

Distribution of *Camptotheca Decaisne*: Endangered Status

Shiyou Li^{1,*}, Wanli Zhang¹, Katie Northrup¹ and Dehui Zhang²

¹National Center for Pharmaceutical Crops, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962, USA; ²State Forestry Administration of P.R. China, Beijing, China

Abstract: *Camptotheca Decaisne* is endemic to southern China. Since 1934, *C. acuminata* has been widely introduced to many gardens and arboreta in North America, Asia, and Europe as living collections. Our national surveys in China between 1995 and 1998 indicated that the genus *Camptotheca* spp. are severely endangered in native range. Our field surveys failed to locate any wild populations of *C. acuminata* although it is often cultivated as landscape trees in southern China. We could not identify any living trees of *C. acuminata* var. *tenuifolia* and var. *rotundifolia*. We estimated that there are approximately 500 mature trees of *C. lowreyana* in Guangdong and less than 50 wild mature trees of *C. yunnanensis* in Yunnan.

Keywords: *Camptotheca*, China, distribution, endangered species.

INTRODUCTION

Camptotheca is endemic to China. Since 1934, *C. acuminata* Decaisne has been widely introduced to many gardens and arboreta in North America, Asia, and Europe as living collections [1]. Recently, there has become an increasing interest in the development of *Camptotheca* plantations for production of CPTs in China, USA, India, Japan, France, Germany, Australia, and Brazil. Although lack of cold-hardiness and drought-tolerance are the two main factors limiting the development of plant resources, it is significant to recognize that the genetic base for plantation resources of *Camptotheca* outside of China is far too limited in size and number to allow selection of a genotype/ecotype for cold-hardiness, drought-tolerance, and high biomass/drug production. *C. acuminata* was successfully introduced in the USA in 1934. As of December 1999, mature trees (> 5 years old) number in the several hundreds with approximately 30 acres of seedlings in the field nationwide. Many of these trees and seedlings are traceable to two mature trees in Chico, California, which germinated from seeds imported from southern China in 1934 [1]. Thus, relatedness is common within plantation populations due to this genetic limit on seed sources. In addition, selfing or inbreeding as a dominant breeding system in plantations also limits the genetic base of *Camptotheca*. The solution to the genetic limitations as well as the adaptability problems will be largely dependent on expansion of the genetic base in China. Prior to our surveys, little data were available on current resources in China, as no survey of this type had previously been performed.

Based on our national surveys in China between 1995 and 1998, we are now able to address issues on geographic distribution and determine the status of naturally occurring

and cultivated resources. Significant findings include the observation that the wild populations of all three species of *Camptotheca* are severely endangered. In southern China, *C. acuminata* is commonly planted for fuelwood and for landscape purposes in four principal locations: waterside, hillside, roadside, and homeside; hence, the “four sides.” The seed sources for these plantations are widely scattered and dependent on where mature surviving natural trees happen to occur. Provenance tests for selection of superior trees have never been made making it impossible to recognize if high-grading and loss of genetic diversity has occurred in the planted stands. In addition, wild populations of *C. lowreyana* [2] could not be located in most provinces, where specimens had been collected early in the last century.

Our field surveys (1994-1999) failed to locate any wild populations of *C. acuminata*. At present, *C. lowreyana* probably numbers 500 mature trees. A population of 50 wild mature trees of *C. yunnanensis* Dode was identified in 1997. We discovered all three species severely endangered with the following factors prompting their endangered status. First, since the mid 1980s with the increase demand for drug extraction, the harvest pressure on the fruit as well as the trees has increased markedly. Second, in the small fragmented populations under natural conditions selfing dominates. Third, a limited number of unselected seed sources and cloned seedlings were commonly used for development of large scale of plantations. In 1997, based on our proposal, the Chinese central government listed *C. acuminata* as a national endangered species and placed it under protection.

RESEARCH METHODS

During the period March 1994 through December 1999, a comprehensive literature review was conducted in China and the United States; and a non-structured field survey was conducted in the southern Chinese provinces of Sichuan, Hunan, Guangdong, and Yunnan with emphasis placed on remote minority regions. Over 100 government agencies,

*Address correspondence to this author at the National Center for Pharmaceutical Crops, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962, USA; Tel: 936-468-2071; Fax: 936-468-7058; E-mail: lis@sfasu.edu

research institutions, universities, companies, hospitals, and farms were visited, including interviews with over 250 people, many of whom participated in our field surveys. Interviews with ethnic groups included the minority nationalities Dong, Bai, Hui, and Dai, and majority Han in the southern Chinese provinces. All available specimens of *Camptotheca* on deposit at the herbaria worldwide (A, CDBI, HNNU, IBSC, KUN, MO, P, PE, SZ, and US) were examined. Information on location, habitat, and local names were recorded for each specimen.

