) Greene, Fl. Franc. p. 125. 1891.
Type: Bolander 3891, in the streets of Ukiah, Mendocino Co., California, 1864 (GH, holotype!; UC, MO, isotypes!).

Annual with slender taproot. Branches slender, ascending or sometimes decumbent. Basal rosette of leaves lacking. Lower cauline leaves linear, 5.0-23 mm long. Upper cauline leaves becoming subulate toward tip, 1.0-4.5 mm long at apex. Cauline leaves apiculate. Pedicels filiform, weakly glandular pubescent or glabrous. Sepals ovate to orbicular, tips frequently purple, occasionally the entire hyaline margin purple tinged. Sepals (1.5-) 1.75-2.0 (-2.5) mm long. Petals elliptical, nearly equaling the sepals, (1.25-) 1.5-2.0 mm long. Stamens 5 or 10, filaments (1.0-) 1.5 mm long, anthers 0.25 mm long. Capsules globose prior to dehiscence, valves thin, dehiscing to ca. half the capsule length. Valves (2.0-) 2.5-3.0 (-3.5) mm long. Sepals remaining appressed following dehiscence. Seeds light brown, obliquely triangular, with dorsal groove, surface smooth to slightly pebbled, rarely with elongate ridges on the lateral surfaces, 0.4 mm long. Figure 31.

Ecology and distribution: On dryish hillsides, margins of vernal pools, along streams, open spots in redwood and pine woods, along roadsides and around dwellings. Ranging northward from southern California along the Great Valley and Coastal Range to the southern border of British Columbia. Flowering April to June. Figure 32.

Representative specimens: CANADA: BRITISH COLUMBIA: Gordon Head, Vancouver Island, Macoun s.n., 30 May 1887 (US). Vicinity of Victoria, Vancouver Island, Macoun s.n., 23 May 1893 (F, MICH, MIN).

UNITED STATES: CALIFORNIA: ALAMEDA CO.: near summit on south side of Redwood Ridge, Constance 502 (UC); vicinity of Oakland, Holder 2522 (US); Berkeley Hills, Mulliken 30 (UC). AMADOR CO.: New York Falls, elev. 2000 ft., Hansen 537 (DS, GH). CALAVERAS CO.: Mokelumne Hill, Blaisdell s.n., no date (CAS); Big Meadow, elev. 6600 ft., Jepson 10084 (JEPS). CONTRA COSTA CO.: Rock City Camp, Mont Diablo, Bowerman 2028 (UC). DEL NORTE CO.: Gasquet to Patricks, Bacigalupi 8542 (DS). HUMBOLDT CO.: at Eureka, Tracy 2181 (DS, UC); Garberville, Tracy 16212 (UC). LOS ANGELES CO.: Pasadena, Grant s.n., 28 March 1898 (DS); Los Angeles, Hasse s.n., May 1889 (DS); grassy hillsides, specific locality unknown, Hasse s.n., April 1890 (MO); Avalon, Santa Catalina Island, Trask s.n., February 1898 (US). MADERA CO.: along Fresno-Yosemite road (Calif. 41), 3 mi. north of crossing with Madera Lateral, elev. 750 ft., Bacigalupi 4876 A (JEPS). MARIN CO.: McClure Beach, Pt. Reyes National

Figure 31. Photographs of *Sagina decumbens* subsp. *occidentalis*. (a) Habit. (b) Close-up. Santa Cruz Is., California (*Howell 6356*, CAS).

Figure 31

Seashore, Crow 1180a (MSC); Inverness Ridge, Howell 19700 (CAS, UC). MARIPOSA CO.: Mariposa, Congdon s.n., 11 April 1897 (MIN). MENDOCINO CO.: Ukiah, Bolander 3891 (GH, MO, UC, US); redwoods east of Mendocino, Eastwood & Howell 2563 (CAS, NY, WTU). Albion Ridge, McMurphy 31 (DS). MERCED CO.: 5 1/2 mi. southeast of Planada, north of LeGrand, elev. 245 ft., Bacigalupi 7339 (JEPS, RM, WTU). MONTEREY CO.: Monterey, Congdon s.n., 12 May 1901 (MIN); Pacific Grove, Heller 8502 (DS, F, GH, MIN, MO, NY, WTU); Carmel, Hardam 10645 (CAS); about 5 mi. north of Jolon, Howell 31146 (CAS). NAPA CO.: Napa River basin, Oakville, Jepson s.n., 26 April 1893 (JEPS); Howell Mountain, 3-4 mi. east of Angwin's, Tracy 1503 (UC). RIVERSIDE CO.: Lake Suprise, San Jacinto Mts., Reed 2442 (UC). SACRAMENTO CO.: Elk Grove, Congdon s.n., 31 March 1894 (MIN). SAN DIEGO CO.: Spencer Valley, near Julian, Abrams 3797 (DS, NY); La Jolla, Jepson 11880 (JEPS). SAN FRANCISCO CO.: Point Richmond, Hall 1663 (GH, MIN); ocean bluffs near Point Lobos, San Francisco, Raven s.n., 9 May 1954 (CAS); serpentine slope above Baker's Beach, San Francisco, Raven 3981 (WTU). SAN LUIS OBISPO CO.: Coast west of Cambria, Hoover 10373 (CAS); Price Canyon, Hoover 6751 (CAS, UC). SAN MATEO CO.: road from La Honda to Pescadero Creek, Mason 3685 (UC). SANTA BARBARA CO.: Santa Rosa Island, Brandegee s.n., June 1888 (UC); Mission La Purisima, Jepson 11937 (JEPS); Kinevan Canyon, Marcos Pass, Santa Barbara, Pollard s.n., 2 June 1958 (DAO); Lady's Cove, East Canyon, Santa Cruz Island, elev. 400 ft., Wolf s.n., 27 March 1932 (DS). SANTA CLARA CO.: Stanford University, Dudley s.n., 25 April 1905 (DS); Isabel Creek, east base of Mt. Hamilton, elev. 2100 ft., Sharsmith &

Sharsmith 1156 (UC). SANTA CRUZ CO.: near Jamison Creek, Hesse 2775 (DS); near Jamison Creek Road and Big Basin, Boulder Creek Highway, elev. ca. 800 ft., Thomas 7015 (DS). SHASTA CO.: Olinda, Blankenship 5 (JEPS, WS). SOLANO CO.: Montezuma Hills, Jepson s.n., 14 May 1892; Violet Station, near Vacaville, Jepson 1205a (JEPS). SONOMA CO.: Analy Twp., Congdon s.n., 16 May 1880 (MIN); Santa Rosa, Eastwood 10329 (CAS); southern half of Lower Marsh, Rubtzoff 448 (CAS). TRINITY CO.: Junction City, Tracy 7530 (UC). TUOLUMNE CO.: Mather, elev. 1400 m, Clausen 1549 (DS). VENTURA CO.: Kennedy Canyon, Ventura River basin, Pollard s.n., 5 May 1946 (CAS). OREGON: CLACKAMAS CO.: Oregon City, Thompson 687 (WTU). CLATSOP CO.: beach near Seaside, Morrill 89 (WTU). COLUMBIA CO.: St. Helens, Suksdorf s.n., 28 May 1895 (WS). CURRY CO.: Port Orford, Peck 8454 (GH, MO, NY). JACKSON CO.: Wimir, Hammond s.n., 21 May 1892 (MO); Evans Creek, Hammond s.n., 3 June 1893 (MO). JOSEPHINE CO.: Grants Pass, Piper 5101 (WS). LANE CO.: 4 mi. above Takilma on the East Fork of the Illinois River, Henderson 5892 (CAS, DS, MO, RM); near Oakridge, Peck 21625 (CAS). LINCOLN CO.: Waldo, Howell s.n., June 1887 (MIN). LINN CO.: Santiam slough near Lebanon, Gilkey & Drake s.n., June 1934 (OSC). MARION CO.: Jefferson, Nelson 177 (DS); Salem, Nelson 66 (DS). MULTNOMAH CO.: Lower Albina, Portland, Sheldon S.10328 (F, GH, MIN, MO, NY, US, WS); southwest of Sylvan, Suksdorf 681 (WS). POLK CO.: Nesbit, Nelson 2073 (GH). TILLAMOOK CO.: Sand Lake south of Tillamook, Thompson 722 (WTU). WASCO CO.: Eight Mile Creek, Mt. Hood National Forest, Jones 4071 (CAS). WASHINGTON CO.: Forest Grove, Lloyd s.n., 20 April 1893 (GH, NY); Millsboro, Lloyd s.n., 12 May 1894 (NY).

