

**NEW COMMERCIAL TREE FOR TENNESSEE: PRINCESS TREE,  
*PAULOWNIA TOMENTOSA* STEUD. (SCROPHULARIACEAE)**

THOMAS E. HEMMERLY  
*Middle Tennessee State University  
Murfreesboro, Tennessee 37132*

ABSTRACT

*Paulownia tomentosa* Steud. is an Asian tree that has become widely naturalized in the eastern United States. Because of the unusual properties of its wood, it is used in the manufacture of various products in Asia, especially Japan. The importation of Paulownia wood by that country is estimated at approximately 80,000 cubic meters per year. The cultivation and marketing of sawlogs in the United States, especially Tennessee, is treated, including predictions of the future economic importance of the species.

INTRODUCTION

Princess tree, also called Royal Paulownia or Empress tree, *Paulownia tomentosa* (Thunb.) Steud., native to China, was introduced into North America in the mid-19th century, probably during the 1840's (Tang et al., 1980). According to one account (Carpenter and Graves, 1979), Admiral Samuel Francis Dupont had shipped from China to Delaware some crates of porcelain in which Paulownia seed pods were used as packing material. After the pods were discarded, the tiny windblown seeds resulted in the tree becoming naturalized over much of the eastern United States.

Except for its use as an ornamental, little attention was given in the United States to the rapidly growing Asiatic tree. Recently, however, demand for the wood by the Japanese lumber industry caused prices to become comparable in the United States to expensive fine native hardwoods. Also, the use of Paulownia in reclamation of surface mines has been recommended (Carpenter and Graves, 1979).

Other papers have treated the occurrence, properties and commercial significance of Paulownia in the eastern United States (Stearnes, 1944), especially in Kentucky (Tang et al., 1980; Cunningham and Carpenter, 1980; Carpenter and Graves, 1979).

The objectives of this paper are to: (1) summarize the economic uses of Paulownia, (2) present current estimates

for world production and consumption, and (3) consider the future of the Paulownia market in the United States.

THE TREE AND ITS WOOD

*Paulownia tomentosa* is one of at least six species of the genus native to mainland China (Hu, 1959). The genus has been assigned to both the Scrophulariaceae (Fernald, 1950) and the Bignoniaceae (Wharton and Barbour, 1973). Distribution of *P. tomentosa* in North America, according to the latest edition of Gray's manual (Fernald, 1950), is from Florida south to New York; more recently the range has extended westward to Wisconsin and Oklahoma.

Princess tree is a medium-sized (to 20 m. high) deciduous tree typically with an asymmetrical growth habit. The usually large cordate leaves are, in the case of very young trees, enormous (to 5 dm. in length). The beautiful panicles of fragrant flowers, which appear in late April before the leaves, include a brownish calyx surrounding the five-lobed tubular corolla. The cluster of round, woody capsules, each 3-4 cm. long, that follow each contain approximately 2,000 tiny winged light-weight seeds (Tang, et al., 1980).

Except for ornamental trees planted in urban areas, *P. tomentosa* occurs usually as scattered trees among native hardwoods, principally in the forests of the southeastern United States, and especially on south-facing slopes of the greater southern Appalachian region. Two reproductive characteristics of the species account for its being a successional tree restricted to these sunny, open, usually disturbed microhabitats; (1) the seeds require a high light intensity for germination (Bonner and Burton, 1974), and (2) the primary root of the young seedling is not able to penetrate the usual litter of a typical forest floor (Tang et al., 1980).

Once established, growth can be very rapid. One 20 year old Paulownia growing near Middlesboro, Kentucky, was measured to have a d.b.h. of 3.7 dm, was 22m in height, and averaged only approximately one ring per cm (Tang et al., 1980).

The wood of *P. tomentosa* combines some unique properties. Although quite light (specific gravity 0.23–0.30), it is extremely strong and does not split easily. When green, it can be worked with great ease; as it dries it becomes harder, although still somewhat softer than most North American woods (Carpenter and Graves, 1979). Also, it is durable and, unlike most woods, neither expands when exposed to a humid environment (Tang et al., 1980), nor shrinks in contact with dry air. It is also remarkably fire resistant.