GEOGRAPHICAL AND ECOLOGICAL DISTRIBUTION

Camptotheca is a relict genus with fossil records suggesting more members with wider distribution in the Tertiary. The wood of fossil species *C. kyushuensis* was reported from the Oligocene of North Kyushu, Japan [3]. The leaves of the fossil species, *C. japonica*, were found in Miocene Yoshiooka, Hokkaido, Japan [4]. Related genera in the family have been recorded in North America [5, 6]. Recently, Manchester *et al.*, (1999) described two fossil genera, *Beringiaphyllum* leaves and *Amersina* fruit from Paleocene of eastern Asia and North America, emphasizing that these two genera likely represent a single extinct genus with leaves similar to *Davidia* and fruit similar to *Camptotheca* [7]. This conclusion, however, was based on data from previously recognized monotypic *Camptotheca* (*C. acuminata*). Actually, both the fruit and cordate leaves of the fossil genus are more similar

to *C. lowreyana* than any other existing species. The differences between the fossil *Amersina/Beringiaphyllum* and extant *Camptotheca* occur in the infructescence bracts and 3(4) locules in fruit of the fossil genus Versus the 1(2) locules in fruit in *Camptotheca*.

Three living species in the genus *Camptotheca* are now recognized with the extant natural distribution restricted to remote regions in southern China (Fig. 1). However, neither the geographical distribution nor the resource availability in China had been investigated prior to our surveys. Consequently, such data are not available in either the government forestry departments or universities, or in the botanical and medical institutions. In southern China the most frequently heard comment from local botanists and foresters was: "In southern China, *C. acuminata* is everywhere in plantations, but nowhere in the wild." Of the 30 genera of trees endemic to China [8], all except *Camptotheca* have been systematically studied regardless of their economic or medicinal importance. Most of these species have been placed under government protection on the national list of endangered species.

A primary reason for the lack of study of the natural populations is that *C. acuminata* is planted "everywhere" in southern China. It is plentiful and in the public view not in danger; therefore, politically it is unimportant. In addition, the medicinal value of the tree has not been fully recognized by either the government, the scientist, or the farmer. A Chinese government official in charge of state natural resource



Fig. (1). Distribution of *Camptotheca* in China.

development told the senior author in December 1994: “China has over 5,000 medicinal plant species, and each one of them has a specific use that should be explored in the future. The Chinese happytree is only one of hundreds of herbal species used for cancer treatment in China.” In other words, before 1997, *Camptotheca* had drawn little official attention and was definitely not treated as a priority species over other medicinal plants.

PLANTATION DEVELOPMENT

C. acuminata is one of 84 major afforestation species in China. Due to its rapid growth and early maturation characteristics, the species has been widely planted in the “four-sides” south of the Yangtze River.

According to our data, Sichuan Province is richest in *C. acuminata* plantations. Prior to 1950, “four-sides” plantations were established only in the Sichuan Basin (Mianyang, Deyang, Shengfang, Fengzhou, and Anxian). Since 1950, *C. acuminata* has been planted in the entire eastern half of the province from Yunyang in the east to Tianquan in middle, and from Pingwu in north to Gulan in south [9]. In the last ten years, many plantations (some 1-5 ha) have been established in the low hills of the province.

C. acuminata grows well from 400 to 1,200 m in elevation, but performs best below 700 m. In the Sichuan basin, however, *C. acuminata* is found at elevations up to 1,500 m, although the trees occasionally suffer frost damage at the upper levels of this range. *C. acuminata* grows especially fast on flatlands with fertile and moist soils.

Near the end of the 19th Century, a French missionary in Bailu Community, Pengzhou City planted 70 seedlings as ornamental trees along a stream [9]. The largest trees observed in southern China in 1995 were among this group of 70 and measured up to 40 m tall and 80 cm in diameter at breast height (Fig. 2). These trees appear to have developed under optimum growing conditions. Elevation of 900 m, with annual precipitation of 1,300 mm, and an average annual temperature of 12°C, and the lowest temperature of 0°C. Presently, these trees are protected by the Sichuan Provincial government as “Old Trees.”

According to local botanists, *C. acuminata* was naturally distributed on the south slopes of the Qingling Mountains in southern Shaanxi which may represent the northern border of the genus range. Although some cultivated trees were found in Xian, Yangling, and Changan Shaanxi during our 1997 survey, no wild trees have been identified recently within the area. In addition, there are no specimens of wild trees from this area in the local herbaria. The recorded annual extreme low temperature here is -15°C.

According to Daming Wang, the Director of Yunnan Research Institute of Forestry (pers. comm. 1995), there are an estimated 2 million mature cultivated *C. acuminata* in Yunnan Province. From these trees the annual fruit production reaches 1,000,000 kg (dry weight). Adaptable to many soil types, some of these trees were found growing even in the limestone mountains of the region. Most of these cultivated trees originated from the seeds collected in Sichuan in the 1960s and 1970s. However, the remainder originated from native seed sources that are actually *C. yunnanensis*.



Fig. (2). *Camptotheca acuminata* trees planted in 1877 in Pengzhou, Sichuan, China (photo by S.Y. Li 1995).

Although cultivated in several locations in China, at present, there is no plantation of *C. lowreyana*. According our field trials in Texas, USA, however, the more drought-tolerant *C. lowreyana* appears promising as a plantation species.