YAMHILL CO.: specific locality unknown, Summers s.n., June 1880 (MONTU). WASHINGTON: KING CO.: Seattle, Piper s.n., 29 May 1889 (WTU); Alki Point near Seattle, Shumway s.n., May 1894 (MICH). KLICKITAT CO.: Bingen, Suksdorf 5014 (WS); western portion, specific locality unknown, Suksdorf s.n., May 1883 (CAN, F, MO, NY, US, WS). PIERCE CO.: prairies, Tacoma, Flett s.n., 2 October 1897 (WTU). SAN JUAN CO.: Cattle Point, San Juan Islands, Peck 12944 (WS); Friday Harbor, Pope s.n., 25 June 1904 (WTU).

As in subsp. *decumbens* there is considerable variation in the glandular pubescence character. Although in the original description Watson indicates the taxon as being glabrous, both glabrous plants and plants with sparsely pubescent flowers are present on the type sheet. However, few of the flowers of the pubescent form in this collection are glandular. The glandular form, however, is predominant in the taxon and relatively few herbarium sheets consist entirely of glabrous specimens.

In the northern portion of its range more robust plants appear very similar to more slender growth forms of *S. maxima* subsp. *crassicaulis*. This observation led Piper (1906) to state that species lines in *Sagina* are not well defined and he doubted that the two taxa were really distinct. The saginoid seed type readily distinguishes this taxon from *S. maxima* subsp. *crassicaulis*.

Although not previously recognized nomenclaturally, subsp. *occidentalis* has long been considered to be the western equivalent of *S. decumbens*. Watson (1875, p. 344) makes note to this effect in the

Figure 32. Geographical distribution of Sagina decumbens subsp. occidentalis.

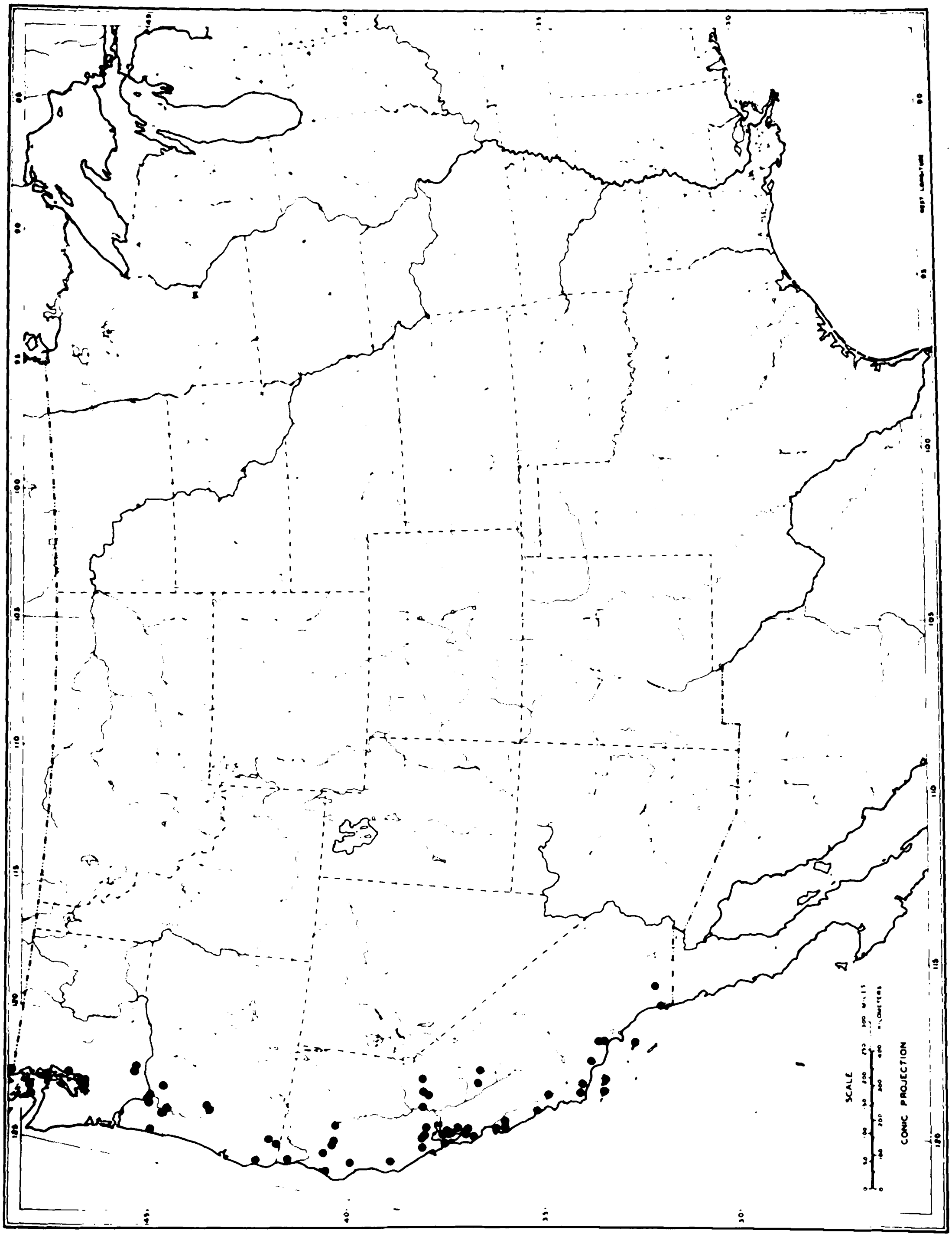

Figure 32

Figure 33. Photograph of holotype of *Sagina occidentalis* Wats. (= *Sagina decumbens* subsp. *occidentalis*.

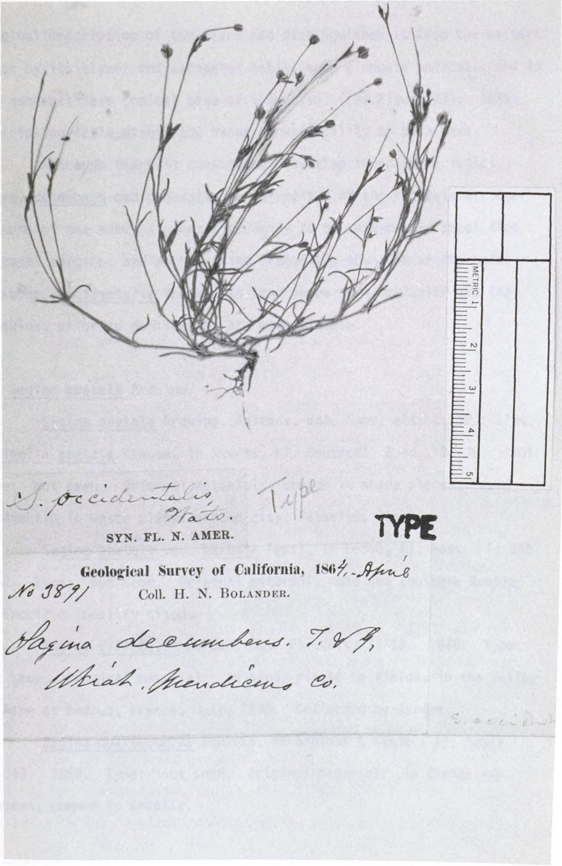
METRIC 1 2 3 4 5
S. occidentalis, Wats.
Type
TYPE
SYN. FL. N. AMER.
Geological Survey of California, 1864,-April
No 3891
Coll. H. N. BOLANDER.
Sagina decumbens. T. & G.
Ukiah, Mendocino Co.

