Tree of the Year: *Liquidambar*

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With contributions from Anne Boscawen (UK), John Bulmer (UK), Koen Camelbeke (Belgium), John Gammon (UK), Hugh Glen (South Africa), Philippe de Spoelberch (Belgium), Dick van Hoey Smith (The Netherlands), Robert Vernon (UK) and Ulrich Würth (Germany).

Affinities, generic distribution and fossil record

Liquidambar L. has close taxonomic affinities with *Altingia* Noronha since these two genera share gum ducts associated with vascular bundles, terminal buds enclosed within numerous bud scales, spirally arranged stipulate leaves, polyporate (with several pore-like apertures) pollen grains, condensed bisexual inflorescences, perfect or imperfect flowers, and winged seeds. Not surprisingly, *Liquidambar, Altingia* and *Semiliquidambar* H.T. Chang have now been placed in the Altingiaceae, as originally treated (Blume 1828, Wilson 1905, Chang 1964, Melikan 1973, Li *et al.* 1988, Zhou & Jiang 1990, Wang 1992, Qui *et al.* 1998, APG 1998, Judd *et al*. 1999, Shi *et al.* 2001 and V. Savolainen *pers. comm.*). These three genera were placed in the subfamily Altingioideae in Hamamelidaceae (Reinsch 1890, Chang 1979, Cronquist 1981, Bogle 1986, Endress 1989) or the Liquidambaroideae (Harms 1930). Shi *et al.* (2001) noted that *Altingia* species are evergreen with entire, unlobed leaves; *Liquidambar* is deciduous with 3-5 or 7-lobed leaves; while *Semiliquidambar* is evergreen or deciduous, with trilobed, simple or one-lobed leaves.

Cytological studies have indicated that the chromosome number of *Liquidambar* is 2n = 30, 32 (Anderson & Sax 1935, Pizzolongo 1958, Santamour 1972, Goldblatt & Endress 1977). Ferguson (1989) stated that this chromosome number distinguished *Liquidambar* from the rest of the Hamamelidaceae with their chromosome numbers of 2n = 16, 24, 36, 48, 64 and 72.

Liquidambar has a disjunct distribution pattern on several continents, which span eastern North America, eastern Asia, and Asia Minor. It constitutes approximately four recognized species with one in eastern North America, two in Asia, and one species (two taxa) in Asia Minor. All of these: *L. styraciflua* from the New World, and *L. orientalis, L. formosana,* and *L. acalycina* from the Old World are in general cultivation. Diels (1900) described *L. rosthornii* from China, but examination of herbarium material has revealed the plant to be an *Acer* species, based on its opposite leaf arrangement (Ferguson 1989).

Not surprisingly, *Liquidambar* has a long, rich fossil record throughout the Tertiary, with the early records in the Paleocene (Kuprianova 1960) and Eocene (MacGinite 1941, Gray 1960, Chandler 1964, Leopold & MacGinite 1972, Tanai 1972, Wolfe 1977). The distinct distribution pattern of *Liquidambar* is a relict of a widespread Miocene range (Lancucka-Srodoniowa 1966, Uemura 1983), during which the current species of *Liquidambar* may have diverged, with a longer

period of separation between eastern and western Asian taxa (Hoey 1990, Hoey & Parks 1991). Supporting this widespread range of *Liquidambar* is fossil material, especially pollen, discovered in the Maryland coastal plain (McCartan *et al*. 1990), the Norwegian Greenland sea (Koreneva *et al*. 1976), Alaska (Wolfe & Tanai 1980), Japan (Uemura 1983), China (Zhang, Wang & Jiang 1982), Europe (Szafer 1954, Lancucka-Srodoniowa 1966, Zagwijn 1966), and central Asia (Abuziarova 1967). Based on genetic studies, Hoey & Parks (1991) stated that eastern North American and Turkish species seem most closely related, providing evidence for a North Atlantic land bridge during the Miocene period. Li *et al*. (1997) and Li & Donoghue (1999) supported this relationship. Later climate changes during the Pliocene and Pleistocene eras further isolated the *Liquidambar* populations on different continents (Hoey & Parks 1991).

Generic description of *Liquidambar*

Deciduous trees to about 35 m tall; branching excurrent (with an extended main axis or leader from which lateral branches develop); bark grey-brown, deeply furrowed; twigs and branches sometimes corky-winged; base of the trunk enlarged. Dormant buds scaly, pointed, shiny, sessile. Leaves alternate, long-petiolate; leaf blade 3-7 (or more)-lobed with each apex long-acuminate, palmately veined, base cordate or truncate, rarely entire, margins serrate, aromatic when crushed. Inflorescences terminal, stalked, in condensed panicles. Male flowers without perianth; staminodes absent; anthers on short filaments, longitudinally dehiscent; pollen polyporate. Female flowers without perianth; 5-8 staminodes; styles indurate (hardened) and spiny in fruit, incurved; ovary semi-inferior. Capsules woody, spherical. Seeds many, flattened, narrowly winged.

Vernacular names: sweet gum, red gum, star-leaved gum, bilsted, alligator-tree.

Key to species of *Liquidambar* in cultivation (Weaver 1976, Zhang et al. 2003)

1a. Mature leaves with three lobes……………………………………………………**2**

  2a. Fruit aggregates with long bristles between capsules, appearing bristly rather than spiny; leaves with two stipules near the base of the petiole, winter buds densely silky hairy……………………………………………**L. formosana**

  2b. Fruit aggregates without long bristles between capsules, appearing scale-like; leaves lacking stipules; winter buds smooth and hairless……………………**L. acalycina**

1b. Mature leaves with 5-7 lobes; fruit aggregates without bristles, appearing and feeling spiny; winter buds not hairy, except on the margins of scales…………………… **3**

  3a. Main lobes of the leaves with smaller lobes near the apex; branchlets without corky ridges……………………………………………………**L. orientalis**

  3b. Main lobes of the leaves without secondary lobes; branchlets usually with conspicuous corky ridges………………………………………………**L. styraciflua**

Liquidambar styraciflua L. (*L. barbata* Stokes, *L. gummifera* Salisbury, *L. macrophylla* Ørsted, *L. styraciflua* var. *mexicana* Ørsted)
Vernacular names: sweet gum, red gum, star-leaved gum, gum, alligator wood, Circassian walnut, bilsted, copalm, opossum tree, incense tree.

The specific epithet *styraciflua* means flowing with styrax or storax. Of the numerous vernacular names, alligator wood refers to the plated bark and bilsted is likely a corruption of "blistered", again a description of the bark (Ware 1970).
Liquidambar styraciflua occurs from western Connecticut and Long Island to central Florida, eastern Texas and southeastern Oklahoma to the southern parts of Illinois, Ohio, Indiana, and southeastern Missouri, as well as in the mountainous regions of Mexico (Veracruz, Puebla, Hidalgo, Oaxaca, and Chiapas), and Central America (Belize, Honduras to Nicaragua). Elwes & Henry (1908) disagreed with Ørsted's opinion that the Mexican and Guatemalan trees constitute distinct forms (*L. macrophylla* Ørsted and *L. styraciflua* var. *mexicana* Ørsted) (Ørsted 1863), since *L. styraciflua* occurs over a wide range in diverse climates, and hence the differences in the shape, size, and pubescence of leaves that were observed, e.g. in the arid regions of Mexico, the leaf undersides are densely pubescent. Meyer (1997) lumps *L. macrophylla* and *L. styraciflua* var. *mexicana* under *L. styraciflua*. Plants from Mexican populations were grown in Virginia from seed collected by Marshall C. Johnston in a cloud forest *c.* 1067 m, four miles above Xilitla, San Luis Potosi. When compared with trees from southeastern U.S. populations, they leafed out a week earlier and retained their leaves 3 - 4 weeks later in autumn (Baldwin 1974). In a comparison of frost tolerance among seedlings derived from field-collected seed from U.S., Mexico, and Central America, those from the U.S., especially Fairfield County, Connecticut, had the greatest frost tolerance, with the Mexican and Central American populations sharing similar hardiness (Williams & McMillan 1971). The conservation status of *L. styraciflua* is that of Least Concern (Craig Hilton-Taylor *pers. comm.*).
There has been much speculation about the role of corky ridges or growths on *L. styraciflua*; one theory is that they increase the wind resistance of the tree, but young trees lose the corky features when they mature. Gregory (1888) noted that cork wings in *L. styraciflua* are unusual in their one-sided origin and growth as wings on lateral branches occurred on the upper side, standing at such an angle to form troughs along the entire length of the branches.
The variability of the leaves on a tree or trees, has been the subject of much research. Smith (1967) discovered that *L. styraciflua* produced two types of leaves; the first leaves formed in early spring are shallow-lobed, while the late leaves are more deeply lobed and generally have shorter petioles. The earlier leaves originated from the overwintering bud, in contrast to late leaves produced from the apical meristem without overwintering as leaf primordia. This leaf dimorphism exists only in mature trees. It is thought that the late leaves are more drought resistant. Although a commonly grown ornamental tree in

Europe, the bristly fruits fail to form in the cooler more maritime areas.

