Wood and bark anatomy of Muntingiaceae: A phylogenetic comparison within Malvales s. l.

SHERWIN CARLQUIST

Carlquist, S. (Santa Barbara Botanic Garden, 1212 Mission Canyon Road, Santa Barbara, California 93105, U.S.A.; e-mail: s.carlquist@verizon.net). Wood and bark anatomy of Muntingiaceae: A phylogenetic comparison within Malvales s. l. Brittonia 57: 59-67. 2005.—Quantitative and qualitative data on wood and bark anatomy are given for Muntingia calabura L. and Dicraspidia donnell-smithii Standley. These data are compared with phylogenetic schemes, based on DNA analysis, in which Muntingiaceae belong to the “dipterocarp clade” within Malvales. The data are consistent with this hypothesis, although Muntingiaceae lack pit vestures in vessels, which are seen in the other malvaceous families (Cistaceae, Dipterocarpaceae, Neuradaceae, Sarcolaenaceae, Thymeleaceae), and this may represent a loss of pit vestures. All families of the dipterocarp clade agree with both genera of Muntingiaceae in having tracheids as the imperforate tracheary element type (at least ancestrally), although fiber-tracheids also occur in some Dipterocarpaceae and Thymeleaceae. The large size of some malvaceous families (with attendant greater diversity in character states) and a paucity of wood studies in those families make for difficulty in comparison of features such as axial parenchyma and ray types with those of Muntingiaceae; character states of these features are consistent with placement of Muntingiaceae in the dipterocarp clade of Malvales. Banded phloem fibers in bark of Muntingiaceae are much like those of other Malvales. Wood of Muntingiaceae is highly mesomorphic according to quantitative vessel features.

Key words: bark anatomy, Cistaceae, Dipterocarpaceae, Elaeocarpaceae, Malvales, Thymeleaceae, tracheids, vessel grouping, vestured pits.

Introduction

Muntingiaceae consist of two monotypic genera, Muntingia (Mexico to West Indies, but now weedy in tropical America) and Discraspidia (Central America). These two genera had frequently been placed in Elaeocarpaceae, although evidence from wood anatomy (Metcalfe and Chalk, 1950; Gasson, 1996) indicated they were discordant elements in that family. This contention was confirmed by molecular work (Alverson et al., 1998), who placed them in a “dipterocarp clade” of Malvales. The family Muntingiaceae was formally proposed by Bayer et al. (1998), who present reasons for its recognition. Neoreussmannia has been tentatively referred to Muntingiaceae (Bayer et al., 1998) but is not included in the present study. The dipterocarp clade of Malvales includes Neuradaceae, Muntingiaceae, Cistaceae, Sarcolaenaceae, and Dipterocarpaceae according to Alverson et al. (1998). A similar result was reached by Soltis et al. (2000), who excluded Neuradaceae (but placed it as an outgroup to the clade) and placed Thymeleaceae as an outgroup to the remainder of the dipterocarp clade. This placement of Muntingiaceae was accepted by Jansen et al. (2001) in a study of vestured pits in Malvales. The Angiosperm Phylogeny Group (APGII, 2003) included Muntingiaceae within Malvales but did not offer an explicit phylogenetic placement within that order.

One purpose of the present study is to offer as complete as possible a description
of wood anatomy of Muntingiaceae based on the materials available, and to describe bark anatomy, the latter not previously recorded. The second purpose of this study is to compare the wood of Muntingiaceae, primarily to the wood of other members in the dipterocarp (“dipterocarpalean”) clade of Malvales (tentatively defined here as including Thymeleaceae, Muntingiaceae, Cistaceae, Sarcolaenaceae, Diperocarpaceae), and to give a preliminary analysis of the differences and similarities among the families of that clade with respect to wood character states. Comparisons of features of Muntingiaceae to the other clade of Malvales (Bixaceae-Malvaceae) are also appropriate. The Bixaceae-Malvaceae clade includes Bixaceae, Bombacaceae, Malvaceae, Sterculiaceae, and Tiliaceae, according to Soltis et al. (2000). The treatments of Soltis et al. (2000) and APGII (2003) group the latter four families as Malvaceae. For convenience, the four families are recognized here.

There is rather extensive information on the wood of Dipterocarpaceae (Gottwald and Parameswaran, 1966) and on the wood of Sarcolaenaceae (Den Outer and Schütz, 1981). There have been no family-level monographs on woods of the remaining families, although many good generic descriptions have been published (see Gregory, 1994). Comparison of Muntingiaceae to Thymeleaceae is particularly troubling because wood anatomy of Thymeleaceae is remarkably diverse, and much of the diversity has not been recorded. I have attempted to supply citation of key wood character states of Thymeleaceae from my slides of the family, which have been accumulated for the purpose of a familial monograph that I hope to publish soon. However, detailed presentation of information on Thymeleaceae is inappropriate for this paper. The summaries of Metcalfe and Chalk (1950) prove helpful because of their coverage of all families concerned. These are the references used for comparisons with Muntingiaceae unless otherwise stated below.

**Materials and Methods**

Stems of the two genera were collected by Dr. Scott Zona in the Montgomery Botanical Center and preserved in 50% aqueous ethanol. The collection data are: *Dicraspida donnell-smithii* [Montgomery Botanic Garden 941105c; Zona 935 (FTG)]; *Muntingia calabura* [Montgomery Botanic Garden 982204; Zona 933 (FTG)]. The stem of the *Muntingia* (4.9 cm including bark; bark thickness 3 mm) was appreciably wider than that of the *Dicraspida* (1.4 cm including bark), a fact that is of significance in the descriptions below.

Wood of both genera was only moderately hard, and thus was successfully sectioned without treatment on a sliding microtome. Presence of secondary phloem fibers in the bark, which is otherwise soft in texture, necessitated use of a different method (Carlquist, 1982). Sections to be made into permanent slides were stained with safranin and counterstained with fast green. Sections to be studied with scanning electron microscopy (SEM) were dried between clean slides, mounted on aluminum stubs, sputter coated, and studied with a Hitachi S-2600N scanning electron microscope. SEM studies of vessel pits were attempted only with *Muntingia* because the pervasive deposits of resinlike compounds in *Dicraspida* obscured fine cellular details. Macerations were prepared with Jeffrey’s Fluid and stained with safranin.

Vessel diameter is measured as vessel lumen diameter, because the lumen volume is hydrologically significant, whereas the outside vessel dimension is not (vessel wall thickness is, however, also given in the descriptions). Diameter of vessels, oval in transection, is measured as an average of long and short chords. Mean number of vessels per group is based on a solitary vessel = 1, a pair of vessels in contact = 2, etc. Means are based on 25 measurements. Terms are used in accordance with the IAWA Committee on Nomenclature (1964) and Carlquist (2001). The term “tracheid” for imperforate tracheary elements of Muntingiaceae is advisable because Muntingiaceae are one of the families that validate the concept that in dicotyledons, tracheids are conductive cells and thereby forestall the evolution of grouping of vessels (Carlquist, 1984). Wood of *Muntingia* is described before that of *Dicraspida* because