Figure 33

original description of the taxon and distinguishes it from the eastern taxon by its "laxer and slenderer habit, more elongate pedicels, and in the somewhat less conical base of the calyx" (see Figure 33). This description falls within the range of variability of both taxa.

Although there is considerable overlap in characteristics, subsp. decumbens can generally be segregated on the reticulate ridge pattern of the seed, a greater tendency to possess purple sepal tips or sepal margins, and anthocyanins frequently abundant at the nodes. In subsp. occidentalis the sepals tend to be more orbicular and the capsules, prior to dehiscence, are more globose.

8. Sagina apetala Arduino

Sagina apetala Arduino, Animadv. Bot. Spec. alt. 2: 22. 1764. Alsinella apetala Krause, in Sturms, Fl. Deutschl. 2 ed., 5: 38. 1901. Type: not seen. Original material: common in shady places, found abundantly in waste places around city; Patavium, Italy.

Sagina apetala var. barbata Fenzl, in Ledeb, Fl. Ross. 1: 338. 1842. Type: not seen. Original material: mid and southern Russia. No specific locality cited.

Sagina filicaulis Jordan, Obs. Pl. Crit. 7: 16. 1849. Type: not seen. Original material: in sandy places in fields, in the valley of Aspe at Bedous, France, July, 1838. Collected by Jordan.

Sagina quarternella Schloss, in Schloss & Vukot., Fl. Croat. p. 343. 1869. Type: not seen. Original material: in fields and meadows, common in Croatia.

Sagina melitensis Gulia ex Duthie, Jour. Bot. 13: 37. 1875. Type: not seen. Original material: Maltese Islands, near Masciar and in Wied Xlendi, Gozo, in rather moist sandy soil. Also collected on Corradino heights, Malta, 1874.

Alsinella ciliata Greene, Fl. Franc. p. 126. 1891. Sagina ciliata (Greene) Heller, Muhl. 1: 50. 1904. Sagina ciliata (Greene) Piper, Contr. U.S. Nat. Herb. 11: 259. 1906. Type: not seen. Original material: vicinity of Ione, California. Presumably collected by Greene.

Annual with slender taproot. Plants ascending to decumbent, much branched and many flowered. Basal rosette-like whorl of leaves sometimes present, withering early. Stems filiform, glabrous or sometimes glandular pubescent. Lower cauline leaves linear, 4-8 (-12) mm long, upper cauline leaves linear to subulate, 1-3 mm long at apex. Hyaline portion of leaf bases long ciliate, cilia occasionally occurring the length of the leaf, lower cauline leaves sometimes lacking cilia. Leaf tips aristate. Pedicels glandular pubescent (North American plants), short (1.5-) 2.0-5.0 (-13) mm long. Flowers 4-merous, very rarely 4- and 5-merous. Calyx glandular pubescent. Sepals ovoid to elliptical, sometimes lanceolate and somewhat acute, 1.5-2.0 mm long. Petals lacking, rarely present and then minute. Stamens 4, filaments 0.75-1.0 mm long, anthers 0.2 mm long. Capsules globose, dehiscing to base, valves thin, barely exceeding sepals, 1.5-2.0 (-2.5) mm long. Seeds brown, obliquely triangular, with dorsal groove, distinctly notched at hilum, surface smooth, pebbled or more frequently papillose (papillae distinctly mamillate when viewed under SEM), 0.3-0.4 mm long. Chromosome number: 2n = 12. Figures 34 and 35.

Ecology and distribution: Introduced. A weed of open places, frequently in hard packed soils around buildings, along paths, on roadsides, in sidewalk cracks. It less frequently occurs in such places as grassy hillsides and stream banks. California, western Oregon and Seattle, Washington. I have seen but three herbarium specimens from eastern North America referable to this taxon, one from Maryland, one from Illinois and one from Louisiana. Native to Eurasia. Flowering April to June. Figure 36.

Representative specimens: UNITED STATES: CALIFORNIA: ALAMEDA CO.: Berkeley, Heckard 1228 (JEPS); Strawberry Canyon, Berkeley Hills, Howell 11359 (CAS). AMADOR CO.: Jackson, Hansen 537 (UC). CALAVERAS CO.: Angels Camp, Eastwood 11580 (CAS). ELDORADO CO.: Diamond Springs, Jepson 18632 (UC); Lotus, Jepson 18601 (UC). FRESNO CO.: Parlier, Frazier 101 (DS, WTU); Fresno, Quibell 2433 (UC). HUMBOLDT CO.: 1/4 mi. southeast of village of Willow Creek, Crow 1927 (MSC); Alton, Tracy 9839 (UC); Eel River, between Alton and Fortuna, Tracy 12200 (DS, GH, UC). LAKE CO.: just north of Middletown, Howell 42249 (CAS). LOS ANGELES CO.: Pasadena, Grant s.n., 15 April 1917 (DS, JEPS, UC). MADERA CO.: North Fork, Bacigalupi 2261 (DS); Raymond, Eastwood 12524 (CAS). MARIN CO.: Black Canyon, San Rafael hills, Howell 17896 (NY); Angel Island, Raven & Johnson 21233 (DS); about 1 mi. from Tomales, Thomas 11542 (DS). MARIPOSA CO.: Aqua Fria, Congdon s.n., April 1883 (MIN); Oakvale, Congdon s.n., 27 April 1897 (GH, MIN). MENDOCINO CO.:

Figure 34. Photographs of Sagina apetala. (a) Living specimen. (b) Close-up showing glandular trichomes on pedical and cilia of leaf base (photographed under epi-illumination). Jaspar Ridge, Stanford, California (Crow 1176, MSC).

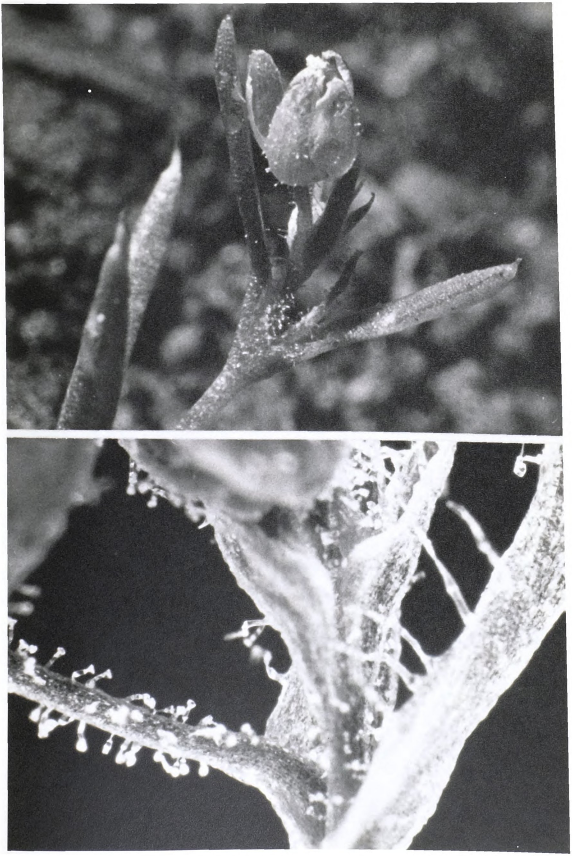

Figure 34

Figure 35. Photographs of Sagina apetala. (a) Habit, Berkeley, California (Howell 24202, CAS). (b) Habit, Angel Is. Marin Co., California (Raven and Johnson 21233, DS).

