# OBSERVATIONS ON THE DISTRIBUTION AND ECOLOGY OF *SIDA HERMAPHRODITA* (L.) RUSBY (MALVACEAE)

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ABSTRACT

*Sida hermaphrodita* (L.) Rusby (Malvaceae) is a perennial herb of riverine habitats in the northeastern and midwestern United States that presently is under consideration for listing as a federally endangered or threatened species. Although the species is rare in most sections of its range, it is locally common in a limited area along the Kanawha and Ohio rivers in West Virginia and Ohio. In contrast to previous reports, evidence is presented that *Sida hermaphrodita* is indigenous to the Great Lakes drainage. Its distribution and abundance is not limited either by soil type or by low seed viability or germination potential. Gametophytic and sporophytic chromosome numbers are 14 and 28, respectively. Although *Sida hermaphrodita* is not immediately in danger of extinction, its habitat continues to be severely altered by man, and no populations of this species presently are protected from destruction.

## INTRODUCTION

*Sida hermaphrodita* (L.) Rusby (Malvaceae) (Virginia mallow, River mallow) is a polycarpic perennial herb of open, moist, sunny to partly shaded riverine habitats. The species is the only member of *Pseudonapaea* A. Gray, a section without close affinity to any other section in the genus (Clement 1957; Fryxell 1985). The shoots emerge from the soil in April and early May from buds at the base of the previous year's stems and from the ends of numerous radiating rhizomes. Many large populations possibly

*SIDA 11(2): 215–225. 1985.*

are clonal. Flowering begins in early August and continues until a hard frost occurs. Seeds are dispersed throughout the winter, and they germinate in early spring. It is not known how old the plants are when they first flower in their natural habitat, but well-watered plants grown in a transplant garden can reproduce the same year the seeds germinate.

Although geographically widespread (Fig. 1), *Sida hermaphrodita* is rare in most parts of its total range. Thomas (1979) studied populations of this species in the Potomac and Susquehanna drainages. He documented that the species had been extirpated from two-thirds of the sites where it had occurred one hundred years prior to his study. On the basis of these results, Thomas recommended that *S. hermaphrodita* be considered for federal listing as an endangered or threatened species. Thomas (1980) also suggested that the species was declining because of occasional flooding of its habitat, natural plant succession, soil compression in (human) populated areas, and low seed germination.

*Sida hermaphrodita* recently has been assigned to Category 2 status of the U.S. Fish and Wildlife Service (Arnett 1983), indicating that it possibly should be federally listed but that substantial supporting evidence is lacking. The present study attempts to determine the geographical distribution of *S. hermaphrodita* and to ascertain if either soil type or low seed germination potential and/or viability is responsible for the rarity of the species.

A considerable amount of research on *Sida hermaphrodita* by Russian botanists previously has not been cited in the western literature. The species has been studied since 1930 in the southern Ukraine for its economic potential as a soil stabilizer, fodder crop, honey plant, and fiber plant for the pulp and paper industry (Medvedev 1940; Dmitrashko et al. 1971). Seed anatomy (Savchencko & Dmitrashko 1973) and seed germination (Dmitrashko 1970, 1972, 1973) have been studied in an attempt to increase germination percentage. These latter studies indicate that without pretreatment, 10 to 15% of freshly gathered seeds germinate. After 6 to 8 months of storage in a laboratory, germination percentage was 60%, but after 13 years storage it was less than 10%. Germination percentages have been increased to various degrees by different treatments, including scarification, soaking in hot water, sulfuric acid, and irradiation with cobalt-60. Spooner wrote Dmitrashko for further details of this research and requested seeds to compare germination results with those reported in this paper. However, Dmitrashko is now retired, and all research on *S. hermaphrodita* at his institution has been discontinued (in litt. 1982, V. Koval, Dean of Biol. Sci., Odessa State Univ.).

## MATERIALS AND METHODS

Field work was planned using locational data from the following sources: specimens cited in Clement (1957), Iltis (1963), Cusick & Silberhorn (1977), Broome et al. (1979), Thomas (1979), Wiegman (1979), Cranfill & Medley (1981); herbarium specimens from the institutions cited in the acknowledgements; and from Ohio field survey records maintained in the data base of the Division of Natural Areas and Preserves, Ohio Department of Natural Resources, Columbus, Ohio.