'Andrew Hewson' ('Andrew Henson') Miller (2000) unsuccessfully attempted to locate the source of this cultivar as well as the origin of the name. Several Dutch nurseries carry 'Andrew Hewson' as 'Andrew Henson'; Boskoop have known it as the latter since the early 1990's. Miller (2000) noted that Andrew Hewson was once a student at Hilliers, but Hewson, once contacted, said that it was not named by or for him. Nonetheless, 'Andrew Hewson' has an upright habit with distinctive finely lobed foliage that turns dark red to orange in autumn. It seems to colour early as the young specimen at the Jubilee Arboretum in Wisley had brilliant wine-red leaves (9/10/03).

'Anja' A Dutch selection having horizontal branches, prominent long central lobes and purple autumn colour. Known before 1993 and named for Anja Zweinenberg of Boskoop.

'Anneke' There is a young tree (W965024) at RHS Wisley ex Hadlow College nursery in 1996. Known before 1993.

'Argentea' Listed in the *RHS Plant Finder 2003-04*, but not a recognized name.

'Aurea' - see under 'Variegata'.

'Aurea Marginata' ('Aureomarginata') Origin unknown but available before 1993. The leaf margins are edged with gold. Slow growing, and an eight year-old tree in the UK National Collection of Dr J. Gammon is only 10 ft tall.

'Aurora' Introduced by the Dutch nursery Alphons van der Bom of Oudenbosch in 1977, this cultivar has bright yellow variegated foliage and pink autumn colour. According to Dr Gammon, the Rare and Skylark Nursery in California described its autumn display as "a technicolor sequence of yellow, orange, red and purple." However, plants exhibited before Floral Committee B in November 1999 did not have variegated foliage. A small tree planted in the Jubilee Arboretum at RHS Wisley also lacks variegation.

'Autumn Glow' Listed in Santamour & McArdle (1984).

'Bratzman' Listed in Dirr (1990).

'Burgundy' Known for its purplish-tinted young foliage that turns deep purple in autumn. This is a 1969 cultivar from the Sarogata Horticultural Foundation, California. It is superior to other cultivars in holding its 5-lobed, deeply cut leaves longer (until December or January), even when they have turned purple.

'Byrne' Listed in Plant Sciences Data Center of the American Horticultural Society (Santamour & McArdle 1984). No description is available.

'Carnival' Listed in Dirr (1990). Said to be similar to'Oconee' (*q.v.*).

'Corky' An invalid name from 1968 with no description (Santamour & McArdle 1984). Listed in Jacobsen (1996).

'Elstead Mill' Erroneously listed under *L. acalycina* in the *RHS Plant Finder 2003-04,* this selection is similiar to 'Lane Roberts' (*q.v.*) in its crimson autumnal colour and shape. Only the leaves are slightly larger than 'Lane Roberts'.

'Emerald Sentinel' Possibly another fastigiate cv (Todd Lasseigne *pers. comm.*).

'Fastigata' Listed in the *RHS Plant Finder 2003-04*. An infrequently seen narrow-growing selection.

'Festeri' Introduced by Hazelwood Bros. Pty. Ltd., Epping, NSW, Australia in 1947. This was named for Mr Fester, a gardener at Kenmore Hospital, Goulburn, NSW, who recognized this tree's ornamental value (Santamour & McArdle 1984). Notable for retaining its autumn foliage into midwinter.

'Festival' ('Lee') Another Saratoga Horticultural Foundation selection, this 1964 cultivar has a narrow upright habit, grows rapidly, and is a "festival of light, bright shades" (Santamour & McArdle 1984). Registered with the Arnold Arboretum, 'Festival' was discovered in the yard of a Saratoga resident, Paul Lee. The autumn leaves are a golden colour infused with apricot or peach (Wyman 1969).

'Fremont' Listed in Jacobsen (1996) and now not known in the trade.

'Frosty' ('Starlight') - A cultivar with white-speckled leaves discovered in Raleigh, North Carolina by Tony Avent of Plant Delights Nursery. The variegation persists on the new growth only with summer heat (Todd Lasseigne *pers. comm.*).

'Gold Dust' - See under 'Variegata.'

'Golden Treasure' An Australian cultivar that was introduced from the 1974 Catalogue of Duncan and Davies, New Plymouth, New Zealand. 'Golden Treasure' has leaves with gold margins that turn cream to white while the green centres turn burgundy, orange, and pink (Santamour & McArdle 1984). Karan Junker *pers. comm.* noted that it is slow-growing as well as difficult to grow but has "awesome autumn colour." A tree (W19991064*A) at the RHS Wisley Jubilee Arboretum appears stunted and gnarled with corky twigs.

'Goldstar' or 'Gold Star' - Listed in Dirr (1990).

'Gum Ball' ('Gumball', 'Globosum', 'Globe') 'Gum Ball' is described as a 'bush-like, slow-growing form of sweetgum, which is characterized by a proliferation of small erect stems originating from a central root collar (Wyman 1969). Supposedly introduced in 1965, but it did not appear in the trade until 1970/71. It was discovered by Hiram B. Stubblefield of Forest Nursery, McMinnville, Tennessee. *The Hillier Manual* (Anon. 1991) singles out its "dense shrubby habit with long lasting leaves turning orange-red and purple." See illustration on p.37.

'Hagen' No published description.

'Happidaze' According to Chris Pattison *pers. comm.*, this selection has a distinct habit when young, and is very free branching. It acquires the corked stem at a much earlier age than other cultivars. Pattison obtained it as scion material from Bernheim Arboretum, Kentucky, USA *c.* 2000.

'Jennifer Carol' Listed in Van der Laar (1985) but no description located.

'Joseph's Coat' Exhibited by Lord Aberconway on November 25, 1987, but no description has been found (Miller 2000).

'Keith Davey' No published description.

'Kent' Listed in Santamour & McArdle (1984).

'Kia' Selected in Canberra, Australia in 1968, 'Kia' has a tall, spire-like habit with good red autumn colour (Santamour & McArdle 1984). Dr Gammon *pers. comm.* observed that the foliage turns a rich orange before becoming crimson and finally purple. Kia is an Aboriginal word for spear.

'Kirsten' - There is a small tree (W19994136) at RHS Wisley Jubilee Arboretum and another one at Savill Garden has yet to colour (18/10/03). The dark green leaves are finely cut and smaller than other cultivars.

'Lane Roberts' This is perhaps the best form in the trade today. 'Lane Roberts' was named after a gynaecologist in Hertfordshire who purchased several seedlings from the Hillier Nursery. A friend of Lane Roberts, Sir Harold Hillier was visiting his garden when he was impressed with one of the seedlings and obtained scion wood for propagation. It was first listed by Hilliers in 1971. 'Lane Roberts' has an upright pyramidal shape, vigorous growth, and large 5-lobed leaves that turn a rich crimson or deep black crimson-red. It also can have quite a smooth bark. Micropropagation, misidentified scion wood, or site conditions may account for variations in cultivated plants. The Royal

Horticultural Society gave it an Award of Garden Merit in 2002.

'Levis' Listed in the 1955 Marchants Catalogue from Dorset. 'Levis' is very hardy with smooth branches and trunk; its leaves colour well in autumn (Santamour & McArdle 1984).

'Lollipop' - Listed in Dirr (1990).

'Manon' ('Albomarginata Manon') A cultivar with variegated leaves edged and spotted cream, but appearing deformed. It has a less definite variegation than 'Silver King'. Hillier Nurseries Ltd. imported this cultivar from Paris under a different name, which now cannot be traced (John Hillier *pers. comm.*). Plants from Italian sources lack any variegation!

'Midwest Sunset' Warren & Son Nursery, Oklahoma City, Oklahoma, selected this form for good autumn colour, but tests in Texas and Illinois failed to uphold its ornamental traits. Said not to have been available (Santamour & McArdle 1984) but there are now plants in the UK (Chris Pattison *pers. comm.*).