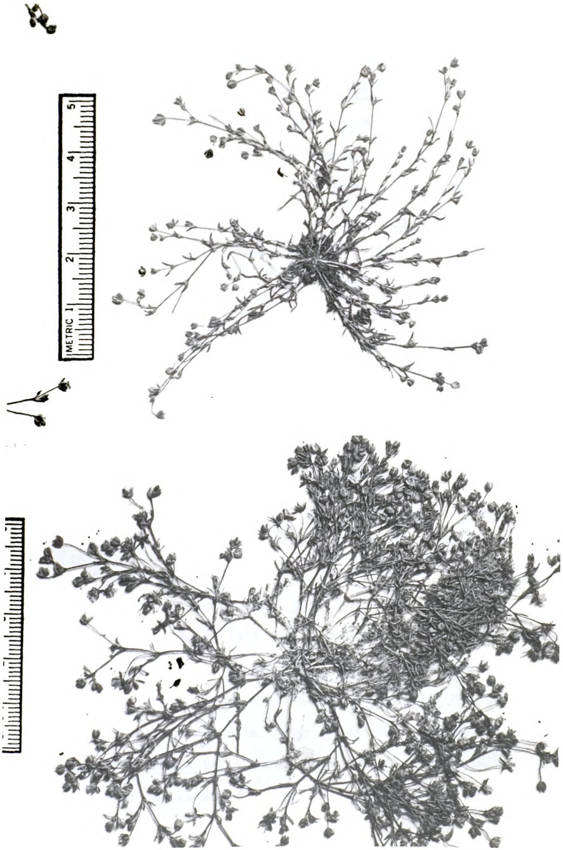

Figure 35

near Yorkville, Eastwood & Howell 4570 (CAS). MERCED CO.: 5 mi. north of Snelling, Hoover 2059 (UC); 15 mi. southwest of Merced, Howell 4112 (CAS). MONTEREY CO.: near Monterey, Abbott s.n., January 1905 (DS); Jolon, Howell 39155 (CAS). PLUMAS CO.: Big Meadows Manstin s.n. August 1899 (US). SACRAMENTO CO.: Sacramento, Crampton 7840 (CAS). SAN BENITO CO.: 5 mi. north of Pinnacles, Howell 33016 (CAS); 2 mi. west of Panoche, Panoche Valley, Wiggins & Rollins 42 (DS). SAN FRANCISCO CO.: McLarsen Park, San Francisco, Raven 9254 (CAS); Presidio, San Francisco, Rubtzoff 2439 (CAS). SAN JOAQUIN CO.: Wooland, Biswell 181 (UC); Waverly, Sanford 395 (UC). SAN LUIS OBISPO CO.: Santa Lucia Mts., 1/2 mi. west of Paso Robles, Hardham 4036 (CAS). SAN MATEO CO.: Burlingame, Howell s.n., 5 May 1955; Jasper Ridge Biological Experimental Area, ca. 5 mi. southwest of Palo Alto, Thomas 9073 (DS); San Bruno Mountain in northern part of county, Thomas 9268 (DS). SANTA BARBARA CO.: vicinity of Pelican Bay, Santa Cruz Island, Abrams & Wiggins s.n., 26 April 1930 (DS); Oak Park, Santa Barbara, Pollard s.n., 11 April 1958 (DAO). SANTA CLARA CO.: San Antonio Valley, Mt. Hamilton Range, Sharsmith & Sharsmith 3272 (UC); Stanford University Campus, Thomas 9205 (DS). SANTA CRUZ CO.: Boulder Creek, Hesse 397 (CAS). SHASTA CO.: Anderson, Smith s.n., 21 April 1913 (CAS). SISKIYOU CO.: Klamath River at Cherry Flat, Siskiyou Mts., Wheeler 2606 (GH, MO, US). STANISLAUS CO.: 8 mi. east of Oakdale, "Haystack Hill," Hoover 3955 (UC, US). TEHAMA CO.: 5 mi. west of Paskenta, Baker 12542 (UC). TULARE CO.: 4 mi. east of Exeter, Mason 11718 (UC). TUOLUMNE CO.: Columbia, Jepson 6297 (JEPS); base of Peoria Mt., Williamson 102 (CAS, DS). OREGON:

JACKSON CO.: Wimer, Hammond 46 (MO); 2 mi. north of Central Point, Peck 14966 (DS, WTU). JOSEPHINE CO.: Grants Pass, Piper 5072. MARION CO.: Turner, Nelson 1672 (GH); Salem, Peck 9284 (WTU). MULTNOMAH CO.: Albina, Portland, Suksdorf 1345 (GH, WS). WASHINGTON: Fairhaven, Piper s.n., 2 July 1897 (WS).

Our phase of the species has been regarded as var. barbata Fenzl, the glandular pubescent phase. However, the species in Eurasia is extremely variable with regard to cilia of leaves and pubescence of calyx and pedicels. The character states seem to be without geographical correlation. It thus appears that taxonomic recognition of varieties based on these characters is not valid in this species. The treatment of the species in Flora Europaea (Clapham and Jardin, in Tutin et al., 1964) recognizes two subspecies, subsp. apetala and subsp. erecta. Our plants do not fit well into either taxon, but do approach subsp. erecta. However, the treatment in Flora Europaea is regarded by the contributors as tentative. Considering the great variability within the species and that those subspecies recognized in Flora Europaea are completely sympatric, it does not appear useful to recognize any North American infraspecific taxa of S. apetala.

Linnaeus is often erroneously cited as the author of the name Sagina apetala. Following this description of S. apetala in Mantissa Plantarum Altera (1771) Linnaeus clearly credits Arduino with authorship of the name. The specimen of S. apetala in the Linnaean herbarium likewise indicates Arduino as the authority.

Figure 36. Geographical distribution of Sagina apetala in North America.