Bulk soil samples from selected populations were analyzed in the Ohio Soil Characterization laboratory of the Agronomy Department, The Ohio State University. Samples were ground to pass a 2 mm sieve, and all analyses were performed on the <2.0 mm fraction. Analyses included pH, particle-size distributin (texture), and organic carbon. Values of pH were determined using a suspension 1:1 v/v soil/distilled water ratio. The pipette method of Kilmer and Alexander (1949), as modified according to Method 3A1 of the Soil Conservation Service (1972), was used to determine particle-size distribution. Percent organic carbon was determined by the combustion method of Allison et al. (1965) outlined in Method 6A2b of the Soil Conservation Service (1972).

Germination/viability tests were conducted during February 1984 on seeds of *S. hermaphrodita* collected from 10 natural populations in Adams (two populations), Scioto, Lawrence (two populations), Gallia, and Williams counties, Ohio and from Allegany (two populations) and Cecil counties, Maryland in late summer or autumn of 1982. Seeds were scarified (*i.e.*, a hole was cut through the seed coat) and then incubated on moist filter paper in temperature- and light-controlled incubators at alternating temperatures of 35° (day)/20°C (night) at a 14 hour daily photoperiod (20 $\mu E/m^2/sec$, 400 − 700nm, of cool white fluorescent light) for 15 days. Three replications of 50 seeds each were used for each population.

The meiotic chromosome count was obtained utilizing techniques outlined in Keil and Stuessy (1975). The mitotic count was made from root tips of freshly germinated seeds. Root tips were pretreated in 0.05 M colchicine for 6 hr at 25°C, fixed in a 3:1 v/v solution of absolute ethanol/glacial acetic acid, hydrolyzed in 0.1 N HCl for 15 min at 50°C, and then squashed in acetocarmine. Voucher specimens for the chromosome counts are deposited at OS and US.

## RESULTS AND DISCUSSION

The historical geographical distribution of *Sida hermaphrodita* is shown in Fig. 1. This map is based on the sources cited above plus new records

obtained during this study. Significant early collections not included in the publications of Clement (1957), Iltis (1963), and Thomas (1979), as well as a representative selection of recent new collections, are listed in the appendix to this article.

The most extensive and vigorous populations of *Sida hermaphrodita* are located along the Kanawha River from Charleston, West Virginia to its confluence with the Ohio River at Point Pleasant, and then downstream along both sides of the Ohio River to the vicinity of Huntington, West Virginia. Numerous populations of *S. hermaphrodita* are scattered along this corridor. The majority of plants grow in sunny, moist, disturbed situations along roadsides and railroad rights-of-way. They occasionally grow in the cinders of railroad embankments. Other populations grow in partially-shaded areas at the edges of woods near streams and rivers. All of these sites are located on riverine terraces or floodplains.

*Sida hermaphrodita* is rare and local in all other sections of its range. In the Ohio River Valley widely scattered populations occur as far west as Clermont Co., Ohio and Campbell Co., Kentucky. In West Virginia, the species occurs sporadically along the Kanawha and New rivers from Charleston south to Summers County. Though not common, small but vigorous stands of *S. hermaphrodita* occur in these valleys.

Thomas (1979) has documented the historical distribution and continuing decline of *S. hermaphrodita* in the Potomac and Susquehanna drainages in Maryland, Pennsylvania, Virginia, and the District of Columbia. Recent field work by Cusick and Spooner has confirmed the rarity of the species in this area.

In Tennessee, the species has not been rediscovered since Gattinger's collections of 1883-1885. Iltis (1963) maps one of Gattinger's specimens as an adventive population, though he does not explain his reason for such an opinion. We consider *S. hermaphrodita* indigenous to that state. *Sida hermaphrodita* presently is presumed extirpated from Tennessee (in litt, P. Somers, Tennessee Heritage Program).

The presence of Virginia mallow in Virginia only recently has been substantiated by specimens (Harvill et al. 1981). Apparently it is very rare in that state. More field work is needed to determine the status of *S. hermaphrodita* in Virginia.

The occurrences of *Sida hermaphrodita* is Massachusetts, New Jersey, and New York are problematical. The few specimens from these states lack habitat data, and they may have been collected from adventive populations or cultivated plants. Whether or not the species is indigenous in these states is debatable.