'Moonbeam' Introduced in 1976 by Duncan and Davies, New Plymouth, New Zealand. This cultivar has pale yellow blushed leaves that fade to green during summer, before turning soft yellow overlaid with rose in autumn. 'Moonbeam' has corky-ridged branches.

'Moraine' Singled out for its exceptional hardiness (-13°C/-25°F) and outstanding red autumn colour, 'Moraine was discovered in Indianapolis, Indiana and introduced in 1982 by the Siebenthaler Co., Dayton, Ohio (Flint 1997). It is patented in the US and has corky twigs with "fleshy" foliage.

'Naree' An Australian introduction with yellow leaves smaller and less vigorous than 'Moonbeam.' The foliage remains yellow during summer and turns pink in autumn, but 'Naree' requires part shade or fertile soil for best colour (Karan Junker *pers. comm.*).

'Oconee' Listed in Dirr (1990). This is a dwarf congested form that originated in Oconee County, Georgia. After ten years, the top-grafted tree at the J.C. Raulston Arboretum is 3 x 3 m (Todd Lasseigne *pers. comm.*).

'Paarl' Listed in Rijneveld Nursery, Boskoop, Netherlands as having yellow leaves.

'Palo Alto' - A Saratoga Horticultural Foundation selection described as "a well proportioned, pyramidal tree with small, rich green leaves which turn a bright orange-red in autumn" (Thomas 1961). It is distinct in having exceptionally brilliant autumn colouration all over the tree. It is popular in

California for landscaping and as a street tree. Two young plants near the RHS Wisley glasshouses were not yet in colour (9/10/03).

'Parasol' This selection has a shrubby, spreading habit and very small, deeply-cut leaves that become dark red in autumn. Karan Junker *pers. comm.* noted its striking progression of colour from yellow to orange to finally red. Dr Gammon stated that his plant was only 1.8 x 1.8-2.4 m and looked like an umbrella (Miller 2000).

'Pendula' Found by Miss Sara W. Crawford in 1935 near Hatton, Arkansas and described as f. *pendula* by Alfred Rehder in 1939. This form has an upright trunk from which pendulous branches turn abruptly downward, resulting in a columnar shape (Thomas 1961). Its habit is similar to 'Parasol' but the degree of weeping is variable. In the Harvard Herbaria, the type specimen is accompanied by two photographs of the type tree. This fits the description (Thomas 1961), but it is likely that grafting will influence the form. Karan Junker *pers. comm.* warned that 'Pendula' needs considerable space and is prone to breakage if planted in windy sites, but commends its scarlet autumn colour. There is a young tree 3.6 x 1.15 m at Savill Garden, Windsor. This is not a plant for windy situations.

'Penwood' Little is known other than that Doug Harris obtained it as a seedling and named it after his nursery in Hampshire. There is a young plant at Savill Garden but its autumn foliage is typical of the species.

'Pieces of Eight' No information available.

'Plattsburg' Listed in Jacobsen (1996) and introduced *c.*1993 by the Arborville Nursery, Holt. Plattsburg is north of Kansas City. This cultivar has rough, corky bark.

'Rotundiloba' ('Obtusiloba', 'Rotundifolia') Discovered by R.E. Wicker near Pinehurst, North Carolina c. 1930, this selection has distinct leaves with short, rounded lobes and less serrate margins. He sent several samples to Alfred Redher at the Arnold Arboretum, who named it **f. rotundiloba**. In 1986, an old tree planted at the campus of the University of North Carolina, Chapel Hill, was discovered to be a nearly nonfruiting clone, and the J.C. Raulston Arboretum at North Carolina State University, Raleigh, distributed propagating material (Flint 1997). 'Rotundiloba' has orange autumn colour and Schelle (2003) wrote up a good account of it.

'Savill Torch' An unregistered cultivar which is not yet readily available. According to Mark Flanagan *pers. comm.*, the original seed-raised tree was planted by the stream at the Savill Garden in the Windsor Great Park c. 1930's-early 1940's. A 12-15 m tree, it blew down in the Great Storm in October 1987,

but it threw up a secondary trunk, which itself grew into a tree. In 2002 this also blew down and was removed!
Consistently their best sweet gum for autumn colour, with intense and reliable colouring of reds, oranges and golds, it could easily be seen and enjoyed from the garden restaurant. Luckily, several grafts were made 4-5 years ago and these will be planted out in the Savill and Valley Gardens in the near future.

'Silver King' ('Albomarginata', 'Argenteovariegata', 'Variegata' misapplied) This cultivar has large leaves with cream edges. *The Hillier Manual* (Anon. 1971) originally listed 'Variegata' with "leaves attractively margined creamy-white, flushed rose in late summer and autumn," but the later edition (1991) corrected this description to "leaves broad, mottled yellow". Hillier's 'Variegata' is now called 'Silver King'.
The small plant at RHS Wisley was starting to show pink suffusions on the white portions (9/10/03), and at Savill Garden, a tree 7.5 x 2.10 m had yellow autumn colour.

'Slender Silhouette' ('Shadow Columnar Form') The Tennessee nurseryman Don Shadow found and named this fastigiate form; the original tree is approximately over 18 x 1.5 m (Todd Lasseigne *pers. comm.*). Roy Lancaster saw this as a young tree in Louisville, Kentucky as "2 m tall and like a pencil" (Miller 2002).

'Stared' This selection is very distinctive in having deeply-cut seven-lobed leaves, giving the tree a starry appearance. Young leaves emerge tinted red, and the autumn colour is deep red to purple. It also has a tidy habit (Karan Junker *pers. comm.*).
The young plant at RHS Wisley was decked entirely deep red (9/10/03). The RHS Herbarium has specimens of leaves collected by Colin Crosbie from a plant in a nursery labelled as **'Red Star'** with which 'Stared' may be synonymous, as could '**Stella**' (Chris Pattison *pers. comm.*).

'Suberosa' Described by Schwerin in 1933, this selection scarcely differs from some *L. styraciflua* in having corky branches.

'Sunnyvale' Listed in Santamour & McArdle (1984). No description exists.

'Thea' - A Dutch cultivar from before 1993, distinguished by long central leaf lobes and dark autumn foliage similar to that of 'Burgundy.'

'Tirriki' Another Australian cultivar selected for its uniform red autumn colouring and broad pyramidial growth (Santamour & McArdle 1984). *Tirriki* is an aboriginal word meaning "flame of fire".

'Variegata' ('Aurea', 'Aureum', 'Golden', 'Gold Dust', 'Goduzam', 'Foliis Aureo-

Variegatis') Cultivated in North America since 1914 although most specimens seen in the UK date from *c.*1940 (John Gammon *pers. comm.*). All have green leaves irregularly specked with yellow. Under the *International Code of Nomenclature for Cultivated Plants*, any Latinised cultivar names before January 1, 1959 are considered valid, therefore 'Variegata' has legitimacy. It is said that a Mr Overeynder first described 'Variegata' in 1880, as having leaves speckled light yellow, but the reference to this has been mislaid (E. Hsu *pers. comm.*). Krüssman (1985) noted that the leaves were marbled yellow and 'Variegata' was grown in Holland. Santamour & McArdle (1984) suggested that 'Aureum' grown by E.H. Scanlon & Assoc., Olmsted Falls, Ohio, from 1962 to 1966, is probably 'Variegata', since their Wholesale List described the leaves irregularly variegated with gold splashes, streaks, and speckles. Lake County Nursery of Ohio listed 'Aurea', which has leaves striped and mottled with flecks of gold. Thomas (1961) also mentioned a yellow variegated form as 'Aurea'. More confusion arose when the *RHS Dictionary of Gardening* (Huxley 1992) distinguished 'Aurea' in having mottled and striped yellow leaves, whereas 'Variegata' has only mottled yellow leaves. See illustration on page 69.
In a letter (August 12, 2000) addressed to Diana Miller, the Keeper of the Wisley Herbarium, Madame Adeline, the holder of the French National Collection of *Liquidambar*, stated that the leaves of 'Aurea', while larger and shorter than 'Variegata', are yellow in spring and pink in autumn, but those of 'Variegata' are variegated green and yellow. She added that in autumn, the green areas of 'Variegata' leaves turn red while the yellow areas become gold and pink. As a result of the above confusion, we feel that it would make sense to have a **Variegata Group** and comments to this effect would be welcome. Santamour & McArdle (1984) remarked that a 14 year old tree was 6 x 2.4 m. There are two trees labelled 'Aurea' at RHS Wisley; one of these trees (W962757*A) at Seven Acres is only 4.5 m tall with a 0.16 m girth after it was planted in 1978.