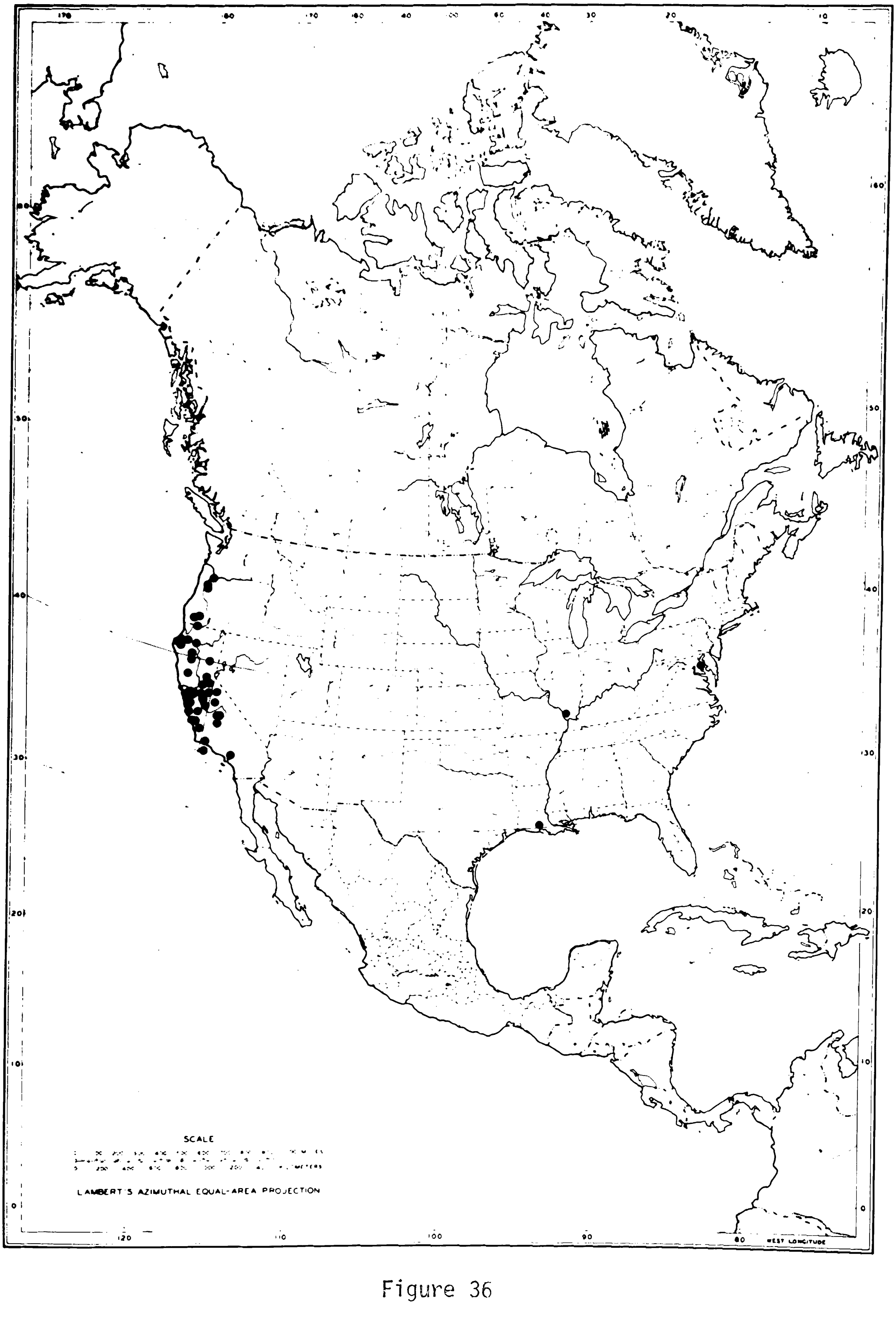
SCALE
LAMBERT'S AZIMUTHAL EQUAL-AREA PROJECTION
WEST LONGITUDE

Figure 36

Sagina sect. *Maxima* Crow, sect. nov.

Semina reniformis vel quasi globosus, sine dorsum sulcatus; foliis linearis, succulentis.

Seeds reniform or nearly globose, dorsal groove lacking; leaves linear, fleshy. Eastern Asis, northward, spanning the Aleutian Islands, south on the Pacific coast in North America to California; New Guinea.

9. *Sagina maxima* A. Gray

Key to the subspecies:

Upper portion of pedicels and calyx bases densely pubescent, upper portion of upper stems frequently pubescent . . . . 9a. subsp. *maxima*

Plants entirely glabrous . . . . 9b. subsp. *crassicaulis*

9a. *Sagina maxima* A. Gray subsp. *maxima*

Sagina maxima A. Gray, Mem. Am. Acad. N. S. 6: 382. 1859. *Sagina Linnaei* Presl var. *maxima* (Gray) Maximowicz, Bull Acad. St. Pétersb. 18: 372. 1873. Nom. illeg. Type: *C. Wright s.n.*, Cape Sangar, Hakadadi, Japan. U.S. North Pacific Exploring Expedition under Commanders Ringgold and Rodgers, 1853-1856. (GH, holotype; NY, isotype!).

Sagina maxima f. *littorea* Mak., Bot. Mag. Tokyo 25: 156. 1911. *Sagina crassicaulis* var. *littorea* (Mak.) Hara, Jour. Jap. Bot. 13: 556. 1937. *Sagina maxima* var. *littorea* (Mak.) Hara, Jour. Jap. Bot. 33: 147.

1958. Type: G. Koidzumi s.n., Misaki, Prov. Sagami, Japan. December 27, 1905. (TI, holotype.)

Sagina litoralis Hult., Svensk Vet. Akad. Handl. ser. III. 2: 78. 1928. Sagina crassicaulis var. litoralis (Hult.) Hult., Arkiv. for Botanik 7: 147. 1968. Type: Hultén 789, Sarannaja Bay HN, Toporkof Island, South Kamtchatka (S, holotype).

Annual or short lived perennial, from slender taproot. Stems stout, rarely filiform, much branched, spreading to decumbent. Upper portion of upper stems frequently pubescent. Usually with basal tuft of ascending linear leaves, secondary fascicles or basal rosette rarely present. Cauline leaves linear, succulent, glabrous, upper pairs rarely minutely glandular ciliate. Lower cauline leaves (6-) 8-15 (-20) mm long, upper cauline leaves linear, becoming shorter toward apex but rarely subulate, (2.5-) 3.5-7 (-9) mm long at apex. Leaf tips apiculate. Connate leaf bases conspicuous, forming a shallow scarious cup. Pedicels usually stout or sometimes slender, densely glandular pubescent at base of calyx, becoming less dense toward the lower portion, lower one-fourth usually glabrous. Flowers 5-merous, protandrous. Calyx glandular pubescent at base. Sepals ovate to orbicular (2-) 2.5-3.5 mm long, sepals with hyaline margins whitish, occasionally purple tinged on margins or tips. Petals elliptical to nearly orbicular, 2.0-2.5 (-3.0) mm long. Stamens 10, filaments 1.5-2.0 mm long, anthers 0.25 mm long. Capsules globose prior to dehiscence. Capsule valves thickish, dehiscing to ca. one-fourth the length of the sutures, (3.0-) 3.5-4.5 mm long. Sepals remaining appressed following capsule dehiscence. Seeds reddish-brown, reniform, dorsal groove lacking, lateral sides plump, surface pebbled or less frequently smooth, 0.5 mm long. Chromosome number: 2n = 22, 42 or 44. Figure 37.

Ecology and distribution: Coastal, growing on rocky or sandy bluffs, along rocky shores and gravelly beaches. The taxon occurs in eastern Asia, spanning the Aleutian Islands and ranging southward along the coast of North America to northern Washington and intergrading with subsp. crassicaulis on the Queen Charlotte Islands and Vancouver Island. Subspecies maxima in eastern North America is adventive. The taxon occurs sporadically and does not show signs of aggression or spreading. Known localities include Toronto, Montreal and Quebec, Canada and Amherst, Massachusetts. Flowering June to August. Figure 38.

Representative specimens: CANADA: BRITISH COLUMBIA: QUEEN CHARLOTTE ISLANDS: Empire Anchorage, Athlow Bay, Graham Island, Calder, Savile & Taylor 21443 (DAO); Old Masset, Graham Island, Calder, Savile & Taylor 21241 (DAO); Hotspring Island, Calder, Savile & Taylor 22280 (DAO, DS); Limestone Island, Calder, Savile & Taylor 22424 (DAO); Cumshewa Inlet, Moresby Island, Calder, Savile & Taylor 21969 (DAO); Fairfax Inlet, Tasu Sound, Moresby Island, Calder & Taylor 23620A (DAO); Skedans group off Louise Island, Calder, Savile & Taylor 22388 (DAO, WS). VANCOUVER ISLAND: Esquimalt, Calder & MacKay 29529 (DAO); Seabird Rocks between Cape Beal and Pachena Pt., 48°45'N., 125°10'W., Calder & MacKay 30253 (NY, OSC); near Port Alberni, Henry 9059 (GH); Campbell River, Howell 7712 (CAS); Nanimo, Macoun 24032 (NY); Oak Bay, vicinity of Victoria, Macoun 78513 (CAN, F, MO); District of Renfrew, Rosendahl & Brand 62 (COLO, NY, US). ONTARIO: Toronto, Clarkston s.n., 4 August 1946 (WTU). QUEBEC: Montebello, Charlebois 5 (DAO).

Figure 37. Photographs of *Sagina maxima* subsp. *maxima*. (a) Habit. (b) Close-up showing glandular pubescence. Aleutian Islands, Alaska (*York 44 196*, F).

