

**A NEW SESSILE-FLOWERED *TRILLIUM*
(LILIACEAE: SUBGENUS *PHYLLANTHERUM*)
FROM SOUTH CAROLINA**

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ABSTRACT

Trillium oostingii, a new sessile-flowered *Trillium* from Kershaw and Richland County, South Carolina is described. It is closely related to *Trillium lancifolium* Raf. and *Trillium recurvatum* Beck. All known populations of this plant are found just below the Fall Line in the floodplain of the Wateree River.

KEY WORDS: sessile-flowered *Trillium*, *Trillium oostingii*, *Trillium lancifolium*, *Trillium recurvatum*, Wateree River, floodplain.

In April of 2002, I found an unusual sessile-flowered *Trillium* along the Fall Line in Kershaw County, South Carolina. Its petals were green to yellowish-green with maroon, clawed bases. The plant was growing in rich floodplain woods along the Wateree River in the Inner Coastal Plain of South Carolina. Although I immediately recognized the plant as one of the sessile *Trillium*, I could not determine the species.

From 2003 to 2007 I revisited the general area each year and discovered additional nearby subpopulations of the *Trillium* and continued research on the identity of the plants. While reviewing the database of the South Carolina Natural Heritage Program in 2002, I had noticed that a *Trillium* collection by H. J. Oosting on April 7, 1937 was known from same general area. Oosting had originally called the plant *Trillium viride* Beck; Oosting's specimen was later annotated *Trillium lancifolium* Raf. by S. J. Smith (1947) and by J. D. Freeman (1967). After an examination of Oosting's specimen (housed at DUKE), I concluded that the plant I was observing in the Wateree floodplain was the same plant he had collected in 1937.

Most of the plants on the Wateree were more robust and had broader petals than any *T. lancifolium* I had ever seen. Furthermore, the intrafloral structure of the plants' flowers was significantly different from that of the flowers of *T. lancifolium*. I, therefore, concluded the plant was not *T. lancifolium* (as the DUKE specimen had been annotated). After examining images of the Wateree trillium, Mr. Tom Patrick of the Georgia Natural Heritage Program, an expert on the genus *Trillium*, pointed out to me that the plant appeared to exhibit some morphological elements of *Trillium recurvatum* Beck, a Midwestern species never reported from South Carolina, and could represent a relict population of that species. Mr. Patrick's observations were partially borne out after measurements and images of the Wateree trillium were compared to those of *T. recurvatum*, but, in the end, I also concluded that the plants were not *T. recurvatum*.

After five years of morphological and biogeographical research and a review of the Wateree trillium's DNA and chromosome data, I have concluded that the Wateree trillium is a new species and hereby name it *Trillium oostingii*, in honor of its original collector Henry John Oosting, professor of Botany at Duke University from 1932 to 1968.

TRILLIUM OOSTINGII Gaddy, **sp. nov.**, Fig. 1.

A *T. lancifolium* et *T. recurvatum* filamentis minus quam 1/2 longioribus quam antheris differt; a *T. lancifolium* bracteis et petalis multis latioribus differt; a *T. recurvatum* bracteis sine petiolis differt.

Scapes (stems) 10-30 cm tall; **bracts** (leaves) elliptic-ovate to attenuate, rarely petiolate, 5-10 cm wide, 8-24 cm long; **sepals** elliptic-lanceolate, green to maroon, 20-60 mm long, 10-20 mm wide, acute-tipped, reflexed to semi-erect; **petals** broadly spatulate, to 30 mm wide and 80 mm long; 2.5 to 5 times longer than wide, clawed, claws 1/7 to 1/5 petal length; **stamens** 8-15 mm in length, slightly longer than gynoecium; anther connectives erect to slightly incurved, anther connective slightly exceeding filaments, filament length less than 1/2 the length of anther; **ovary** hexagonal, 6-16 mm long, deeply grooved to winged, globose to subglobose with persistent non-spreading

stigmas; stigmas (to 8 mm long) about the same length as the ovary. $2n=10$.