'Ward' (Cherokee™) A nearly nonfruiting selection by Earl Cully of Jacksonville, Illinois. The original tree has produced fewer than a dozen fruits in 30 years and has survived low temperatures to -33°C/-28°F without injury (Flint 2003). See also comments by Schelle (2003).

'White Star' Resembling the better known 'Silver King', this selection was found in the North Carolina Botanical Garden, Chapel Hill, and grafted for the late J.C. Raulston by a local nurseryman, Ben Brown. It has excellent variegation (Todd Lasseigne *pers. comm.*).

'Woorby Rose' No information available. There is a plant at the de Belder estate of Hemelrijk, Essen and at the Arboretum Kalmthout (1986.1310) in Belgium.

'Worplesdon' Introduced by George Jackman & Son, Woking Nursery Ltd.,

Surrey, England in 1968, this selection has "rich autumn tints and beautiful finger-like foliage". Common in the trade, it roots easily from cuttings and fruits well. However, 'Worplesdon' may not colour in alkaline soils, turning brown instead (Robert Vernon *pers. comm.*), but the ability to colour is dependent on a wide range of environmental factors. The Royal Horticultural Society gave it an Award of Garden Merit in 2002. Worplesdon is a village outside Guildford in Surrey. See illustration on p.33.
Contrary to opinions in Germany, the Netherlands and Turkey, 'Worplesdon' is not a hybrid between *L. styraciflua* and *L. orientalis*. In addition, reports of this cultivar having "brilliant fire engine red" autumn colour appear to belong to a different taxon (John Gammon *pers. comm.*). However, reports keep circulating about plants with red leaves! Are there two clones here? If so then one needs a new clonal epithet. Comments, please.

L. orientalis Mill., Gard. Dict. ed. 8: no. 2 (1768)
(*L. imberbe* Ait., *L. orientalis* var. *integriloba* Fiori)
Vernacular name: Turkish sweetgum, oriental sweetgum

A native of Turkey (SW Anatolia) and the island of Rhodes, *L. orientalis* occurs in riparian habitats, such as river deltas, that are usually flooded during spring. Generally associated with *Pinus brutia, Quercus cerris, Fraxinus angustifolia, Plantanus orientalis, Cotinus coggygria* and other Turkish woody flora, it is common in the provinces of Mugla, Antalya, and Denizli. The conservation status of *L. orientalis* is listed as Vulnerable (Craig Hilton-Taylor *pers. comm.*). Yaltirik & Efe (2000) noted that the largest wild trees are a 35 m specimen at Sutçuler, while another has a trunk 1.05 cm diameter at Koycegiz. In fact Turkey has some 1600 ha of natural *L. orientalis*, which is under the protection of the Turkish Forestry Service. There was a good illustrated article on *L.orientalis* by Faik Yaltirik and Asuman Efe in *Curtis' Botanical Magazine*, Vol 17. Part 2, May 2000. See line drawing overleaf & photographs on pp.37 & 40.

L. formosana Hance, Ann. Sci. Nat. Bot., ser. 5, 5: 215 (1886)
(*L. acerifolia* Maximowicz, *L. formosana* var. *monticola* Rehder & E.H. Wilson, *L. maximowiczii* Miquel, *L. tonkinensis* A. Chevalier)
Vernacular name: feng xiang shu

Liquidambar formosana is distributed throughout moist temperate forests of Fujian, Guangdong, Guizou, Hainan, Hubei, Jiangsu, Jiangxi, and Sichuan at 500-800 m in China, as well as Taiwan, South Korea, Laos, and northern Vietnam. There is no conservation status rating for this species (Craig Hilton-Taylor *pers. comm.*). See line drawing on page 23.
Both *L. formosana* and *L. acalycina* show similar vegetative characteristics, but

Liquidambar orientalis by W H Fitch, from *Icones Plantarum*

Liquidambar formosana by W H Fitch, from *Icones Plantarum*

L. acalycina has shorter petioles (no more than 20 mm), scaly-like fruits lacking staminode teeth, and smooth pointed winter buds. The leaves of *L. formosana* have two stipules near the base of the petioles, whereas these stipules are absent in *L. acalycina*.
Lancaster (1987) saw three huge trees at least 30 m (100 ft) in a school playground near Guangzhou, China, where *L. formosana* is a popular street tree tolerating industrial pollution, soil compaction, and bad pruning.
Autumn foliage can vary from bright red to deep burgundy, and may persist until December.

'Afterglow' Selected by the Saratoga Horticultural Foundation in California in 1961, this tree is broad and symmetrical, with three-lobed downy leaves, red-violet new growth and soft rose autumn colour.

Monticola Group First described as var. *monticola* Rehder & E.H. Wilson in *Plantae Wilsonianae*, Vol. 1 (1913), this variety supposedly differed in having glabrous leaves and better cold hardiness. However, Boufford & Spongberg (1982) asserted that var. *monticola* is a synonym of *L. formosana* var. *formosana*, since the type specimens designated by Wilson did not agree entirely with the description. Furthermore, a comparison of these specimens with others throughout the range of the species revealed that they fall into the range of variation of *L. formosana* var. *formosana*. See photograph on page 36.

L. acalycina H.T. Chang, *Acta Sci. Nat. Univ. Sunyatsen.* 1959(2): 33 (1959)
Vernacular name: que e feng xiang shu

Once classified under *L. formosana, L. acalycina* is found in the montane evergreen forests of Anhui, Guangdong, Guangxi, Guizhou, Hubei, Jiangsu, Jiangxi, and Sichuan at 600-1000 m. There is no conservation status rating for this species (Craig Hilton-Taylor *pers. comm.*).
Bartholomew *et al.* (1983b) noted several large trees of *L. acalycina* growing with species of *Salix, Acer, Pterocarya* and *Quercus* in the *Metasequoia* region in western Hubei and it can grow up to 25 m in the wild. According to Chu & Cooper (1950) and Hu (1980), *L. acalycina* is associated with the following plants: *Houttuynia cordata* Thunb.; *Populus adenopoda* Maxim.; *Pterocarya hupehensis* Skan, *P. paliurus* Batalin, and *P. stenoptera* C. DC.; *Betula lumnifera* Winkler, *Carpinus fargesii* Franchet; *Cocculus orbiculatus* (L.) A.P.DC.; *Ulmus multinervis* Cheng; *Nyssa sinensis* Oliver; *Cornus controversa* Hemsley and *C. macrophylla* Wallich; *Clethra fargesii* Franchet; and *Styrax bodinieri* Levl. as well as *S. suberifolius* Hooker f. & Arnott. The soil in the *Metasequoia* region is sandstone-derived, and trees must withstand periodic flooding in poorly drained soils (Bartholomew *et al.* 1983b). See photographs on pages 33 & 41.

'Burgundy Flush' This selection has red tinted young growth. According to Todd Lasseigne *pers. comm*., the red colour of the new growth persists through June in southeastern USA. However, Karan Junker *pers. comm.* has noted a "burgundy flush" to the new growth of her *L. acalycina*!

Propagation

Fordham (1961) recommended that the spiny aggregrate fruits of *L. styraciflua* must be collected before they dehisce. It is best to place them in a warm, dry place until they open to release the seeds within a week or two. To separate the fertile seeds from abortive ones, a sieve with 1.5 in holes will do the trick. Stratify the seeds by placing them in equal parts moist perlite and peat moss under refrigerated conditions (41°F) for 60-90 days. Germination should occur in 18 days after the seeds have been sown following stratification. Fordham recommended cuttings, which will root successfully if half-ripe summer wood is used, and bud grafting. Propagation treatment for the other species are presumably the same.

Derivation of the name *Liquidambar* and its economic uses

Liquidambar is derived from the Latin and Arabic words "*liquidus*" and "*amber*" meaning "fragrant liquid", in reference to the tree's resin or balsam. This resin is formed as result of injury - when the tree is wounded, a group of gum canals is formed in the cortex or inner bark near the wound and specialized cells develop along the margins of the canals. These cells then secrete the resin, which moves through the canals to the wound; presumably the resin deters insects or fungi that may invade the wound.

The resin from *L. orientalis* is harvested commercially in Turkey, where it is known as Gunluk or Sigala (Pesmen 1972). By bruising the outer bark in early summer, the trees are stimulated to produce the resin in the inner bark. Later, during autumn, the inner bark is scraped from the tree after the outer layers of the bark are removed. Boiling the inner layers in seawater yields the crude balsam, a viscous, grey-brown, opaque substance with a strong aroma (Thomas 1961, O'Neil 1984, Yaltirik & Efe 2000). This crude balsam, known as storax, was often exported to Bombay, India, and China where profitable markets were located.