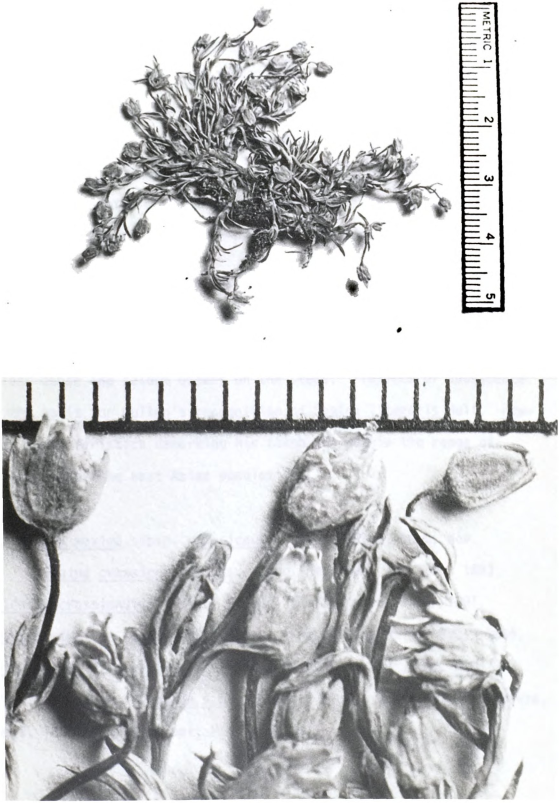

Figure 37

UNITED STATES: ALASKA: Mouth of Mahoney Creek, George Inlet, Revillagigedo Island, Shacklette 4853 (US). ALEUTIAN ISLANDS: Ilak Island (near Adak Island), Bank 361-A (MICH, US); Carlisle Island, Bank 511 (MICH); Adak Island, Jordal 2623 (CAN, US); Iliulink Unalaska, Jepson 232 (UC, US); Umnak Island, Johnson 1052 (WIS); Akutan Island, Rudd s.n., July 1935 (WTU); Attu Island, Van Shaack 776 (GH, US); Aleutian Island, specific locality unknown, York 196 (F, MO). MASSACHUSETTS: HAMPSHIRE CO.: Amherst, Torrey s.n., 25 June 1951 (WTU). WASHINGTON: CLALLAM CO.: Port Crescent, Lawrence 259 (UC, WS).

By comparison to the east Asian members of this taxon, specimens from the Aleutian Islands and the west coast of North American tend to have slightly larger flowers and smooth seeds. In addition, pubescence is less dense and seldom occurs on the stems. Presence of pubescence was the basis for Hultén's recognition of Sagina litoralis Hult. However, characteristics demarking his taxon lie within the range of variability of the east Asian populations.

9b. Sagina maxima subsp. crassicaulis (Wats.) Crow, comb. nov.

Sagina crassicaulis Wats., Proc. Am. Acad. 18: 191. 1883.
Alsinella crassicaulis (Wats.) Greene, Fl. Franc. p. 125. 1891.
Sagina maxima var. crassicaulis (Wats.) Hara, Rhodora 41: 392. 1939.
Sagina maxima f. crassicaulis (Wats.) Mizushima, Jour. Jap. Bot. 35: 337. 1960. Type: Congdon s.n., Dillon's Beach, Marin Co., California, June 6, 1880 (GH, holotype!; MIN, isotype!).

Figure 38. Geographical distribution of Sagina maxima subsp. maxima in North America.

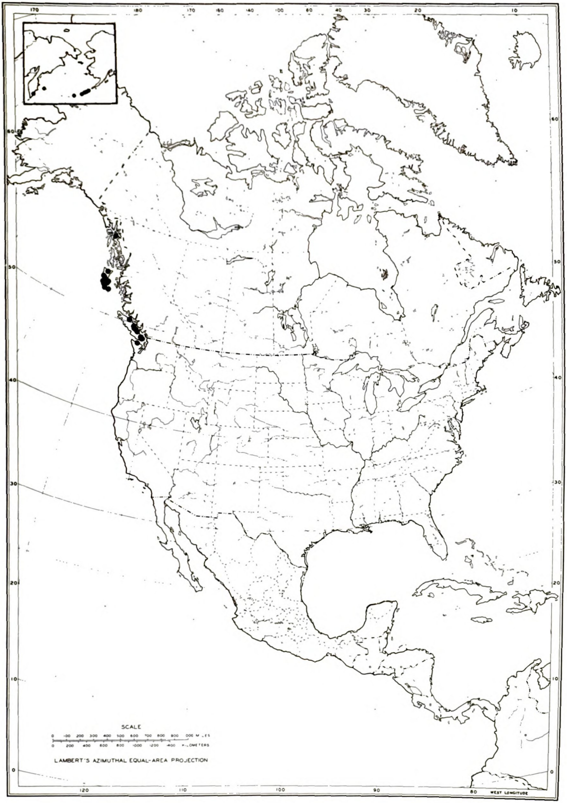
SCALE
LAMBERT'S AZIMUTHAL EQUAL-AREA PROJECTION
WEST LONGITUDE

Figure 38

Perennial. Plants glabrous. Stem stout or rarely filiform, much branched, spreading, decumbent or procumbent. Basal rosette of broadly linear succulent leaves, or if lacking, then primary or secondary tufts of ascending linear basal leaves present; ascending leaves with conspicuous midrib, usually less succulent than rosette leaves (rosettes rarely present in plants occurring north of Washington). Nodes frequently purplish tinged. Cauline leaves linear, succulent. Lower cauline leaves 6-15 mm long, upper cauline leaves linear, becoming shorter toward apex but rarely subulate, 3.0-7.0 mm long at apex. Leaf tips apiculate. Connate leaf bases conspicuous, forming shallow scarious cup. Pedicels slender to stout. Flowers 5-merous, protandrous. Sepals ovate to nearly orbicular (2.0-) 2.5-3.0 (-3.5) mm long, hyaline margins whitish, occasionally purple tinged along margins or at sepal tips. Petals conspicuous, elliptical to orbicular (1.5-) 2.0-2.5 (-3.0) mm long, slightly shorter than sepals. Stamens 10, filaments 1.5-2.0 mm long, anthers 0.3-0.5 mm long. Capsules globose prior to dehiscence. Valves thickish, dehiscing to ca. one-fourth the length of the sutures, (3.0-) 3.5-4.0 (-4.5) mm long. Sepals remaining appressed following capsule dehiscence. Seeds reddish-brown, reniform, lateral sides plump, dorsal groove lacking surface smooth to slightly pebbled dorsally, 0.5 mm long. Chromosome number: $2\underline{n} = 66$.

Ecology and distribution: Strictly coastal, predominantly on sandy bluffs or crevices of rock cliffs of the Pacific Coast, most frequently at or near the high tide mark. Less often on gravelly-sandy beaches. Monterey Co., California, northward to Aleutian Islands.

Flowering May to September. A few specimens have been collected in flowering condition from California in December and February. Figure 39.

Representative specimens: CANADA: BRITISH COLUMBIA: Fulford Harbour, Saltspring Island (Straight of Georgia), Ashlee s.n., 24 July 1960 (DAO). Duncan Bay, ca. 6 mi. west northwest of Prince Rupert, Calder, Savile & Ferguson 14956 (DS, WTU). Hope Island, off north end of Vancouver Island, Calder & BacKay 31180 (DAO). Vancouver, Greene s.n., 19 July 1890 (US). Ann Island, Queen Charlotte Sound, McCabe 1783 (UC). Calvert Island, head of Kwakshua Inlet, McCabe 1701 (UC). Crane Rocks, Gordon Channel, McCabe 7103 (UC). Hakai Pass, McCabe 7203 (DS, UC, WTU). Nigei Island, McCabe 7075 (UC). Porcher Island, Freeman Pass, McCabe 7345 (UC, WTU). Spider Island, McCabe 4337 (UC). QUEEN CHARLOTTE ISLANDS: east side of Naden Harbour, Graham Island, Calder & Taylor 36872 (DAO); Massett Inlet, Graham Island, Calder, Savile & Taylor 21642 (DAO); 11 1/2 mi. east of Massett on road to Tow Hill, Graham Island, Calder, Saville & Taylor 21306 (DAO, NY, UC); Rennell Sound, Graham Island, Calder & Taylor 23384 (DAO); Skidegate Channel, Graham Island, Calder, Saville & Taylor 21412 (DAO); Bigsby Inlet opposite Lyell Island, Moresby Island, Calder, Savile & Taylor 22155 (DAO); Deena River, Skidegate Inlet, Moresby Island, Calder & Taylor 23785 (DAO); Langara Island at northwest corner of Graham Island, Calder, Savile & Taylor 22543 (COLO, DAO); Limestone Island, Calder & Taylor 34826 (DAO); Louise Island, Osgood s.n., 29 June 1900 (US). VANCOUVER ISLAND: Fanny Bay, south of Courtenay, Calder & MacKay 30619