Disjunct populations of *Sida hermaphrodita* are known from a limited

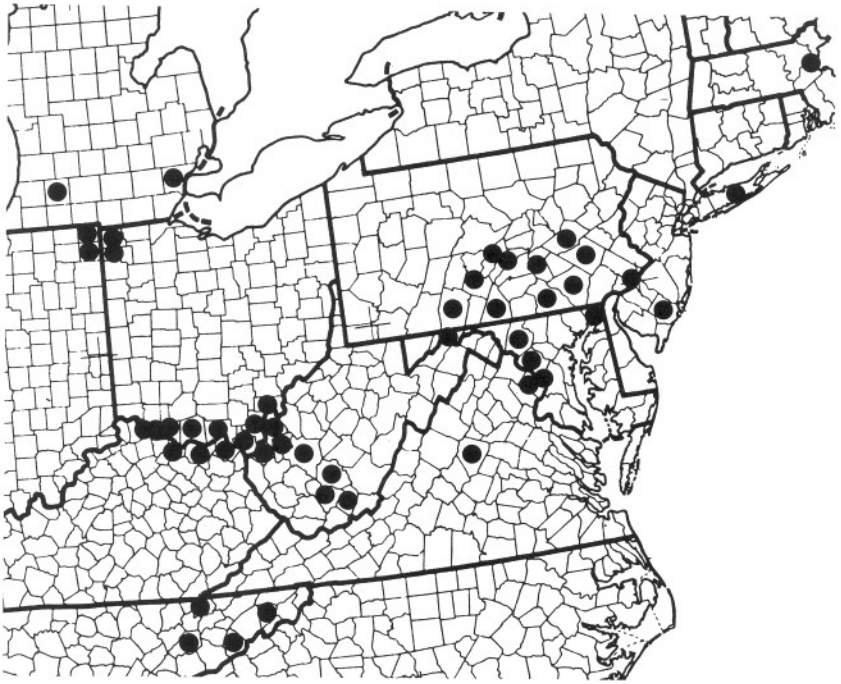

Figure 1. Historical geographical distribution of *Sida hermaphrodita*.

area of northwest Ohio, southcentral Michigan, and northeast Indiana. These are the only known localities of the species in the Great Lakes drainage. The species generally has been considered non-indigenous to this region (Deam 1940; Iltis 1963; Thomas 1979). However, in our opinion *S. hermaphrodita* is native in this part of its range.

Bradner (1892) reported *S. hermaphrodita* from Steuben Co., Indiana. Deam (1940), however, excluded the species from the Indiana flora, considering it a possible adventive from cultivation. In his catalog of the Steuben County flora, Bradner marks those species that are adventive or naturalized. *Sida hermaphrodita* is not so marked, and thus Bradner considered it indigenous. Unfortunately, there is no specimen to substantiate Bradner's report. The species recently was discovered by Cusick in adjacent Dekalb County growing on the bank of a small stream near its confluence with the St. Joseph River.

In northwest Ohio, two extensive populations of *S. hermaphrodita* are extant in Williams County. They occur on (apparently) undisturbed soils along a small tributary of the St. Joseph River. There also are two

nineteenth century collections from Defiance and Williams counties. No habitat data are included on the labels of these specimens, but the Williams County collection is from the drainage of the St. Joseph River.

*Sida hermaphrodita* was reported from along railroad tracks in Kalamazoo County, Michigan (Tuthill 1876). There are two Farwell specimens of this species collected in Wayne County in 1924 and 1931. One is from a railway right-of-way, and the other is labelled "low, moist ground." The species presently is not known to be extant in Michigan.

Iltis (1963) cites these reports of *S. hermaphrodita* from Michigan and Ohio, but he dismisses them as being based on escapes from old gardens. Iltis apparently was unaware of the Indiana records of this species. There are numerous occurrences of *S. hermaphrodita* along railroads in sections of the range where the species unquestionably is native. We feel that previous authors have been overly impressed by the disjunct distribution pattern of Virginia mallow. Unusual disjunctions in range are well documented for many vascular plants. Points in favor of an indigenous status for *S. hermaphrodita* in the Great Lakes drainage include the age of the records, their clustered geographical distribution, and the persistence of the species in the region. Today, *Sida hermaphrodita* is extremely rare in the Great Lakes drainage. Its riverine habitat in this region nearly has been annihilated by stream channelization and modern agricultural practices.