#### ASIAN USES OF PAULOWNIA WOOD

Paulownia wood (“kiri” in Japanese) has been used for centuries in eastern Asia, and especially in Japan, as a multiple-use wood. In the shipping industry, it is used for crates and boxes; also for coffins. Many small items utilize kiri: rice pots, bowls, saucers, wooden spoons and jewelry boxes. Of special interest are the “geta” or wooden shoes.

Kiri is the wood of choice for tight-fitting chests of drawers and dressers (often lacquered) in which expensive items such as kimonos can be safely stored. This use is due to the humidity- and fire-resistant nature of the wood. A Japanese tradition is to plant a Paulownia tree when a baby girl is born; when she is 20 years old, there is sufficient wood for building furniture for her dowry.

The excellent acoustic properties of kiri make it highly desirable for the construction of Japanese stringed instruments, especially the traditional and popular koto. The modern Yamada koto is six feet in length, and is made from two pieces of kiri; one is hollowed out to form the sound box, the other covers the bottom (Malm, 1978). The angle at which the former piece is cut from the sawlog is crucial; the surface of the instrument must exhibit parabolic designs resulting from the tree rings.

Although the use of Paulownia wood in China also has a long history, less is known in the West of its recent uses there. According to Uphof (1968), the wood was used in making gunpowder and fireworks. Li (1590) discussed the medicinal uses: wood and bark for the treatment of typhoid fever; and extract, to promote the growth, and restore the color of hair. Considering the continued importance of traditional medicine in China, it's likely that these and other such uses of Paulownia continue today. Paulownia is the principal tree used in the massive Chinese reforestation program begun over two decades ago (Page, 1983). In China, as in Japan, Paulownia is a tree of “good fortune,” having special symbolic and religious significance.

#### MARKETING OF PAULOWNIA SAWLOGS IN THE UNITED STATES

In 1972, a Japanese businessman (name not known) discovered that the Paulownia tree is fairly common in the United States and has wood at least as high in quality as that

which the Japanese had been growing or importing from other countries. Soon, the Kokusan Company of Japan began importing Paulownia wood from Staunton, Virginia. For a while, neither the craftsmen using the wood nor the consumers were aware of its American origin. Later, as demand increased, other collection centers were established, including Sheboygan, Wisconsin, the Susquehanna Valley of Maryland, Paducah, Kentucky, and another one in eastern Kentucky (Carpenter and Graves, 1979). Centers of collection and export in Tennessee included: Obion County in western Tennessee, Greenville in eastern Tennessee and McMinnville, Columbia and Lebanon, all in middle Tennessee. Some, but not all of these, are still active as collection centers today.

At these centers, a lumberman grades and buys the sawlogs from local landowners who bring them to the yard (Figure 1). Here, they are packed in large containers to be transported eventually to Japan. During the last decade or so, several firms involving a considerable number of Japanese and Americans have been active as “middle men.” In Japan, the logs are bought principally by operators of cottage industries which utilize the wood.



Figure 1. Sawlogs of Paulownia at a collection center near Lebanon, Tennessee. Photograph by author.

Like that of other timber species, the value of Paulownia sawlogs varies from year to year and according to grade. Wholesale prices paid currently by the Japanese to dealers are (per cubic meter): grade AA, \$1,500; A, \$1,000; B, \$750; C, \$550; D, \$350. Prices paid to landowners who sell their logs at local collecting centers are considerably less, but prices are generally comparable to those paid for black walnut, a premier native hardwood. Neither the sawlogs with wide rings from the deep South nor those with narrow rings from the northern United States are as desirable as those from the Appalachian region (Carpenter and Graves, 1979).