(DAO); Hesquiat Harbour, ca. 49°29'N., 126°24'W., Calder & MacKay 31107 (DAO). Ivy Green Provincial Park, 2 1/2 mi. northwest of Ladysmith, Calder & MacKay 28979 (DAO); Kelsey Bay, 50°22'N., 125°57'W., Calder & MacKay 32454 (DAO); Sarita, 48°53'N., 125°02'W., Calder & MacKay 30342 (DAO); Seabird Rocks, between Cape Beale and Pachena Pt., 48°45'N., 125°10'W., Calder & MacKay 30253 (DAO). Port Alberni, Henry 9060 (GH); vicinity of Ucleulet, Macoun 78507 (CAN, F); Nanaimo, Macoun 24032 (CAN); Bould Point, 4 mi. west of Jordan River, McCabe 5586 (UC); Boat Basin, 49°N., 126°W., Bzczawinski s.n., 28 June 1961 (WTU).

UNITED STATES: ALASKA: Beardslee Island, Glacier Bay, Anderson 1218 (NY). Juneau, Anderson 436 (NY). Bartlett Cover, Gustavus, Glacier Bay, Butts 117 (DS). Farragut Bay, Coville & Kearney 477 (US). Sitka, Cowles 1085 (US). Port Vita, Raspberry Strait, Raspberry Island, Kodiak group, Eyerdam 4026 (CAN, GH, MIN, UC, WTU). Washington Bay, Kuiu Island, Eyerdam 5462 (WTU). Helm Bay, Cleveland Peninsula, Flett 1981 (US). Attu Island, 1/2 mi. northeast of Krupa Point, Aleutian Islands, Hardy 241 (GH). Nome, Hill 137 (US, WS). Agattu Island, Aleutian Islands, Hultén 6296 (CAS, DS). Amchitka Island, Aleutian Islands, Hultén 6467 (US). Atka Island, Aleutian Islands, Hultén 6968 (CAS). Kenai Peninsula, Seward, Hultén 7966 (US). St. Paul Island, Bering Sea, Macoun 19580 (CAN). Afognak Island, Shelikof Strait off Alaskan Peninsula, Rich s.n., August 1931 (DS). Popof Island, Shumagin Islands, Saunders 3706 (MO). Revillagigedo Island, George Inlet, Shacklette 4853 (MICH). Attu Island, Aleutian Island, Soule 230 (MO). Unalga Island, Unalaska, Steenis 4657 (WIS). Middleton Island, Gulf of

Alaska, Thomas 6394 (CAN, DS, US). Long Island, Kodiak, Trelease 3695 (US). Yakutat Mission, Yakutat Bay, Trelease 3701 (MO, US). Prince of Wales Island, Walker & Walker 913 (GH). Gravina Island, Went 127 (US). CALIFORNIA: DEL NORTE CO.: mouth of Klamath River, Baker 11872 (CAS); Crescent City, Ripley & Barneby 6759 (CAS, NY). HUMBOLDT CO.: Big Lagoon, Tracy 17927 (DAO, US, WS, WTU); Eureka, Tracy 2181 (DAO); Trinidad, Tracy 16564 (DS, GH, UC, US). MARIN CO.: Dillon's Beach, Congdon s.n., 6 June 1880 (GH, MIN); McClure Beach, Pt. Reyes National Seashore, Crow 1180 (MSC); Sea Beach, Congdon s.n., 9 June 1880 (NY). MENDOCINO CO.: Mac Kerricher State Park, near Fort Bragg, Crow 1185 (MSC); 2 mi. south of Westport, Crow 1197 (MSC); Mendocino City, Eastwood 11474 (CAS, UC, WS, WTU); Alder Beach, near Manchester, Rose 37337 (CAS, MO, UC, WTU). MONTEREY CO.: Asilomar, Monterey Peninsula, Howell 40368 (CAS); Monterey, Michener & Bioletti s.n., July 1891 (UC). SAN FRANCISCO CO.: Sea Cliff district, Pollard s.n., 31 July 1955 (CAS); Baker's Beach, Raven 2741 (CAS). SANTA CRUZ CO.: Santa Cruz, Hesse 986 (DS). OREGON: CLATSOP CO.: Seaside, Abrams 8883 (DS); Columbia River, Astoria, Nelson 3126 (GH). COOS CO.: Coos Head, Abrams & Benson 10589 (DS). CURRY CO.: Port Orford, Peck 8435 (CAS, GH, MO, NY). DOUGLAS CO.: Winchester Bay, Pringle s.n., 22 October 1881 (CAS, MSC). LANE CO.: Heceta Head, Cronquist 6112 (WS). LINCOLN CO.: Newport, Hawkins s.n., 17 August 1917 (WIS); Seal Rocks, Peck 10595 (WTU). TILLAMOOK CO.: Tillamook, Howell s.n., 15 July 1882 (F, MIN, MO, NY, US); Netarts Bay, Thompson 3158 (MO); Sand Lake, Thompson 722 (MO). WASHINGTON: CLALLAM CO.: Clallam Bay, Jones 5981 (WTU); near Lake Crescent, Lawrence 320

(WS); Makah Bay, Meyer 2077 (MO, WS); 4 mi. west of Neah Bay, Rossbach 513 (DS). GRAYS HARBOR CO.: Ocean City, Jones 3894 (WTU); Moclips, Piper 5205 (WS). ISLAND CO.: Langley, Grant s.n., July 1922 (WTU); Cornet Bay, Whidbey Island, Smith 1520 (UC, WTU). JEFFERSON CO.: Ruby Beach, 10 mi. north of Queets, Meyer 1002 (MO, US). KING CO.: Seattle, Piper 470 (US, WS). KITSAP CO.: Orchard Point, Piper 2312 (F, GH, WS); Bainbridge Island, Savage, Cameron & Lenocker s.n., 20 June-12 July 1898 (F). PACIFIC CO.: Nahcotta, Willapa Bay, Kincaid s.n., 20 June 1952; North Head, McGregor s.n., 13 August 1907; Ilwaco, Piper 4996 (US, WS). SAN JUAN CO.: Cattle Point, Peck 12668 (WS). WAHKIAKUM CO.: Altoona, Suksdorf 6682 (WS).

In the original publication of this taxon, Watson (1883) cites the type specimen as "on Dillon's Beach, Marin County, California (J. W. Congdon, June 1880)." The holotype (GH) is dated June 6, 1880 and is a poorly developed plant (Figure 40). An isotype, acquired by the University of Minnesota (MIN) by the purchase of the herbarium of J. W. Congdon, is much more robust and is more representative of the plants at the type locality and of the taxon as a whole.

Climatic conditions in the higher latitudes sometimes have a dwarfing effect on the growth habit, and several specimens of subsp. *crassicaulis* from Kodiac Island and the Aleutians are somewhat caespitose. These specimens tend to approach *S. nivalis* in general appearance.

Figure 39. Geographical distribution of _Sagina maxima_ subsp. _crassicaulis_.