Soils have been implied to be a limiting factor in the distribution of *S. hermaphrodita* (Thomas 1979). However, our research suggests otherwise. Most stands of this species are found on disturbed and fill soils of roadsides and railroad rights-of-way. Other populations grow on naturally disturbed floodplain or terrace soils. Soil types from two such natural sites are Sloan (Williams Co., Ohio) and Wheeling (Adams Co., Ohio). Sloan soils are fine-loamy, mixed, mesic Fluvaquentic Haplaquolls and are distributed widely in Indiana, Michigan, New York, and Pennsylvania. Wheeling soils are fine-loamy, mixed, mesic Ultic Hapludalfs that are common in Indiana, Kentucky, Illinois, and Virginia (National Cooperative Soil Survey 1979). The combined acreage of these two soils is over 280,000 acres. Surface horizons from both "natural" and mechanically altered soils in which plants of *S. hermaphrodita* grow were analyzed (Table 1). These soils have a wide variety of textures (silt loam, sandy clay loam, and clay loam), the pH varies from 5.4 to 7.5, and organic matter content is medium to high. Thus, we conclude that physical-chemical properties of the soils are not a factor limiting the geographical distribution of *S. hermaphrodita*.

Thomas (1980) obtained very low germination percentages ($\bar{x} = 6.6\%$) of *Sida hermaphrodita* seeds collected from natural populations in Maryland,

Table 1. pH, texture and organic carbon content of soil collected from selected populations of *Sida hermaphrodita*.

| LOCALITY | pH | ORGANIC CARBON | % SAND | % SILT | % CLAY | TEXTURE |
|---|---|---|---|---|---|---|
| Williams Co., OH | 7.4 | 3.78 | 43.2 | 37.3 | 19.5 | loam |
| Adams Co., OH | 6.3 | 4.48 | 41.6 | 42.6 | 15.8 | loam |
| Scioto Co., OH | 6.9 | 3.76 | 26.8 | 51.1 | 22.1 | silt loam |
| Lawrence Co., OH | 5.4 | 4.40 | 15.3 | 59.2 | 25.5 | silt loam |
| Lawrence Co., OH | 6.6 | 2.87 | 23.8 | 47.9 | 28.3 | clay loam |
| Lawrence Co., OH | 6.9 | 4.58 | 37.5 | 37.7 | 24.8 | loam |
| Gallia Co., OH | 5.8 | 2.98 | 27.7 | 49.5 | 22.8 | loam |
| Gallia Co., OH | 7.5 | 2.07 | 17.4 | 53.8 | 28.8 | silty clay loam |
| Mason Co., WV | 7.2 | 10.80 | 57.4 | 22.4 | 20.2 | sandy clay loam |
| Putnam Co., WV | 7.2 | 5.69 | 34.4 | 48.6 | 17.0 | loam |

Pennsylvania, and Virginia. However, he did not scarify the seeds. On the basis of these results, Thomas suggested that the low germination percentage of the seeds may be a factor contributing to the rarity of this species. However, in our germination tests, utilizing scarified seeds, 81 to 99% of the seeds collected from the 10 populations of *S. hermaphrodita* in Maryland and Ohio germinated. The average germination for all 10 populations was 92%. Hard seeds are common in a number of species in the Malvaceae (Rolston 1978), including *Sida spinosa* L. (Baskin & Baskin 1984). Egley and Paul (1981, 1982) have shown that water impermeability in *Sida spinosa* seeds is due, in part, to a compact layer of integumentary palisade cells. A similar layer of cells occurs in seeds of *Sida hermaphrodita* (Savchencko & Dmitrashko 1973). The low germination percentages obtained by Thomas (1980) apparently are due to his failure to scarify the seeds.

A large plant of *Sida hermaphrodita* can produce several thousand seeds, most of which are viable and potentially can germinate. And, in fact, many seeds of this species do germinate in the natural habitat. On 13 May 1984, J. Baskin observed several hundred seedlings (with cotyledons only or with cotyledons plus 1, 2, or 3 leaves) within ca 25 $m^2$ in each of two natural populations in Adams and Scioto counties, Ohio. Thus, the rarity of *S. hermaphrodita* is not due to low seed viability or to low germination potential.