Much confusion has arisen from the interchangeable use of the term storax for products of different botanical origin, as well as several forms of the resin varying in constituency (Hanbury 1857, Thomas 1961, O'Neil 1984). Compounding the confusion is the use of the word styrax for the products. After examining several samples, Hanbury (1857) attempted to clarify the confusion by concluding:

> "That the original and classical Storax was produced by *Styrax officinale* L. That always scarce and valuable it had in modern times wholly disappeared from commerce. That Liquid Storax is the produce of *Liquidambar orientalis* Miller and that it is collected in the South West of Asia Minor."

However, Thomas (1961) reserved the use of styrax for *Liquidambar* and storax for *Styrax officinalis* based on the fact that the early writers of *Materia Medica* designated the styrax for the resin of *Liquidambar* and storax for the resin of *Styrax officinalis*. O'Neil (1984) stated:

> "…. that 'solid storax (storax solidus) and liquid storax (Styrax liquida) were used to differentiate between the balsam of *Styrax officinale* and that of *Liquidambar orientalis* but as the former became scarcer and finally ceased to be used in commerce…solid storax applied to any solid form of the latter and was presumed to be of the same botanical source."

Hence, *Styrax officinalis* (from mainly Outer Anatolia in Turkey, Italy to Cyprus, W. Syria and California, as well as naturalised in S. France), was the original source of storax, but when overharvesting led to its decrease, *L. orientalis* became an adequate substitute that was collected and prepared similarly. Storax was valued for its medicinal properties, having been used to treat respiratory diseases such as asthma or bronchitis, as well as wounds; in addition, it formed a fixative used in soaps, perfumes, and incenses (Thomas 1961, O'Neil 1984, Yaltirik & Efe 2000). Furthermore, storax was sometimes consumed unadulterated. Storax consists of 33-50% storesin and various esters of cinnamic acid, and 5-15% free cinnamic acid (Anderson 1955).

The Chinese apparently believed that *Liquidambar* was a cure-all tree (Thomas 1961). Pen Ts'ao Kang Mu (1595) in one of the volumes of Chinese *Materia Medica*, stated that styrax could cure swellings, toothache, scales, boils, ulcers, cancerous growths and internal haemorrhaging, while the bark can effectively treat dropsy, diabetes, dysentery, cholera, and colds. Properly prepared roots, leaves, and fruits supposedly prevented the plague, cleared the eyes, stopped spasms, soothed backaches, and relieved the aching body. The dried bark of *L. formosana* found further use as a pest control against caterpillars and plant diseases (Yang & Tang 1988).

Although *L. orientalis* provided the storax of commerce, *L. formosana* and *L. styraciflua* will yield storax of comparable quality. The Jicaque and Paya Indians in Honduras, Central America, mix the sap of *L. styraciflua* with honey into a potion consumed by women before and after childbirth; they also drink a mixture of sap, hot water, garlic, and onions to treat intestinal worms (Lentz 1986, 1993). *Liquidambar styraciflua* was regarded as a medicinal plant for the Native American Indian tribes, especially the Cherokee, Choctaw, Houma, Koasati, and Rappahannock, who applied the gum, bark, and roots as an antidiarroheal, dermatological aid, gynaecological aid, sedative, febrifuge, and other uses (Moreman 1986). During World War II, *L. styraciflua* became an adequate substitute for *L. formosana*, when exports of storax from Taiwan under Japanese rule ceased; thus Clarke County, Alabama, became the centre of the storax industry (Peattie 1991).

Ranking second among the hardwoods and fifth among all woods in 1936, *L. styraciflua* is still an important timber tree in United States; hence one of its common names, red gum, is derived from the heartwood (Betts 1939). The

popularity of this wood is due to its colour and the readiness with which it can be finished and used mainly for lumber, veneer, and slack cooperage. Considerable lumber was shipped to Europe for furniture produced under the name satin walnut or Circassian walnut (Betts 1939). According to Gibson (1913), the wood weighs 36.83 pounds per cubic foot, contains numerous medullary rays, and has small diffuse pores; it is sometimes stained or painted to resemble oak, cherry, mahogany, or even maple.
In China, the wood of *L. formosana* was once used for making tea chests and in silkworm cultivation.

History - in Europe

The Spanish were the first Europeans to see the New World *Liquidambar*. Loudon (1854) stated that the first record of *Liquidambar* occured in *Nova plantarum, animalium et mineralium Mexicanorum historia* published in 1651 under the name of Father Ximenes, but written by Francis Hernández, a Spanish naturalist and physician. Hernández was sent by King Philip II of Spain to report on the natural products of Mexico and lived there from 1571 to 1575. In the chapter entitled "De *Xochiocotzo Quahuitl*, seu Arbore Liquidambari Indici", Standley (1922) quoted from Hernández:

> "*Xochiocotzo Quahuitl* is a large tree, with leaves almost like those of a maple, divided into three points and two notches, toothed, on one side whitish and on the other darker. The bark of the trunk is partly yellow and partly green. It grows in plains and in hot, or sometimes in temperate places… Its nature is hot and dry, and its odor pleasant. If the bark of this tree is cut, there flows from what is called Indian Liquidambar by the Spaniards, and by the Mexicans Xochiocotzol, in the sweetness of its odor very like Styrax."

However, Hernández's account was not the first reference to *Liquidambar*. Peattie (1991) mentioned that Don Bernal Díaz del Castillo, who escorted Cortez in 1519 on the conquest of Mexico, observed the ceremony between Cortez and Montezuma, the Emperor of Aztecs, during which canes with the unmistakable smell of *Liquidambar* were presented. Peattie included a translated excerpt of Castillo's experience published in 1632:

> "After [the Emperor] had dined, they presented to him three little canes highly ornamented, containing liquidambar, mixed with an herb they call tobacco, and when he had sufficiently viewed and heard the singers, dancers, and buffoons, he took a little of the smoke of one of these canes."

Storax was much prized during Castillo's time and thus it is no surprise that he was able to identify the odour. Some nine years after Castillo's witness of Cortez and Montezuma's ceremony, another Spaniard, Alvar Núnez Cabeza de Vaca, became the first European to see *Liquidambar* near Appalachicola, Florida in 1528 (Peattie 1991). Cabeza de Vaca observed:

> "The country where we came on shore to this town and region of Apalachen is for the most part level, the ground of sandy and stiff earth. Throughout are

> immense trees and open woods, in which are walnut, laurel, and another tree called liquid-ambar, cedars, savins, evergreen oaks, pines, red oaks and palmitos like those of Spain." (Peattie 1991)

It would be nearly two hundred years before *Liquidambar* was successfully introduced into cultivation in Europe, when John Banister, the missionary collector sent by Bishop Compton of Fulham Palace, discovered *L. styraciflua* in Virginia. He sent home a plant in 1681 to the Bishop, whose gardener George London planted it in the palace gardens (Loudon 1854).

One of the earliest European sightings of *L. styraciflua* was that by the English naturalist Mark Catesby (1682-1749), who collected and painted wildlife and plants throughout his travels in the Carolinas, Florida, and Bahamas. His paintings and descriptions were published in a two volume work and contained a magnificent illustration of *L. styraciflua* (plate 65, Catesby 1754). André and François Michaux, the French botanical explorers, respectively made subsequent introductions of *L. styraciflua* from Charleston to France in 1787 and 1803; in the list accompanying the 1803 shipment, François singled out *L. styraciflua* as one of the two most desirable trees for its outstanding environmental tolerance of climate, soil, terrain, its fast growth, and the beautiful, easily worked wood (Savage & Savage 1986).

Linnaeus first described *Liquidambar* as a genus in 1753 in *Species Plantarum* and in the fifth edition of *Genera Plantarum* in 1754. *Liquidambar orientalis* was first introduced into France by M. Peyssonel, Consul at Smyrna, Turkey and did not reach England until 1759, when Philip Miller (1691-1771), the Curator of the Apothecaries' Garden (now the Chelsea Physic Garden) in London obtained plants (Loudon 1854). Aiton (1813) mentioned two taxa, *L. styraciflua*, which was cultivated before 1683 by Bishop Compton, and *L. imberbe* (now *L. orientalis*) grown by Philip Miller in Chelsea. There are several historic cultivated specimens in the Kew Herbarium from mainland Europe and England dated 1816 onwards, including two from an old tree at Woburn Abbey, Beds. collected by A.B. Jackson. This was planted in 1838 and blew down in October 1934.