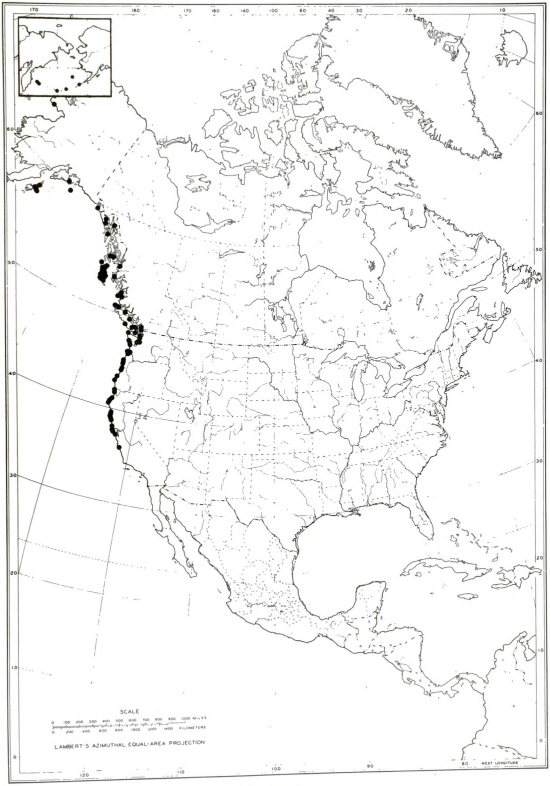
SCALE
0 100 200 300 400 500 600 700 800 900 1000 MILES
0 200 400 600 800 1000 1200 1400 KILOMETERS
LAMBERT'S AZIMUTHAL EQUAL-AREA PROJECTION
WEST LONGITUDE

Figure 39

Figure 40. Photograph of holotype of *Sagina crassicaulis* Wats. (= *Sagina maxima* subsp. *crassicaulis*).

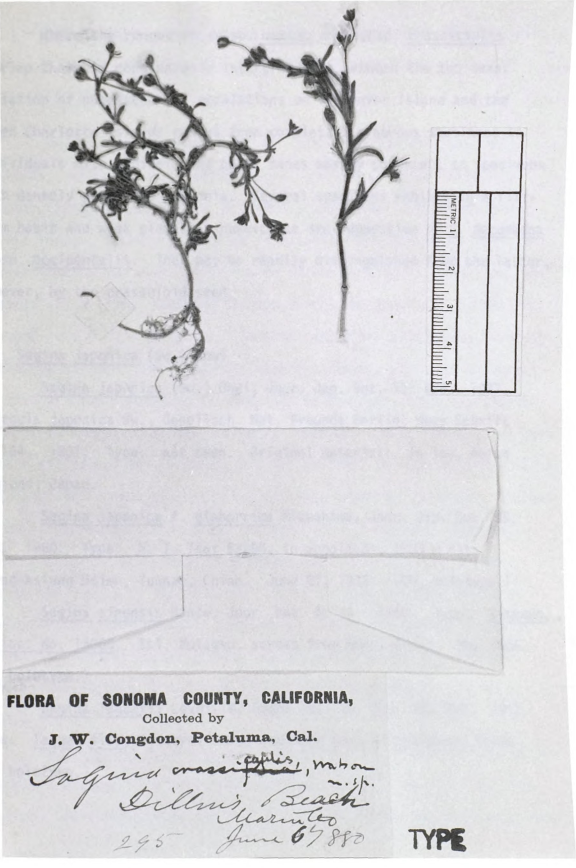
METRIC
FLORA OF SONOMA COUNTY, CALIFORNIA,
Collected by
J. W. Congdon, Petaluma, Cal.
TYPE

Figure 40

Where the ranges of subsp. maxima and subsp. crassicaulis overlap there is considerable intergradation between the two taxa. Variation of pubescence in populations on Vancouver Island and the Queen Charlotte Islands ranges from completely glabrous specimens to individuals with pedicels and calyx bases weakly pubescent to specimens with densely pubescent pedicels. Several specimens exhibiting a filiform habit and weak glandular pubescence are suggestive of S. decumbens subsp. occidentalis. They may be readily distinguished from the latter, however, by the crassuloid seed.

10. Sagina japonica (Sw.) Ohwi

Sagina japonica (Sw.) Ohwi, Jour. Jap. Bot. 13: 438. 1937. Spergula japonica Sw., Gesellsch. Nat. Freunde Berlin, Neue Schrift 3: 164. 1801. Type: not seen. Original material: in low, moist regions, Japan.

Sagina japonica f. glaberrima Mizushima, Jour. Jap. Bot. 35: 258. 1960. Type: H. T. Tsai 52295, in woodlands, 1800 m alt. Cheng-hsiung Hsien, Yunnan, China. June 21, 1932. (GH, holotype.)

Sagina sinensis Hance, Jour. Bot. 6: 46. 1868. Type: Sampson, Exsicc. No. 13060. Isl. Kulagsu, across from Amoy, China. May 1866. (S, holotype.)

Sagina Taquetii Léveillé, Fedde Rep. Sp. Nov. 10: 350. 1912. Type: Taquet 4125, littoral zone, southern part of Quelpart, Korea. (E. holotype.)

Sagina echinosperma Hayata, Icon. Plant. Formos. 2: 39. 1913. Type: S. Saski s.n., 9000 ft. alt., Mt. Morrison, Formosa, October 1909. (TI, holotype.)

Annual, from slender taproot. Stems usually filiform, much branched, ascending to spreading, upper portion of upper stems frequently glandular pubescent. Frequently with basal tuft of ascending linear leaves, secondary fascicle or rosette rarely present. Cauline leaves linear, succulent, glabrous or rarely pubescent. Lower cauline leaves 9-20 mm long, becoming shorter toward the apex, 4.0-7.0 mm long at apex. Leaf tips apiculate. Connate leaf bases conspicuous, forming a shallow scarious cup. Pedicels slender, densely glandular pubescent at base of calyx, becoming less densely so downward, lower one-fourth of pedicel usually glabrous. Flowers 5-merous. Calyx glandular at base. Sepals elliptical to orbicular, 2.0-2.5 mm long, hyaline margins whitish. Petals ovate to orbicular, 1.0-2.0 mm long, sometimes caducous. Stamens 10 or 5, filaments 1.5 mm long, anthers 0.25-0.3 mm long. Capsules globose prior to dehiscence, the valves thickish, dehiscing to one-fourth the length of the sutures, 2.5-3.0 mm long. Sepals remaining appressed following capsular dehiscence. Seeds dark brown, reniform to nearly globose, dorsal groove lacking, sides plump, the surface densely tuberculate, 0.4-0.5 mm long. Chromosome number: $2n = 42$ or 44. Figure 41.

Ecology and distribution: Introduced. Growing in dryish sites and waste places. The only North American collections known are from Nanaimo, Vancouver Island and Prince Ruppert, British Columbia; Portland,

Figure 41. Photographs of _Sagina japonica_. (a) Habit, Hondo Is., Japan (_Ohwi 9142_, UC). (b) Close-up showing glandular pubescence, Tokyo, Japan (_Ohwi s.n._, 9 May 1950, MO).

Figure 41

Oregon and Ottawa, Ontario. Native to east Asia. Flowering June to August.

Representative specimens: CANADA: BRITISH COLUMBIA: Prince Rupert, Groh 469 (DAO). Nanaimo, Vancouver Island, Macoun s.n., 10 June 1887 (CAN). ONTARIO: Ottawa, Dominion Arboretum, Groh 1696 (DAO).

UNITED STATES: OREGON: Albina, Portland, Suksdorf 2772 (WS) and 2863 (WS).

Status uncertain

Sagina micrantha (Bunge) Fern.

Sagina micrantha (Bunge) Fern., Rhodora 27: 131. 1925.
Spergula micrantha Bunge, in Ledeb, Fl. Alt. 2: 183. 1830.
Type: not seen.

While arranging the specimens of Sagina in the Gray Herbarium, Fernald (1925) found it desirable to make the combination Sagina micrantha (Bunge) Fern. based on five specimens from the Aleutians and St. Paul Island. These specimens of the Gray Herbarium so annotated by Fernald belong to Sagina nivalis. The original description for the taxon is not descriptive of S. nivalis. The status of S. micrantha cannot be solved without examination of Bunge's original material.

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