TYPE: U. S. A., SOUTH CAROLINA: Kershaw County. West side of Wateree River, several miles downstream from Camden, 03 April 2007, *L. L. Gaddy 04040701* (Holotype: USCH; isotypes, DUKE, GA, GH, MO, NCU, NY, TENN, US).

ADDITIONAL SPECIMENS EXAMINED: U. S. A. South Carolina: Kershaw County. In rich floodplain woods above junction of Big Pine Tree Creek with Wateree River, 11 April 2002, *L. L. Gaddy 041102*, (USCH); **Kershaw County.** In rich floodplain woods one-half mile upstream from Wateree River on Big Pine Tree Creek, 02 May 2004, *L. L. Gaddy 050204* (USCH); **Kershaw County.** Rich wooded floodplain, Wateree River just south of Camden, 7 April 1937, *H. J. Oosting 310* (DUKE); **Richland County.** In rich floodplain woods with *Carya cordiformis*, *Quercus pagoda*, *Podophyllum peltatum*, and *Carex cherokeensis* in English Swamp just west of the Wateree River and just south of the Kershaw-Richland County line. 100s of plants in area, 23 April 2008, *L. L. Gaddy 04230801 with Sudie Daves Thomas* (USCH).

Trillium oostingii is closely allied to *T. lancifolium* and *T. recurvatum*. The nearest known population of *T. lancifolium* is in South Carolina 100 km to the west in the Savannah River drainage, and the closest population of *T. recurvatum* is a disjunct population in central North Carolina about 120 km to the north. (*Trillium recurvatum* is known from the Midwest and Mississippi Valley and ranges east to eastern Alabama and central Tennessee. The North Carolina disjunct population is in Catawba County, in the same drainage system as the Wateree River.)

Trillium oostingii has the tall and elongate "look" of these two species, and like both of these species, it has relatively thin (usually less than 20 mm in diameter) creeping rhizomes and forms small to large clones. Its intrafloral structure, however, is more similar to other sessile-flowered *Trillium* unrelated to *T. lancifolium* and *T. recurvatum*. The stamens of *T. oostingii* are shorter than those of *T. lancifolium* and *T. recurvatum* (Fig. 1), and, unlike those of *T. lancifolium* and *T.*

recurvatum, whose filaments are about the same length or slightly shorter than the anthers, *T. oostingii*'s filaments are less than one-half the length of its anthers. Furthermore, its anthers are only slightly incurved, and the stamens are only slightly taller than the stigma (Table 1). The intrafloral region in *T. oostingii* is, therefore, compact, with the area inside of the stamens completely filled with the ovary and its tall stigma (Fig. 1). On the other hand, in *T. lancifolium* and *T. recurvatum*, the strongly incurved stamens and the short ovary creates an open area within the stamens.



Figure 1. *Trillium oostingii* (left) and *T. lancifolium* (right). Note the wider petals, shorter stamens, shorter claws in *T. oostingii*, and differences in proportional size of intrafloral parts.

When *T. oostingii* first appears in late March, its leaves (bracts) angle downward like those of *T. lancifolium* (not arching upward as do those of *T. recurvatum*), but as the plant matures, the

leaves become parallel to the ground. The sepals are strongly reflexed early in some *T. oostingii* plants, but, again, as the plants mature, the sepals become parallel to the ground. Most mature *T. oostingii* plants are large, broad-leaved, robust plants with broad, long petals, with little resemblance to *T. lancifolium*. Occasionally, however, a narrow-leaved, narrow-petaled plant is found in a *T. oostingii* subpopulation; an examination of the intrafloral parts of the flower then becomes necessary to separate the two species. No flowering *T. oostingii* plants in any of the 20 subpopulations had petiolate leaves, as is usually the case in *T. recurvatum*.