Usually the latest to colour, *L. orientalis* often retains its autumn foliage up to early December. At Cambridge University Botanic Garden, several trees were still colourful on December 5, 2003. Their best specimen (19565002*A) was bought from the Hillier Nurseries and planted in 1956, and now measures 11.7 m x 74 cm. Several young trees in the Autumn Garden were rooted cuttings from this tree (Peter Kerley *pers. comm.*).

Liquidambar formosana was first introduced to the Royal Botanic Gardens, Kew in 1884 when seeds were sent from the British Consul at Hankow (Bean 1973). It was growing against the Herbaceous Ground Wall in 1896. However, most of the trees in British gardens are descended from seeds collected by E.H. Wilson between 610-1219 m (2000-4000 ft) in West Hupeh in 1907 (Bean 1973). Although *L. formosana* has a southern range in China, Wilson obtained seed from hardier trees in the northern areas. The nursery firm of James Veitch &

Sons, Ltd. first listed *L. formosana* for five shillings in its Autumn 1911 Catalogue under New Chinese Plants of Botanical Interest.

> "This introduction, once recognized as a distinct variety monticola (growing on mountains), is a handsome tree of medium vigour up to 12 or 15 m (40 or 50 ft). Its bold leaves are characteristically three-lobed, not unlike those of certain maples, but arranged alternatively on the shoots. They emerge in spring a rich purple, paling to bronzy red and finally green. Before falling in autumn they again change colour from yellow to orange and crimson and are then at their most striking." (Lancaster 1987)

At Nymans Garden, West Sussex, there are three young trees (#26213, #26214, and #26215 under L/HC 22) collected by Roy Lancaster in China and planted in 1986. According to David Masters *pers. comm*., the trees usually retain their autumn foliage until mid-December. Two are approximately 4.5 x 2.1 m, while one measures 3.6 x 1.65 m. One tree (#26215) had superb bright red autumn foliage in late October 2003. *Liquidambar formosana* is now well established in gardens and arboreta and is stocked by several nurseries.

Liquidambar acalycina was introduced twice into the UK through the 1980 Sino-American Expedition to China and as seed from Shanghai Botanic Garden. The former came to Kew in 1981 and the latter in 1996 to Wakehurst Place, West Sussex. There are also young plants from both of the above sources at the Savill and Valley Gardens (Mark Flanagan *pers. comm*.). It was noted that by October 9th, 2003, plants at Kew and RHS Wisley had not yet shown any autumnal colour.

In November 1999, a *Liquidambar* Meeting was held at the RHS Westminster Hall in London. Over 70 vases of taxa representing four species and some 30 different cultivars from various sources were considered by members of Floral Committee B. Other interested parties attending were Dr John Gammon, holder of the National *Liquidambar* Collection, C. Tomlin of Starborough Nursery in Kent and Mike Buffin, then the Curator of the Sir Hillier Gardens and Arboretum in Hampshire (Miller 2000). Specimens from this meeting reside in the herbarium at RHS Wisley.

History - in North America

Andrew Jackson Downing (1849) commended the ornamental virtues of *L. styraciflua*:

> "During the summer months it preserves unsoiled that dark glossy freshness which is so delightful to the eye, while the singularly palmate form of the leaves readily distinguishes it from the common trees of a plantation. But in autumn it assumes its gayest livery and is decked in colors almost too bright and vivid for foliage, and forms one of the most brilliant objects in American scenery at that period of the year. The prevailing tint of foliage is then a deep purplish red, unlike any symptom of decay, and this is sometimes varied by a shade deeper or lighter, while occasionally an orange tint is assumed. When planted in the neighborhood of our fine Maples, Ashes, and other trees remarkable for their autumnal coloring, the effect in a warm dry autumn is almost magical."

Although Downing's praise of the tree was effusive, it remained largely underused in landscapes. Dirr (1990) remarked that *L. styraciflua* would have been widely planted for its stress tolerance and autumn colour if it were not for the messy and hazardous fruits. Flint (1997) acknowledged the fruits posing a potential litter problem if trees were used in urban areas. Based on their mission to develop dependable shade and ornamental trees, California natives, and drought tolerant plants, the Saratoga Horticultural Foundation, Saratoga, California, established in 1952, played an instrumental role in popularizing *L. styraciflua* as a superb street tree. They introduced 'Palo Alto', 'Burgundy', and 'Festival', all of which are popular landscape subjects in California.

Dirr (1990) noted a 15 x 15 m tree of *L. formosana* growing at the University of Georgia, Athens. Failing to reach the size of *L. styraciflua* in England, *L. formosana* apparently flourishes in areas with continental climates, particularly those with hot, humid summers. Whereas young plants in the UK rarely fruit, they fruit heavily in the eastern USA. A young tree (#93-404*A) 7 x 3.6 m at Scott Arboretum, Swarthmore, PA, has borne a heavy set of fruits in October 2003 (Jamie Blackburn *pers. comm*.).

Liquidambar acalycina was first introduced into cultivation through the 1980 Sino-American Botanical Expedition to western Hubei, China; seed (SABE 1950) was collected in the *Metasequoia* region of Lichuan Xian in the vicinity of Lojiaba at 1500m altitude (Bartholomew et al. 1983a, Dosmann & Del Tredici 2003). Spongberg (1991) remarked that four trees of *L. acalycina* (AA# 1634-80) have withstood winters outside in the Arnold Arboretum whereas *L. formosana* has never been hardy in the Boston area.

IDS members' comments:

England

Robert Vernon from Smisby in Leicestershire believes that *L. formosana* needs a more sheltered site than the other sweet gums. It survives well in locally sheltered gardens and its purple autumn colours last much longer than *L. styraciflua*, often into late December.

John Bulmer of Wolverhampton planted *L. formosana* out as a small sapling in 2000. Two years later, it was 2 m in height with superb autumn colour. Today it is 2.3 m with a girth of 1.5 at 1.5 m.

According to Anne Boscawen, West Sussex, *L. styraciflua* colours better with more exposure.

Germany

Ulrich Würth of Westerstede comments that *L. styraciflua* 'Worplesdon' has a smooth, never a corky, bark and that with them, the autumnal colour is yellow-red, not a deep red. Their trees are 15-20 years old.

The Netherlands

At the Arboretum Trompenburg in Rotterdam, there is a collection of *Liquidambar*: *L. styraciflua* and the cultivars: 'Gum Ball' ('Globe') ex Hillier in

1981, now 5 x 5 m; 'Pendula' ex Esveld in 1990, now 6 m tall; 'Rotundiloba' ex J.C. Raulston in 1991, which lost its top in a gale and is now 8 m tall, this one is a particular favourite of Dick van Hoey Smith; his 'Silver King' "is a beauty", with good variegation all year; a young 'Stared'; and 'Worplesdon' ex Esveld in 1987 with magnificent autumn colour.
Their specimens of *L. formosana (L. formosana* var. *monticola)* are a 1965 plant ex Hillier which is now 10 m tall, with oustanding autumn colour; plus a 1990 tree from Esveld, which has had its top broken out and is now 4 m tall but with little colour. In 2002 the fruits of the former tree were standing upright on their stalks (see page 36). Comments please?
Finally, there are two plants of *L. orientalis*: a 1964 specimen ex Hillier, which is grafted and is a 5 x 5 m shrub, with little autumn colour and a 5 m tall erect tree, raised from seed sent by Hayrettin Karaca in 1986 from near Izmir, Turkey. Neither have ever been affected by frost (Dick van Hoey Smith *pers. comm*.).