Habitat destruction undoubtedly is the dominant limiting factor in the natural distribution of *Sida hermaphrodita*. Undisturbed riverine woodlands and stream terraces are of exceptional rarity. These were among the earliest

natural systems to be altered by man, since rivers were the avenues of transportation, and alluvial soils were fertile and easily cultivated. Many of the writers cited above considered populations of *S. hermaphrodita* nonindigenous because of their occurrence in disturbed situations. However, the natural habitat of Virginia mallow was among the earliest to be disturbed by humans. This study suggests that high seed germination potential and ability to grow in disturbed habitats have contributed to the survival of Virginia mallow.

*Sida hermaphrodita* is in little danger of extirpation nationally. Indeed, extensive and vigorous populations are not rare in the center of its geographic range. But the species is decidedly rare in the more isolated sections of its range, such as the Potomac and Great Lakes drainages. Also, its natural habitat is under continual alteration by man. At present, there are no populations of *Sida hermaphrodita* protected from destruction in any part of its geographic range. There is a special need for preservation of the species in riverine habitats in the Great lakes drainage. We think it desirable that natural populations of Virginia mallow be preserved from further destruction in all parts of its range.

The first chromosome count of *Sida hermaphrodita* ($2n = 28$) was reported by Spooner & Hall (1983) from a plant collected in Fairfax Co., VA, *Spooner, Thomas & Abercrombie 2166* (OS). A meiotic count ($n = 14$) has been obtained from a plant collected in Mason Co., WV, *Spooner 2161* (OS). Iltis and Kawano (1964) demonstrated that Skovsted's (1935) report of $2n = 28$ for *Napaea dioica* L. was probably based on a misidentified plant of *S. hermaphrodita*. However, Skovsted made no voucher. Base numbers of $n = 7$ and 8 are common in *Sida* and have proved useful in assessing relationships in this large genus (Bates & Blanchard 1970; Bates 1976; Fryxell 1985).

## CONCLUSIONS

*Sida hermaphrodita* is a widely distributed species that is common only in a small part of its total range, namely portions of the Kanawha and Ohio River valleys. Elsewhere, it is rare and local. Populations grow in both mechanically and naturally disturbed soils in a variety of riverine habitats. Its distribution is limited neither by rarity of soil type nor by low seed germination potential. The species appears to be in no immediate danger of extirpation at the national level, and thus it should be withdrawn from consideration for federal listing as endangered or threatened. However, only a few populations are known from natural riverine habitats, and no stands of *S. hermaphrodita* are protected from future destruction.

ACKNOWLEDGEMENTS

The support of the Division of Natural Areas & Preserves, Ohio Department of Natural Resources is gratefully acknowledged. We thank the curators of BH, EKY, F, GMUF, KE, MARY, MICH, MUHW, NY, OKL, OS, US, VDB, and WVA for their courtesy and assistance and Mr. Charles E. Stevens of Charlottesville, Virginia for use of his personal herbarium. Paul Somers of the Tennessee Natural Heritage Program provided information on *Sida hermaphrodita* in Tennessee. Judith D. Dumke, Chesapeake, OH, John W. Thieret and L. K. Thomas, National Park Service, led us to populations of *Sida hermaphrodita*. Robert Gross, Department of Humanities, The Ohio State University, provided translations from the Russian literature. Carol Baskin, University of Kentucky, helped with the germination tests.

APPENDIX

Selected additional records for *Sida hermaphrodita* obtained during this study or not mentioned in earlier publications (see text). Locality data have been condensed; full information is available from the authors. AWC = Allison W. Cusick; DMS = David M. Spooner.

DISTRICT OF COLUMBIA: 18th St near river, 16 Jun 1887, *E. Burgess s.n.* (MARY).

INDIANA: Dekalb Co.: Nancy Davis Ditch, Sect 13, Concord Twp, 6 Aug 1984, *AWC 23766* (F, MICH, NY, OS, US). Steuben Co.: see Bradner (1892).

KENTUCKY: Campbell Co.: bank of Ohio River, 1 mi S of Oneonta, 31 Jul 1984, *AWC 23752* (F, NCU, VDB). Greenup Co.: bank of Ohio River, US Rt 23, 2¼ mi S of Siloam, 13 Aug 1984, *AWC & DMS 23821,* (MICH, NY, OS, NCU, US). Mason Co.: gravel pit area along Ohio River E of Maysville, 5 Aug 1978, *J. Thieret 50628* (EKY, MUHW).