Several hypotheses concerning the origin of *T. oostingii* can be advanced, none of which is satisfactory in explaining how this species arose. When I first saw *T. oostingii*, I thought that it was *Trillium maculatum* Raf. *forma similans* Freeman, a form of *T. maculatum* with yellow petals and maroon claws, or a hybrid between *forma similans* and *T. lancifolium*. After further research, however, the only real similarity between the two taxa is flower color and intrafloral structure. It later occurred to me that *T. oostingii* may be a natural hybrid between *T. lancifolium* and *T. recurvatum*, but DNA sequences indicate that the all three species are unique. In fact, according to the DNA sequence presented in Figure 2 (courtesy of Dr. Susan Farmer), *T. lancifolium* and *T. recurvatum* are more closely related to each other than either is to *T. oostingii* (Fig. 2).

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ATATGCGTTCCTTTATCTTCTATTTTTTCT~~~~~CCGATCTTCTC
ACATGCGCTCCTTTATATTCTCTTTTTTCT~~~~~CCAATCTTTTC
ATATTGTTCTTTCATATT~~~~~CTCATAATCCGATATTCTA
* * * * * * * * * * * * * * * * * * * * * * * * * * * *
TT~~~~~CTTTTATCTTTCTATTTT~AACCTCG lanc.
TT~~~~~CTATTCTCTT~CTATTGAACTCG recurv.
TTCTATTTTTTCTTTTCTATT~CTTTTTTGAACTAG oost.
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Figure 2. DNA sequences: *Trillium lancifolium*, *T. recurvatum* and *T. oostingii* (top to bottom). Sequence is based on the psbA-trnH intergenic spacer, a non-coding gene region (Farmer, 2007).

Furthermore, chromosome counts revealed that the Wateree plant had a chromosome number of $2n=10$ (Fig. 3), the same number as all known North American *Trillium* species (Hill, 2005), and is probably not a hybrid. [All known *Trillium* hybrid species are polyploids (Samejima and Samejima, 1962)].

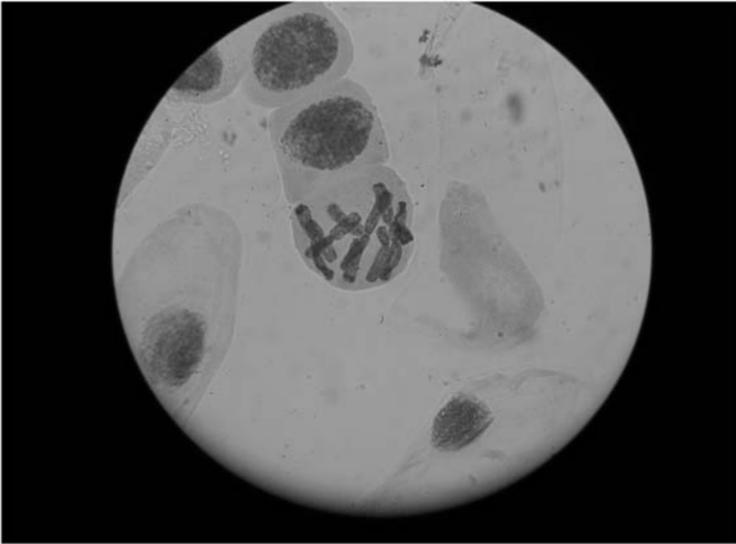


Figure 3. Chromosome division in *Trillium oostingii*.

Key to *Trillium oostingii* and Allies

[based on keys in Case and Case (1997), Case (2003), and Freeman (1975)]

Sepals frequently strongly reflexed at bases; rhizomes horizontal, elongated, slender (usually less than 20 mm in diameter), brittle, forming clones

1. Anther connectives strongly incurved; filaments long, more than $\frac{1}{2}$ anther length
 2. Petals ca. 2 X longer than wide, attenuate to weakly clawed; bracts petiolate.....***T. recurvatum***
 2. Petals ca. 4-7 X longer than wide, strongly clawed; bracts not petiolate.....***T. lancifolium***
1. Anther connectives slightly incurved; filaments short, less than $\frac{1}{2}$ anther length.....***T. oostingii***.