Belgium
Koen Camelbeke has compiled the following data from the Beltrees database and other sources. The database is owned by the Belgium Dendrology Society and managed by the Arboretum Wespelaar, where Koen is Curator.
The Arboretum Lenoir at Rendeux is not particularly rich in Liquidambar. Their oldest specimen of *L. styraciflua* dates from 1955 and there are 1995 plantings of 'Anja', 'Lane Roberts' 'Thea' and 'Worplesdon'. Plants of *L. formosana (L. formosana* var. *monticola)* and *L. orientalis* died in 1956 and 1963 respectively (Charles Snyers d'Attenhoven *pers. comm*.).
At Nevele is the private garden of Dr A. De Clercq, who has two good plants of *L. orientalis*. One is a seedling from the Petaloudas Valley in Rhodes and the other is an 1987 graft from a tree in Hemelrijk. Both are perfectly hardy.
The Arboretum Kalmthout has a collection of several *Liquidambar*. There are four accessions of *L. formosana* planted in 1963, 1964, 1966 and 2000; five of *L. orientalis* from 1975, 1977, 1984 and 1987 as well as an 1984 accession of *L. taiwaniana,*which is an unpublished epithet and thus this plant needs to be reverified. *Liquidambar styraciflua* is represented by five specimens, one of which is 15 m in height. The following can also be seen: 'Gum Ball', 'Lane Roberts', 'Rotundiloba', 'Silver King', 'Variegata' x 1 ('Aurea' x 3) and 'Woorby Rose' (Abraham Rammeloo *pers. comm*.).
The de Belder estate at Hemelrijk, Essen has some interesting records as there is an *L. acalycina* with a girth of 15 cm (2002). Two trees of *L. orientalis* have girths of 75 cm and 52 cm (2002), while *L. styraciflua* 'Woorby Rose' has a girth of 64 cm (2002).
The National Botanic Garden at Meise has a 1983 planting of *L. formosana (L. formosana* var. *monticola)* (1982.0314) ex Hillier and grafted onto the base of *L. styraciflua*. It stands at 8 m with a girth of 59 cm, flowers and fruits regularly, but does not produce viable seed. There are five plants of *L. orientalis* (1990-1987) originating from seed at Koycegiz in Turkey ex the Bornova-Izmir

Botanic Garden. They were planted 1993-1998 and stand 3-4 m high, with girths of 31, 20, 16, 16 and 15 cm. Another accession (1992-2183-32) has nine progeny from the previous source and the largest is 4 m with a girth of 34 cm. One had marvellous autumn colour in November 2002 but it died the following winter. A tree of *L. styraciflua* (1953-4185) grown from seed ex Coimbra Botanic Garden in 1953 is now 17 m with a girth of 111 cm. Two others trees (1973-1922) ex the Washington Park Arboretum as seed in 1973 are 11 m x 72 cm and 7 m x 49 cm, while 'Variegata' ('Aurea') (1985-0216) from Esveld and planted in 1990 is 7 m x 43 cm (Dirk De Meyere *pers. comm.*).

The Arboretum Wespelaar and Philippe de Spoelberch's garden at Herkenrode, Wespelaar, contain many interesting sweet gums. There are three plants of *L. acalycina* that were acquired from the Pavia Nursery in Belgium in 2000. All have late colouring and keep their foliage for a long period. Of their holdings of *L. formosana*, one tree ex Waasland Arboretum had its leaves caught by frost in 1991. It colours late but is unremarkable. The others have been put in the Monticola Group (but see comments on p. 24), four of which are ex Hillier and have been rated as excellent by de Spoelberch and Camelbeke; their autumn colour is more spectacular after a warm summer. One of them measured 11 m x 48.5 cm in 2002. Another measured 6 m x 24 cm in 1990, then suffered frost damage and died in 1992. There is only one small specimen of *L. orientalis* and it came from a nursery in Binche in 1999.

There are seven specimens of *L. styraciflua*, one of which is 23 m x 262 cm and expands in girth by a centimetre per year. It has good autumn colour but the others vary in their coloration. The following cultivars can also be seen: 'Andrew Hewson' a young plant (1998) with very regular, deeply-cut leaves that colour a uniform red, interesting; 'Anja', planted in 1998, had turned an almost blackish colour with some red and yellowish-red leaves by 31/10/02; a fortnight later the foliage was dark to black towards top of plant, interesting. 'Anneke', acquired in 1999, appears to be nothing special, the colour on 4/11/03 being a mixture of green, yellow, orange, red and purple, which looked good from a distance. 'Burgundy', obtained in 1989, has spectacular autumn colour; by 31/10/02 the leaves had turned black at the top and yellowish-red-purplish-green below, on 12/11 the top leaves were really black and also on the lower branches; this is one of the best. 'Gem Ball' ('Globe') is a peculiar cultivar, with good dark autumn colour on 31/10/02, good on 26/11 and still good with many leaves on the plant by 5/12. 'Lane Roberts' with many different accessions (c. 37) over both areas,and their best plant for autumn colour, was acquired in 1998 and is in an open windy site; the colours start on its north side and it had a really red - not purplish - colour on 12/11/02; this specimen has a good pyramidal habit, with corky branchlets and it suckers. 'Manon' ('Albomarginata Manon') is a young plant (2002), with green leaves and thin yellowish-white margins. 'Palo Alto', here since 1998, has very corky stems and branches, with large, deeply cut leaves that turned from yellow to dark purple on 31/10/02, with disappointing colours of orange-yellow and some reddish foliage by 12/11; the next year it had quite

Above: *L. acalycina (L)* and *L. styraciflua* (R), at the Arnold Arboretum (see key on page 12)
Below: Elongated fruit on *Liquidambar styraciflua* 'Worplesdon' at Hemelrijk (see pages 20-21)

photographs © Philippe de Spoelberch

good mixed and late colour on the 4 November. 'Parasol'was planted in 1998 and its autumn colour is unremarkable, yellow to reddish-yellow. 'Rotundiloba' arrived in 1990 and is an interesting cultivar colouring a brown-purplish on some leaves by 31/10/02, by 12/11 still mainly green, with some purplish and yellow leaves, 26/11 still very green, 5/12 a little more colour of green, yellow and pale red, notable for the shape of the leaves and the fact that they remain so long on the tree, particularly in the shade; by 9/12 the leaves were floppy after the first real frost. Two examples of 'Silver King' acquired in 1999 and 2000 are very susceptible to scale insects and show no autumn colour. 'Variegata' ('Aurea') was planted in 1989 and by 31/10/02 had few leaves left but the combination of red-pinkish-yellow autumn colour looked good from a distance. This has one of the earliest leaf falls. 'Worplesdon', obtained in 1987, is one of the best for autumn colour and is also a good fruiter; in 1996 the pale green fruits did not contrast well with the coloured foliage; by 31/10/02 it had lost many leaves after a storm,and seemed stressed, the leaves becoming extremely red and a large proportion of the fruits being elongated (see p. 33).

In 2001 P. de Spoelberch and Herlinde De Jaeck observed the autumn colours of the above sweet gums. The most spectacular were a good clone of *L. styraciflua*, 'Variegata' ('Aurea'), which was the first to colour, while 'Lane Roberts' and 'Worplesdon' were the first to lose their leaves. In 2002 'Burgundy' was the best overall but was late, while 'Worplesdon' performed well early on, followed by 'Lane Roberts' and 'Variegata' ('Aurea'). 'Anja' was very spectacular, very dark and early.

Other notable Belgian sweet gums are a *L. formosana (L. formosana* var. *monticola)* in Hof ter Saksen at Beveren-Waas with a 16 cm trunk in 1990. Is it still alive? The champion tree of *L. orientalis* measured 4 m x 100 cm (2001) in the Park Ten Bosch in Brussels, while another in the Domein het Hamel at Lummen had a girth of 60 cm in 1986, but it could not be found in in 1998.

As for *L. styraciflua*, there are 76 entries in the Beltrees database including: a champion tree in a hospital garden in Ghent with a girth of 346 cm in 1992; the next largest girth was 330 cm in 1987 at the Château de la Briquetterie in Tournai; after that came a tree of 321 cm at Kasteel Fortona in Kruibeke in 1989; the thickest and most recently measured tree has a girth of 306 cm and grows at the Royal Golf Club Ravenstein in Tervuren. There are six trees with a girth larger than 300 cm and nine over 250 cm in this database. At the same golf club is 'Variegata' ('Aurea') with a girth of 30 cm in 2003, while 'Aurora' at the Hof ter Saksen measured 73 cm in 2002.

One of the most comprehensive collections of *Liquidambar* is at the Arboretum Het Leen, Eeklo near Gent but the plants are all young. All four species are grown, together with 18 cultivars of *L. styraciflua* (K. Camelbeke *pers. comm.*).

Tanzania

Kew Herbarium has several specimens of *L. styraciflua* from the once-renowned Amani Arboretum, Amani in the East Usambara Mts, at 1311m, collected in 1929-1932 and 1969-1979. The tree itself was planted in 1904 (R.J. Greenway 3288).

South Africa

Hugh Glen from Durban noted that Johannesburg Botanic Garden is the only place in South Africa with three species of *Liquidambar*. All are a good size and around the same age. In the Kew Herbarium is a 1942 specimen of *L. styraciflua* from Pretoria Zoo (J. Evans 3298).

