Taxodium Breeding Brochure from the Nanjing Botanical Garden received from Professor Yin Yunlong in February 2010.
The breeding of Taxodium hybrids, based on the use of Montezuma (Taxodium mucronatum) as the female parent for the cross, has been a difficult technique to reproduce by Taxodium breeders in China. In 1963, Professor Peizhong Ye, the founder of tree breeding in China, performed a cross breeding experiment using T. mucronatum as the female parent and Cryptomeria fortunei as the male parent. 12 seedlings were obtained from his experiment. These seedlings were believed to be the cross of T. mucronatum × C. fortunei. These seedlings were then used to propagate more than 6,000 saplings which were transplanted in Shanghai, Hubei and other provinces of southeastern China.

It was not until late in the 1990’s that those “hybridized Mexican cypress,” that had been planted in the coastal area of Shanghai 30 years before, came to the attention of the local foresters. They had grown into big trees and showed many desirable traits, such as huge individual biomass, strong wind resistance, and high salinity tolerance. The foresters from the Forestry Department of Shanghai were very excited to find these trees, because Shanghai was built on bare coastal land lacked fine native tree species. The tree soon got a new commercial name “The Oriental Cypress” for the purpose of extension in Shanghai.

However, the dispute arising from the inter-genus-hybrid issue has never been resolved since “The Oriental Cypress” was found because the validity of the hybrid can not be ascertained even when using the most advanced DNA technology (Yunpeng Chen, 2002; Yan Ling, 2006). Nevertheless, the cross process has been experimented with numerous times by the breeders at the Nanjing Botanical Garden since 2002; however, the experiments did not work and no hybrid was secured (Dave Creech, 2006).

The fact that the cross breeding of “The Oriental Cypress” can not be duplicated and proven, encouraged the scientists to find a new way to renew the hybridized Mexican Cypress. Their research brought about the cross of T. mucronatum × T. Disticum (balk cypress).
INNOVATION

Researchers at the Institute of Botany, Jiangsu Province and Chinese Academy of Sciences, have dedicated themselves to the crossbreeding of T. distichum × T. mucronatum since the 1970’s. Many “fruits” have been produced. The first generation of hybrid clones, named ‘Zhongshansha 302, 301, and 401’ have the traits of fast-growing, salt-resistance, and good looking. These clones were bred out in the 1980’s. The second generation of hybrid varieties, named ‘Zhongshansha 118, 149, 102, and 146’ were bred with the crossing of Zhongshansha 302 × T. mucronatum. The second generation of clones was bred out in 1990’s. ‘Zhongshansha 302’ and ‘Zhongshansha 118’ were certificated as National Level Improved Tree Varieties in 2002 and 2006, respectively. Both have been propagated into more than 10 million saplings and have been widely transplanted in more than 10 provinces of southeastern China.

The breeding technique and popularization method of ‘Zhongshansha’ have laid the foundation of theory and technique for the further breeding and development of the T. mucronatum hybrid. However, the cross using T. mucronatum as the female parent and T. distichum as the male parent was not successful until significantly improved hybridizing approaches were introduced after 2004.

BREAKTHROUGH

Current research has proven that there is an apparent phenomenon of maternal inheritance among the hybrids of Taxodium, such as the traits of evergreen, fast-growing, salt tolerance, etc. Therefore, we concluded that the matching of male
and female parents will significantly impact the biological and ecological characteristics of the hybrids. Under the hypothesis that the result will be different if the combination of \( T. \) disticum \( \times T. \) mucronatum were reversed, Institute of Botany, Jiangsu Province and the Chinese Academy of Sciences launched the experimental work of "\( T. \) mucronatum \( \times T. \) disticum" in 2003. After the continuous efforts of six years, the scientists have successfully broken the barrier by setting up a seed producing technique for the hybrid combination of "\( T. \) mucronatum \( \times T. \) disticum". Eleven hybridized seedlings were bred out. Among them, four merit clones were selected and have been measured with molecular identification, salt tolerance, growth rate, etc. Nursery observations have confirmed that Montezuma hybrids show super-parent-advantage in the growth of height, diameter, and biomass. In addition, they keep the characteristics of semi-evergreen-leaf and high landscape value. Moreover, some show prominent resistance to red cedar blight. Based on this successful work, the research group has applied for the patent of "A Technique for the Hybrid Breeding of \( T. \) mucronatum (♀) \( \times T. \) disticum (♂)" (Patent No. 200710025662.4). Meanwhile, the group submitted protection applications for four new varieties of Mexican Cypress: "Zhongshansha 405, 406, 407, and 502" to the State Forestry Administration Protection Office of New Plant Varieties on February 19, 2009. The applications were approved in June 2009. Now, further evaluation based on multiple location testing and verification is being undertaken.