## PAULOWNIA PLANTATIONS

A large amount of research has been conducted on the propagation and culture of Paulownia, especially *P. kawakamii* in Taiwan. There, the planting of root cuttings has been found to be more successful than the use of nursery-grown seedlings which are highly susceptible to wind damage and disease during the first year (Tang et al., 1980). Even root cuttings require the use of chemical fungicides as well as insect control and fertilizer during the first year. Thereafter, the annual removal of flower buds and "suckers" (root shoots) is necessary. Large-scale plantations of this same species also exist in Brazil. It has proven successful to use for cultivation propagules derived vegetatively from superior Paulownia stock (Burger et al., 1985; Radojevic, 1979). More recently, Kaul (1987) described a method of micropropagation using shoot segments of mature trees.

In the United States, there are only two plantations of which I have knowledge: one in Kentucky, maintained by the forestry school, University of Kentucky, the other in middle Tennessee. The species planted at both is *P. tomentosa*.

University of Kentucky foresters give directions (Carpenter and Graves, 1979) for producing and planting seedlings. Seeds are stratified to reduce the high light requirement (up to 150 hours) for germination (Carpenter and Smith, 1979). It was also found (Immel et al., 1980) that subjecting the seedlings to long (up to 24 hours) photoperiods 30 days after germination stimulated early biomass accumulation significantly. Seedlings are outplanted when approximately 0.3m high. a spacing of 4x4 or 6x6 feet is recommended. Growth in moist well-drained soils is expected to produce sawlogs in 15 years.

The Tennessee Paulownia plantation previously mentioned (Figure 2) is located among the many nursery farms near McMinnville on the eastern Highland Rim, and approximately 80 km. east of the center of the state. It is

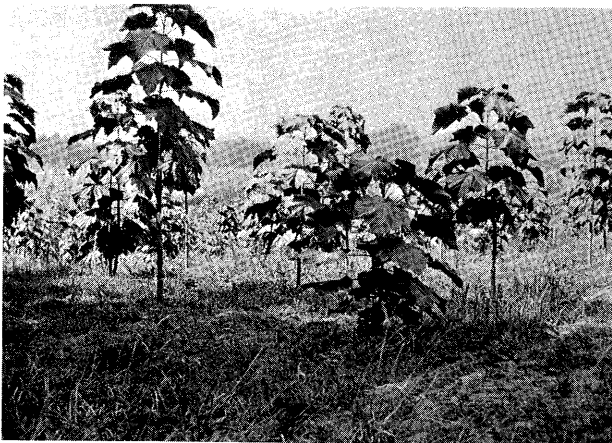


Figure 2. A Paulownia plantation near McMinnville, Tennessee. Photograph by author.

owned by a Japanese nurseryman who prefers as little publicity as possible. Total acreage is estimated at approximately 40 ha. The trees, which were one meter high when transplanted, are now eight years old and 3–4m high. The principal management practices include weeding and removing suckers.

## SURFACE MINE RECLAMATION

As *P. tomentosa* naturally invades open disturbed areas such as abandoned surface mines, it has been recommended for reclamation of these sites, especially in Kentucky (Carpenter, 1977). Its growth requirements and drought tolerance make it ideally suited to the microsites occurring there (Carpenter and Graves, 1979). However, the routine practice of hydroseeding (spraying a mixture of water, seed and fertilizer) has not proven successful. Studies by Cunningham and Carpenter (1980) suggest that the diammonium phosphate used is detrimental to the seeds; one solution to the problem would be the separate application of fertilizer and seeds.

## PAULOWNIA MARKET IN JAPAN

Annual Japanese use of Paulownia wood from all sources at present is estimated at approximately 100,000 cubic meters with a wholesale value of \$40,000,000. Table 1 shows the origin of wood imported into Japan. Most of the remaining 20–22,000 cubic meters per year are grown domestically.

Table 1. Estimated annual sources of Paulownia wood imported by Japan (source of information: Mr. Don Branham).

Country	Cubic m/yr.	Type
People's Republic of China	40,000	plantations
Taiwan	20,000	plantations
Brazil	10,000	plantations
United States	8–10,000	naturalized (principally)
Total	78–80,000	

Because of the ancient and traditional use of this wood, demand is expected to remain high and increase with population growth (Carpenter and Graves, 1979). Furthermore, monopolistic selling policies help to maintain high prices for this premium wood.