C. yunnanensis is restricted to Yunnan Province. In Yangbi in an area where there was obviously neither prior natural distribution nor a history of the tree being present exists a 46 year-old plantation of 200 trees (in 1995). *C. yunnanensis* is the semi-deciduous species. Annual growth rate can reach 3 m in the warm, moist valleys where the growing season is at least 280 days per annum. Although a spring drought is normal in Yunnan, it apparently has little or no significant influence on the total seasonal tree growth.



Fig. (3). *Camptotheca lowreyana* occurs naturally in northwestern Guangdong, China (photo by S.Y. Li, 1995).



Fig. (4). *Camptotheca yunnanensis* occurs naturally in tropical Xishuangbanna in Yunnan, China (photo by S.Y. Li, 1995).

ENDANGERED STATUS OF WILD TREES

Historically widespread throughout southern China at the beginning of the 20th century, wild *Camptotheca* trees are very rare today. *Camptotheca* does not have any major reproduction problems unlike many other Tertiary relicts. Deforestation is the primary reason for the disappearance of the trees from most locations in southern China. The trees usually grow in fertile valley soils, especially along rivers and streams as riparian species. The wild and naturalized trees in these areas have been removed through clear-cutting for agricultural land. Even in the remote mountains, we found wild *Camptotheca* much depleted.

According to interviews with botanists and foresters, wild *C. acuminata* is no longer available in Sichuan, Hunan, and most eastern provinces. In fact, no wild *C. acuminata* was observed in these areas during the field surveys for this study. According to Zhongshu Yao of Kunming Botanical Institute, in the early 1980's wild trees of *C. acuminata* were found growing at elevations up to 2,700 m in the Ailo Mountains of Yunnan Province. Individual trees measured up to 40 m in height and 120 cm in basal diameter. The lowest re-

corded temperature there is -10°C . While only a few young trees can be found at present, their location at such high elevations indicates that these are cold tolerant individuals and may constitute the key genetic source for plantation development in northern subtropical regions.

C. acuminata var. *tenuifolia* was recorded during survey interviews in only Shebei Village, Luogang Community of Huaiji of Guangdong. The only known tree of this variety in Huaiji was cut down in early 1990s and no living material remains to confirm the identification. This action emphasizes the need to protect current wild resources in order to maintain the broadest possible genetic pool.

Living trees of *C. lowreyana* are found only in northeastern Guangdong, although earlier specimens indicated its existence in Fujian, Guangxi, Hunan, and Sichuan (Fig. 3). According to our surveys from 1994 to 1999, there are fewer than 500 wild mature trees of *C. lowreyana* in northeastern Guangdong (Fig. 3). Fortunately, these are under protection by the local government.

C. yunnanensis, a newly recognized species (Li, 1997), occurs only in Yunnan province (Fig. 3). During our 1994 survey, a plantation was located in western Yunnan. On our 1997 trip, we identified additional cultivated trees in Kunming, Yunnan. More importantly, we discovered approximately 50 wild trees in a remote mountainous region in tropical Xishuangbanna of southern Yunnan. The extreme low temperature here is above 0°C (Fig. 4).

These trees represent the only known wild population of *C. yunnanensis* to date. The Government of Yunnan has listed the species as endangered (still listed as *C. acuminata*) and placed it under provincial protection.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

Declared none.

PATIENT'S CONSENT

Declared none.

REFERENCES

- [1] Li, S. Y.; Adair, K. T. *Camptotheca acuminata Decaisne*, *Xi Shu, A Promising Anti-tumor and Anti-viral Tree for the 21st Century*. In: Stephen F., Ed. A Henry M. Rockwell Monograph. Texas: Austin State University: Nacogdoches, 1994.
- [2] LI, S. Y. *Camptotheca lowreyana*, a new species of anti-cancer happytrees. *Bull. Bot. Res.*, 1997, 17 (3), 348-352.
- [3] Suzuki, M. Two new species of nyssaceous fossil woods from the palaeogene of Japan. *J. Jpn. Bot.*, 1976, 50, 228-238.
- [4] Tanai, T. Fossil leaves of the Nyssaceae from the Miocene of Japan. *J. Faculty Sci. Hokkaido Univ. IV. Geol. Mineral.*, 1977, 17, 505-516.
- [5] Prakash, U.; Barghoorn, E. S. Miocene fossil woods from the Columbia basalts of Central Washington. *J. Arnold Arbor.*, 1961, 42, 165-203.
- [6] Eyde, R. H. Fossil record and ecology of *Nyssa* (Cornaceae). *Bot. Rev.*, 1997, 63(2), 97-123.
- [7] Manchester, S. R.; Crane, P. R.; Golovneva, L. B. An extinct genus with affinities to extant *Davidia* and *Camptotheca* (Cornales) from the Paleocene of North America and Eastern Asia. *Int. J. Plant. Sci.*, 1999, 160(1), 188-207.
- [8] Chou, Y. L.; Li, S. Y. *Forests of China*. Science Press: Beijing, 1990.
- [9] Yang, Y. P.; Li, C. B. *Forests of Sichuan*. China Forestry Press: Beijing, 1992.

Received: December 30, 2013

Revised: September 16, 2014

Accepted: September 24, 2014

© Li et al.; Licensee Bentham Open.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.