**Highlight**

Due to the difficulty in the breeding of \( T. \) mucronatum, hybridized seedlings were obtained 40 years later when Professor Peizhong Ye bred out the first selection of seedlings. It is surely a breakthrough in the field of forestry breeding in China and has a bright prospect in the future. The taxodium hybrid "Zhongshansha" will be developed into two series of varieties, including hybridized \( T. \) disticum and hybridized \( T. \) mucronatum. The nursery output of "Zhongshansha" will be improved in product quality and production efficiency. The cultivation area will be enlarged. This will help the nurseries producing the "Zhongshansha" trees to set production with the targets of diverse varieties, standardized techniques, and high-yield. \( T. \) mucronatum hybrids will not only have a fast growth rate and a tremendous timber yield, but will also have a prominent adaptability to salinity and drought prone habitats. With great potentials in timber, energy, carbon sinks, and water conservation forests, \( T. \) mucronatum hybrids can be widely used for urban and rural greening, shelterbelts for farmland, and afforestation of coastal areas in southeastern China, etc.

The four clones which have been registered for legal protection and approved by the Forestry Department of China are briefly introduced in the following.
The four clones which have been registered for legal protection and approved by the Forestry Department of China are briefly introduced in the following.

1. Montezuma Hybrid 'Zhongshansha 405'. Its leaves are semi-evergreen with a dark green color, like the Montezuma Cypress. Its growing period is 1 month longer than bald cypress. The trunk is straight like the bald cypress, different from the Montezuma Cypress. The canopy is loose, with less side branches, which stretch upward and seldom bifurcate at the tip. Nursery observation showed that the height and base diameter of the 4-year-old seedlings were greater than that of bald cypress at the same age by 38.4% and 108.5%, respectively. It can tolerate soil salinity within 4.0%, stronger than bald cypress (within 1.5%), and close to Montezuma Cypress (within 4.6%). The offspring had a mild infection of red blight (Cercospora squarrosa) during the growing period.

2. Montezuma Hybrid 'Zhongshansha 406'. Its leaves are semi-evergreen with a light green color, like the bald cypress. Its growing period is 1 month longer than bald cypress. The trunk is straight like the bald cypress, different from the Montezuma Cypress. The canopy is more closed when compared with Montezuma Cypress and the side branches are multi-bifurcated at the tip. Nursery observation showed that the height and base diameter of 4-year-old seedlings were greater than that of bald cypress at the same age by 57.1% and 87.3%, respectively. Pot plant experiments proved that it could tolerate soil salinity within 3.4%, stronger than bald cypress and weaker than Montezuma Cypress. The offspring appear to resist red blight, unlike Montezuma Cypress.

3. Montezuma Hybrid 'Zhongshansha 407'. Its leaves are semi-evergreen with a dark green color. Its growing period is 1 month longer than bald cypress. The trunk is straight like the bald cypress, different from Montezuma Cypress. Its canopy is closed and the side branches are multi-bifurcated. Nursery observation showed that the height and base diameter of 4-year-old seedlings were greater than that of bald cypress at the same age by 56.7% and 97.3%, respectively. Pot plant experiments proved that it could tolerate soil salinity within 3.4%, stronger than bald cypress. The offspring appear to resist red blight, unlike Montezuma Cypress.

4. Montezuma Hybrid 'Zhongshansha 502': Its leaves are semi-evergreen with a dark green color. Its growing period is 1 month longer than bald cypress. Its trunk is straight like the bald cypress, different from Montezuma Cypress. The canopy is loose and the side branches are less bifurcated. Nursery observation showed that the height and base diameter of 4-year-old seedlings were greater than that of bald cypress at the same age by 29.3% and 68.6%, respectively. The offspring appear to resist red blight.
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