OUTLOOK FOR PAULOWNIA PRODUCTION  
IN THE UNITED STATES

As noted, Japanese demand for Paulownia is expected to remain high for an indefinite period. This fact, combined with the high quality (and price) of naturalized Paulownia

from the United States, might cause one to assume that the future market in the United States should be a favorable one. However, because of considerable harvesting, especially during the last decade, there has been a decline in the availability of sizeable high-grade Paulownia trees.

It is conceivable that United States Paulownia plantations could become somewhat more important than at present. However, the value of plantation-grown wood is less than that of wood from naturalized trees. Furthermore, growers would face stiff competition from the three countries (China, Taiwan and Brazil), where economical production methods combining scientific technology with low-cost labor are already established.

It is therefore predicted that the Paulownia market in the United States has probably already peaked, but will continue to afford an income source for a few landowners fortunate enough to have some sizeable trees. Plantations could provide some income after 15–20 years, but are not expected to be especially lucrative.

The use of Paulownia for mine reforestation certainly deserves further investigation.

#### ACKNOWLEDGEMENTS

Special recognition is made for the market data supplied by Don Branham of Brentwood, Tennessee; Mr. Branham was for several years an exporter of Paulownia. The work was partially funded by the Research Committee of MTSU.

#### LITERATURE CITED

- Bonner, F.T. and J.D. Burton. 1974. *Paulownia tomentosa*, Royal Paulownia. Seeds of woody plants in the United States. USDA Handbook #450.
- Burger, D.W., L. Liu, and L. Wu. 1985. Rapid micropropagation of *Paulownia tomentosa*. Hortscience 20:760–761.
- Carpenter, S.B. 1977. This "princess" heals disturbed land. Am. For. 83:22–23.
- Carpenter, S.B. and D.H. Graves. 1979. Paulownia: a valuable new timber resource. For. Ser. Ky. Agric. Exp. Stn. Publ., Univ. of Ky., Lexington.
- Carpenter, S.B. and N.D. Smith. 1979. Germination of paulownia seeds after stratification and cold storage. Tree Planters Notes 39:4–6.
- Cunningham, T.R. and S.B. Carpenter. 1980. The effect of diammonium phosphate fertilizer on the germination of *Paulownia tomentosa* seeds. Tree Planters' Notes 31:6–8.
- Fernald, M.L. 1950. *Gray's manual of botany*, 8th ed. Amer. Book Co., New York.
- Hu, S.Y. 1959. A monograph of the genus Paulownia. *Quart. J. Taiwan Museum* 12:1–53.
- Immel, M.J., E.M. Tackett, and S.B. Carpenter. 1980. Paulownia seedlings respond to increased daylength. Tree Planters' Notes 31:3–5.
- Kaul, K. 1987. In vitro micropropagation of *Paulownia tomentosa* Steud. Trans. K. Acad. Sci. 48:71–75.
- Li, S.C. 1590. Chinese medicinal herbs (translated by Smith, F.P. and G.A. Stuart 1973). Georgetown Press, San Francisco.
- Malm, W.P. 1978. *Japanese music and musical instruments*. Charles E. Tuttle Co., Tokyo, Japan.
- Page, J. 1983. *Forest*. Time-Life Books. Alexandria, Virginia.
- Radojevic, L. 1979. Somatic embryos and plantlets from callus cultures of *Paulownia tomentosa* Steud. Z. Pflanzenphysiol. 91:57–62.
- Stearns, J.L. 1944. Paulownia as a tree of commerce. Am. For. 52:60–61, 95–96.
- Tang, R.C., S.B. Carpenter, R.F. Wittwer, and D.H. Graves. 1980. Paulownia—a crop tree for wood products and reclamation of surface-mined land. S.J. Appl. For. 4:19–24.
- Uphof, J.C. 1968. *Dictionary of economic plants*, 2nd ed. Cramer. Wurzburg, Germany.
- Wharton, M.E. and R.W. Barbour. 1973. *Trees and shrubs of Kentucky*. University Press of Kentucky, Lexington.