MARYLAND: Allegany Co.: N side of Potomac River E of Luke, 13 Aug 1982, *DMS, Thomas, & Abercrombie 2167* (OS). Cecil Co.: RR right-of-way, Conowingo Lake (Susquehanna River) just S of PA state line, 5 Oct 1979, *Hill & Broome 8853* (MARY); Susquehanna River, 0.15 mi S of PA state line, *DMS 2164,* 12 Aug 1982 (OS). Frederick Co.: Licksville, 17 Aug 1930, *O. M. Freeman s.n.* (NA).

OHIO: Adams Co.: bank of Ohio River upstream from Stout, *DMS, A. Spooner, C. Baskin, & J. Baskin 2360,* 1 Oct 1983 (OS, US). Clermont Co.: Ohio River floodplain, US Rt 52 at Pond Run Rd, 3 Oct 1978, *AWC 18914* (OS). Gallia Co.: mouth of Big Creek, Sect 8, Guyan Twp, 13 Oct 1979, *DMS 215* (OS); floodplain of Ohio River, SW of Chickamauga Creek, Gallipolis, *DMS 2158,* 11 Aug 1982 (MICH, NY, OS, US). Lawrence Co.: Ohio River bank, S of Proctorville, 17 Sep 1979, *DMS 189* (MU); Sect 17, Rome Twp, *DMS 2159,* 11 Aug 1982 (NY, OS, US). Meigs Co.: weedy thickets along Ohio River 0.5 mi S of Middleport, 15 Jul 1974, *AWC 13509* (KE). Scioto Co.: Moores Lane, Washington Twp, 25 Sep 1981, *DMS & M. Silagy 1026* (OS). Williams Co.: Sect. 31, Superior Twp., 18 Aug 1981, *AWC 21116* (OS); Sect 5 & 6, Center Twp, 18 Aug 1981, *AWC 21117* (OS).

PENNSYLVANIA: Berks Co.: Oley Furnace, Oley Twp, 27 July 1969, *W. C. Brumbach 6880* (BH). Mifflin Co.: ca 4 mi E of Lewistown, 12 Aug 1921, *E. M. Gress s.n.* (OKL).

VIRGINIA: Albemarle Co.: James River at Warren Ferry, 25 Jun 1977, *C. Stevens s.n.* (herbarium of C. E. Stevens). Fairfax Co.: bank of Potomac River N of Dead Run, *T. Bradley 6926*, 16 Sep 1974 (GMUF); same location, 12 Aug 1982, *DMS, Thomas & Abercrombie 2166* (OS, US) (chromosome voucher).

WEST VIRGINIA: Cabell Co.: along Hwy 2, 7 mi E of Lesage, 30 Sep 1975, *D. Evans 1189* (MUHW); floodwall of Ohio River near Guyandotte, 11 Aug 1982, *DMS 2160* (NY, OS). Fayette Co.: New River, 2.5 mi below McCreery, 11 Aug 1941, *J. Tosh 1158* (WVA). Kanawha Co.: Rush Creek, Kanawha State Forest, 15 Aug 1966, *M. Denison s.n.* (WVA); N side of Kanawha River at Rt I-64 bridge, Charleston, 13 Aug 1984, *DMS & AWC 2383* (F, MICH, OS, NCU, WVA, US). Mason Co.: St Rt 2, N of Gallipolis Ferry, 17 Aug 1970, *AWC 11246* (OS); just N of Cabell Co. line on St Rt 2, 11 Aug 1982, *DMS 2161* (OS, US) (chromosome voucher); along RR, St Rt 62, 2 mi SE of jct of St Rt 2, 11 Aug 1984, *DMS & AWC 2368* (MICH, OS, NCU, WVA, US). Putnam Co.: roadside, jct of I-64 & US Rt 35, Southside, 26 Sep 1975, *D. Kirk 25* (WVA); RR embankments, 1.25 mi S of Robertsburg, 11 Aug 1984, *AWC & DMS 23793*, (F, MICH, OS, NCU, WVA, US). Raleigh Co.: W side of New River, ½ mi E of Terry P.O., 12 Aug 1984, *AWC & DMS 23809* (MICH, OS, NCU, WVA, US); W side of New River at Sandstone Falls N of Hinton, 12 Aug 1984, *DMS & AWC 2381* (F, MICH, OS, NCU, WVA, US). Summers Co.: New River, Hinton, 13 Aug 1963, *E. McNeil s.n.* (WVA).

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