Found on both sides of the Wateree River, just southwest of Camden, in Kershaw County, SC, and along the Wateree River 15 km southward in Richland County, SC, *Trillium oostingii* grows in large colonies in rich, floodplain alluvium along creek banks and on natural river levees under a canopy of *Carya cordiformis* (Wang.) K. Koch, *Juglans nigra* L., *Ulmus rubra* L., *Quercus phellos* L., *Quercus pagoda* Raf., *Quercus shumardii* Buckl., and *Acer negundo* L.. In the understory, *Philadelphus inodorus* L., *Viburnum prunifolium* L., *Ilex longipes* Chapm., *Ligustrum sinense* Lour., *Arundinaria gigantea* (Walt.) Muhl., *Cercis canadensis* L., *Tilia heterophylla* L., *Vitis rotundifolia* L., and *Menispermum canadense* L. occur. In the herbaceous layer, *Cardamine concatenata* (Michx.) Ahles, *Carex abscondita* Mackenzie, *Carex cherokeensis* Schwein., *Carex crebriflora* Wieg., *Corydalis flavula* (Raf.) DC, *Erigeron strigosus* Muhl. ex Willd., *Erythronium umbilicatum* Parks & Hardin, *Galium aparine* L., *Nemophila aphylla* (L.) Brummit, *Osmorhiza longistylis* (Torr.) DC., *Podophyllum peltatum* L., *Verbesina officinalis* L., *Viola affinis* Le Conte, and *Viola pubescens* var. *scabriuscula* Schwein. ex T. & G. were common associates. Nearly every colony of *T. oostingii* was associated with a large colony of *Podophyllum peltatum*. Thousands of stems of *T. oostingii* occur in about 20 subpopulations.

ACKNOWLEDGMENTS

Dr. Susan Farmer of the University of Tennessee conducted the DNA analysis (Fig. 2) and reviewed early drafts of this paper. Dr. Gerald Smith of High Point College (North Carolina) counted and photographed (Fig. 3) the chromosomes for this species. Mr. Tom Patrick of the Georgia Natural Heritage Program examined images of *Trillium oostingii* and reviewed drafts of this paper. Finally, Dr. John

Byron Nelson, Curator of the A. C. Moore Herbarium (USCH) at the University of South Carolina, assisted me with loans and collections and also reviewed the paper. I would like to sincerely thank these four individuals.

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Table 1. *Trillium oostingii* and allies.

Character	<i>T. oostingii</i>	<i>T. lancifolium</i>	<i>T. recurvatum</i>
Stems (scapes)	1-2 times longer than longest leaf	More than 2 times longer than longest leaf	More than 2 times longer than longest leaf
Leaves (bracts)	Darkly mottled to faintly streaked; ovate to broadly elliptical; bases cuneate to attenuate	Mottled to darkly streaked; elliptical to linear-elliptical; bases attenuate	Mottled to darkly streaked, elliptical to linear-elliptical; bases petiolate
Rhizomes	Thin (< 20 mm)	Thin (< 20 mm)	Thin (< 20 mm)
Sepals	Strongly reflexed to semi-erect	Weakly to strongly reflexed	Strongly reflexed
Petals	Lanceol. to ovate; green to yellow with purple bases; long clawed; 2.5-5 times longer than wide	Ellipt. to narrowly spatulate; purple to yellow with purple bases; long clawed; 4.5-7 times longer than wide	Lanceol. to ovate; green, purple, or yellow with purple bases; attenuate to weakly clawed; 2-3 times longer than wide
Androecia	Stamens slightly incurved; slightly taller than ovary; filaments short, less than 1/2 length of anthers	Stamens strongly incurved; 1.5-2 times taller than ovary; filaments long, equal to the anthers	Stamens strongly incurved; much taller than ovary filaments long; equal to or shorter than the anthers
Gynoecia	Sharply six-angled; stigmas erect	Sharply six-angled; stigmas spreading	Sharply six-angled; stigmas spreading