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Tricalycites and a new genus of winged fruit from the Cretaceous of North America

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Introduction

Prominently winged fruits occur in many families of angiosperms today, but are rare and poorly documented in the mid-Cretaceous. The Cretaceous winged fruit or seed genus Tricalycites has been considered a mysterious plant. The formal description was published in 1895, for these enigmatic winged disseminules. Fossils of this genus have since been reported from more than 15 mid- to upper Cretaceous sediments localities from The Raritan Fm., The Magothy Fm. in New Jersey, New York, Massachusetts, Rhode Island, The Tuscaloosa Fm. in Alabama, and The Woodbine Fm. in Texas (Fig.1, 2). Previous researchers used it as a marker for stratigraphic correlation. However, the genus has not been investigated since early in the last century and has been overlooked in recent treatments of the Cretaceous angiosperm flora. New information for the specimens is not only helping to better characterize the morphology and possible affinities, but also to recognize a new genus, which should be separate from the original genus Tricalycites.

Epoch Age Texas Alabama Eastern US Santonian Austin Fm. Eutaw Fm. Magothy Fm. Coniacian Coniacian Coniacian Coniacian Coniacian Turonian Eagle Ford Fm. Coniacian Coniacian Coniacian Coniacian Image: Coniacian Coniacian

New Genus and Species

Cenomanian Woodbine Fm. Woodbine Fm.

Fig 1. Late Cretaceous Formations indicating inferred positions of *Tricalycites* and a new taxon

Material and Methods

We studied specimens of *Tricalycites* and a new genus housed in four museums: Smithsonian, Washington DC (USNM), Peabody Museum, Yale University, New Haven Connecticut, (YPM), Field Museum, Chicago (FMNH PP), and Florida Museum of Natural History at University of Florida, Gainesville (UF), which were collected from localities located in the Eastern and Gulf coastal, North America. We examined all of these specimens and borrowed some for detailed investigation. We also collected specimens of the new genus from a road cut of Wire Road (Fig.2-6), Alabama and deposited them in the UF paleobotanical collections along with specimens collected earlier by students and colleagues from the same site intermittently over the past three decades.





Fig. 3 Line drawing of Tricalycites and the new taxon a. *Tricalycites papyraceus* b. New genus c. New genus *major*

1. Denton (T. papyraceus); 2. Arthurs Bluff (*T. papyraceus*); 3. Glen Allen (T. papyraceus); 4. Shirleys Mill (*T. papyraceus* and **new taxon**); 5. Gully on the Snow Plantation (*T. papyraceus*); 6. Wire Road (**new taxon**); 7. Woodbridge (T. papyraceus); 8. Glen Cove (*T. major* \rightarrow **new taxon**); 9. Cliffwood (*T. papyraceus*); 10. Staten Island (T. papyraceus); 11. Lloyd Neck (*T. papyraceus*); 12. Montauk Point (*T. major* \rightarrow **new taxon**); 13. Block Island (*T. papyraceus*); 14. Gay Head (T. papyraceus); 15. Nashaqitsa (*T. major* \rightarrow **new taxon**); 16. Chapppaquiddick (*T. papyraceus*);



Unlabeled scale bars = 1 cm New genus major comb. Zhang et al.



Fig. 2 Map of localities

The specimens were photographed with a Canon Rebel 450 digital SLR equipped with an EFS 60 macro lens. Compression specimens with intact cuticle were observed and photographed with Zeiss Epi-Fluorescence microscope and transmitted light microcopy. Upper and lower epidermal surface impression images of *'Tricalycites' major* holotype were obtained while investigating the uncoated specimen under low vacuum with a Hitachi SU5000 Schottky Field-Emission Scanning Electron Microscope (SEM). Additional macromorphological images were obtained using micro-CT scanning X-ray data.

Results — Systematics

Genus Tricalycites Newberry, 1895 - Tricalycites papyraceus Newberry 1895



Unlabeled scale bars = 1 cm

Table 1 Comparison of *Tricalycites* and the new taxon

Features	New genus	New genus major (Hollick) comb.	Tricalycites papyraceous		
Pedicel length(cm)	0.3–0.5	0.3–0.6	0.25–0.35		
Pedicel width(cm)	0.1–0.25	0.15	0.03–0.08		
Central nucleus diameter (cm)	0.5–1	0.3–0.6	0.1–0.4		
Middle wing/wing-lobe length (cm)	0.4–2	0.35–1.5	0.6–2.5		
Middle wing/wing-lobe width (cm)	0.2–0.6	0.4–0.9	0.2–0.6		
Side wings/wing-lobes length (cm)	1.2–2.8	2–4	0.5–1.4		
Wing venation	an approximately parallel longitudinal venation pattern, converging toward the base, with veins forking and anastomosing, ultimately ending in the margins				
The position of three wings	Adjacent wings almost parallel or diverging from each other at angles less than 20°	Always show 2 wings, central wing hidden in the rock. Adjacent	lobes diverging from each other at angles of about 45 $^{\circ}$		
Central wing	Small central wing, small central wing, overlapping the inner margins of the lateral wings	Small central wing, overlapping the inner margins of the lateral wings	Central lobe larger than the two lateral lobes		
Spiny structures	Paired spiny projections arising from the base of the fruit	Unobserved	Unobserved		

Discussion

The disseminules include a pedicellate globose body with longitudinal ribs and a slender apical protrusion interpreted as a style. Three prominent longitudinal wings arise from the base of the fruit, with parallel sides, rounded apices and subparallel venation and the combination of paracytic and cyclocytic stomata, accompanied with

Jnlabeled scale bars = 1 cm

Table 2 Cuticle comparison of *Tricalycites* and the new taxon

	Taxon			
Character		Tricalycites papyraceus	Wireroadia viccallii sp. nov.	Wireroadia major comb. Nov
Upper epidermis	Shape of cells	Polygonal	Polygonal	Polygonal
	Pattern of anticlinal wall	Straight	Straight	Straight
Lower epidermis	Shape of cells	Polygonal	Polygonal	Polygonal
	Pattern of anticlinal wall	Straight	Straight	Straight
Type of Stomatal apparatus		Paracytic and Tetracytic	Paracytic and Cyclocytic	Paracytic and Cyclocytic
Size of epidermal cells		25-35µm long, 12-25µm wide	10-15µm long, 6-15µm wide	20-32µm long, 8-20µm wide
Size of guard cells		13-15µm long, 12-25µm wide	11-14µm long, 3-4µm wide	18-30µm long, 3-6µm wide
Size of subsidiary cells		30-35µm long, 5-11µm wide	20-35 μm long, 10-12μm wide	25-40μm long, 5-7μm wide
Trichome base		Unobserved	Yes (10µm diameter)	Unobserved

trichome bases. The new genus shows in addition to these wings, a pair of prominent antler-like branched spines arising laterally from the base of the fruit and some diminutive rounded basal laminar lobes on the "front" side of the fruit body. This species differs from the type species of Tricalycites which has only a single wing that is tri-lobed, a miniscule seed body and paracytic and tetracytic stomata, and lacks trichome bases. An additional species formerly misassigned to Tricalycites, from the late Cretaceous of New York, New Jersey and Massachusetts, is also attributed to the new genus. This species differs by lacking the branched basal spines, and the epidermal anatomy of its wings remains unknown, but conforms to the new genus in wing number and position, venation pattern, fruit body morphology and pedicel thickness. Morphologically, the winged fruits from new genus display some characters in common with extant Fagales, Malvales and Malpighiales.

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