***Liquidambar* measurements**

Royal Botanic Gardens, Kew

Liquidambar acalycina

Accession number	Donor	Location	Trunk diameter	Height
1981-8314	SABE 1950	125	4.5" (0.11 m)	20' (6 m)
1981-8415	SABE 1950	461	4.5" (0.11 m)	20' tall (6 m)

Liquidambar formosana

1910-65056	WILS 513	F 461	6" (0.15 m)	15' (4.5 m)

Liquidambar orientalis

1969-17646		F 461 08		
1986-8217	N ATTA	109		
1947-16101	ISTB	F 234	7" (0.175 m)	12' (3.6 m) Tree was slanting
1977-773	HILLR	124	7" (0.175 m)	7' (2.1 m)
1983-1504	N STUB	461	9" (0.225 m)	11" (2.75 m) Tree spread was 144"

Liquidambar styraciflua

2000-1653	N EUSA 45	267 01		
2000-1652	N EUSA 45	267 02		
2000-1651	N EUSA 45	267 04		
2000-1650	N EUSA 45	267 04		
2000-1649	N EUSA 45	267 04		
1999-54	N RDGI	461	2" (0.05 m)	7' (2.1 m)
2001-1454	N EUSA 45	267 03		
1969-13359		325		
1996-2631	N RDGI	461	2.5" (0.0625 m)	8' (2.4 m)
1971-5201	N USNA	123	9" (0.225 m)	25' (7.5 m)
1971-5058	N USNA	123	8.5" (0.2125 m)	22' (6.6 m)
2002-1792	N EUSA 45	231		
2001-89	N EUSA 45	162	3" (0.075 m)	7' (2.1 m)

Cambridge University Botanic Garden

Liquidambar orientalis

19565002 A	Near the Old Winter Garden, facing the research plots.	Multi-branched; acquired from Hillier Nursery	74 cm	11.7 m

Scott Arboretum, Swarthmore, PA, USA

Liquidambar formosana

#93-404*A		Young plant with a heavy set of fruit (October 2003)	20 cm	7 x 3.6 m

Above: *L. formosana (L. formosana* var. *monticola*), Villa Taranto (see p. 24)
Below: Erect fruits of *L. formosana (L. formosana* var. *monticola*), Arboretum Trompenburg (see p. 31)

photographs © Philippe de Spoelberch / Gert Fortgens

Above: *L. orientalis* at Hemelrijk (see p. 21)
Below: *L. styraciflua* 'Gum Ball', Arboretum Wespelaar (see p. 16)

photographs © Philippe de Spoelberch

2001-1453	N EUSA 45	267 03		
1969-17643		F 461 08	16" (0.4 m)	38' (9 m)
1965-77601	JACK	P 124	12" (0.3 m)	35' (10.5 m)
1969-17642		F 461 06		
1969-17638		F 234		
1968-16419	OTWA	162	9" (0.225 m)	25' (7.5 m)
1971-5202	N USNA	123	8.5" (0.2125 m)	20' (6 m)
2001-90	N EUSA 45	162	2" (0.05 m)	6' (1.8 m)
2000-5030	N EUSA 45	162	2.5" (0.0625 m)	6' (1.8 m)
1929-65901	MRCH	461	22" (0.55 m)	30' (9 m)
1969-17637		F 339	25" (0.625 m)	37' (11 m)
1953-28601	HLLR	F 125	18" (0.45 m)	35' (10.5 m)
2000-4960	N EUSA 45	336 K		
1988-539 ('Festeri')	TPPT	133 04		
2003-230 ('Worplesdon')	WHHN	411 03		

Royal Horticultural Society, Wisley

Liquidambar orientalis

W853678	Jubilee Arboretum	WA0108	11" (0.275 m)	9' (2.7 m)
W883075	Battleston Hill	W883075	8" (0.2 m)	10' (3 m)

Liquidambar styraciflua

W903140	Seven Acres	WSO409	18" (0.45 m)	25' (7.5 m)
W933170	Pinetum	WC0110	22" (0.55 m)	46' (13.8 m)

***Liquidambar styraciflua* 'Lane Roberts'**

W823165*A	Jubilee Arboretum	WA0108	12" (0.3 m)	20' (6 m)
W823165*B	Jubilee Arboretum	WA0331		

***Liquidambar styraciflua* 'Variegata' ('Aurea')**

W840226	Seven Acres	WSO414	6.5" (0.1625 m)	15' (4.5 m)
W962757	Jubilee Arboretum	WA0103	6.5" (0.1625 m)	16' (4.8 m)

Windsor Great Park

***L. styraciflua* 'Silver King'**	Savill Garden	Yellow fall foliage, white margins turn pink	7.5" (0.1875 m)	25' (7.5 m)
***L. styraciflua* 'Thea'**	Savill Garden	1999-6473	6" (0.15 m)	25' (7.5 m)
L. styraciflua	Savill Garden	Bearing fruits	26" (0.65 m)	40' (12 m)
***L. styraciflua* 'Kirsten'**	Savill Garden	Late fall colour	4.5" (0.1125 m)	15' (4.5 m)
***L. styraciflua* 'Penwood'**	Savill Garden	Deep burgundy colour	3.75" (0.09 m)	12' (3.6 m)
***L. styraciflua* 'Pendula'**	Savill Garden		5" (0.125 m)	7' (2.1 m)
***L. styraciflua* 'Rotundifolia'**	Savill Garden	No fall colour (19/10/03)	4" (0.1 m)	14' (4.2 m)

L. styraciflua	Virginia Water	Deeply cut leaves; distinct tiered appearance	9" (0.225 m)	20' (6 m)
L. styraciflua	Virgina Water (Near the stone bridge adjacent to Savill Garden)	Suckers around the tree	19" (0.475 m)	45' (13.5 m)
L. styraciflua	Allee near Cumberland Lodge		19" (0.475 m)	50' (15 m)
L. styraciflua	Allee	Top crown damaged.	27" (0.675 m)	45' (13.5 m)
L. styraciflua	Allee		24" (0.6 m)	45' (13.5 m)
L. styraciflua	Allee		26" (0.65 m)	50' (15 m)
L. styraciflua	Allee		22" (0.55 m)	43' (12.9 m)
L. styraciflua	Allee		27" (0.675 m)	48' (14.4 m)
L. styraciflua	Allee		22" (0.55 m)	45' (13.5 m)
L. styraciflua	Allee		20" (0.5 m)	45' (13.5 m)
L. styraciflua	Allee	Multi-trunked (6)		
L. styraciflua	Allee		24" (0.6 m)	50' (15 m)
L. styraciflua	Allee		24" (0.6 m)	50' (15 m)
L. styraciflua	Allee		24" (0.6 m)	30' (9 m)
L. styraciflua	Allee		30" (0.75 m)	45' (13.5 m)
L. styraciflua	Allee		28" (0.8 m)	40' (12 m)
L. styraciflua	Allee		24" (0.6 m)	45' (13.5 m)
L. styraciflua	Allee		25" (0.625 m)	39' (11.7 m)
L. styraciflua	Valley Gardens	Leaning.	24" (0.6 m)	45' (13.5 m)
L. styraciflua	Valley Gardens		23" (0.575 m)	50' (15 m)
***L. styraciflua* 'Worplesdon'**	Valley Gardens		11" (0.275 m)	25' (7.5 m)

Johnson, O. (ed.) (2003). Champion Trees of Britain and Ireland. 192 pp. Whittet Books, Ipswich.

Liquidambar formosana

Owen Johnson (2003)	Killerton, Devon		56 cm	73.33' (22 m)

Liquidambar orientalis

Tree Register of Ireland Project (2001)	St. Patrick's College, Kildare		61 cm	40' (12 m)

Liquidambar styraciflua

Victoria Schilling, 1996	South Arboretum, Stratfield Saye, Hampshire		99 cm	93' (28 m)
Owen Johnson, 2002	Syon Park, Middlesex		96 cm	90' (27 m)

***Liquidambar styraciflua* 'Variegata'**

Henry James, 2001	Hillier Arboretum		25 cm	43' (13 m)

Liquidambar orientalis, showing its habitat in Turkey (see page 21)

Above: Leaves of *L. acalycina* (see page 24)
Below: Mature leaves of *Quercus rubra* 'Cyrille' (left) *Q. rubra* (right), both from Hillier Gardens
(see page 46)

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Tree of the Year 2004-5: *Magnolia campbellii*

The Tree of the Year for 2004 has had to be carried over to the 2005 Yearbook due to a lack of space in this issue.
Please send your comments to Susyn Andrews, 86 Thompson Avenue, Kew, Richmond, Surrey TW9 4JN, UK to arrive not later than 30th September 2005.