

Morphological Characteristics of a Unique 'Chain Tree' *Bauhinia scandens* Willd (Caesalpinioideae, Leguminosae) from Pager Wunung Darupono Conservation Park, Central Java, Indonesia

Lianah Kuswanto*

Islamic University of Walisongo, Semarang, Central Java, Indonesia.

*Corresponding author; email: lianahkuswanto@yahoo.co.id

Abstract

A tree species having a unique stem morphology has been found at Sam Poo Kong temple, Gedung Batu, Semarang city, and at Pager Wunung Darupono Conservation Park, Central Java, about 30 km away from the temple. Based on plant key reference identification the name of this tree species is *Bauhinia scandens* Willd, a liana from Leguminosae family. This species has a local name of 'pohon rantai' due to the chain-like shape of the stems. It flowered in August and the fruits matured in October. *In vitro* germination of the seeds collected from the Conservation Park was not successful and only one out of 30 seeds germinated *in vivo* after 12 weeks. Further studies should be conducted on conservation and propagation of this unique species.

Introduction

Bauhinia is a genus under Leguminosae family. Genus *Bauhinia* has more than 500 species of flowering plants, mostly grown in the tropical and subtropical regions. *Bauhinia* is known as orchid trees or kachnar (India and Pakistan) due to the orchid-like shapes of their flowers. Many species of *Bauhinia* are considered to have medicinal effects, and in folk medicine has been used to treat diabetes, infections, and anti-inflammation (Filho, 2009), and anti-tumour (Hazra and Chatterjee, 2008).

One of the unique *Bauhinia* species, *B. scandens*, was found to grow in the Sam Poo Kong temple, Semarang, and the author recently found the same species growing in Pager Wunung Darupono Conservation Park, Central Java, Indonesia, about 30 km away from Sam Poo Kong temple. The stems of *B. scandens* are like ladder or chains, and the plants have attractive white inflorescences. *B.*

scandens has a local name of 'pohon rantai' (chain tree) or 'tapak kerbau' (cow's paw) which reflects the shape of the leaves, whereas in India the species has a local name of 'monkey ladder'.

This study describes the morphological characteristics of *B. scandens* at Pager Wunung Darupono Conservation Park and Sam Poo Kong temple, East Java, and summarizes the propagation studies conducted at the Faculty of Science and Technology, Walisongo Islamic University, Semarang, Indonesia.

Methods

Morphological Characteristics

The study was conducted at Pager Wunung Darupono Conservation Park, and Sam Poo Kong complex, Gedung Batu, Semarang, Central Java, Indonesia in April 2015 to May 2016. Plant identification was conducted using plant key reference by Ding Hou, et.al (1996), De Wit (1956), Sari et al. (2010), and Tjitrosoepomo (1994). For plant identification study, observation was conducted on the tree at Sam Poo Kong and a group of seven trees at Pager Wunung Conservation Park. Nineteen fruits were collected from the trees in the Conservation Park in October 2015 for fruit and seed identification.

Propagation Study

For the propagation study seeds that fell around the trees in Pager Wunung were collected in October 2015, and transported to Biology Laboratory, Faculty of Science and Technology, Walisongo University for further study. Thirty seeds were cleaned and sown on pasteurised media consisting of soil, rice-hulls charcoal and compost (1:1:1 by volume), and 30 seeds were sown *in vitro*.

Prior to sowing on the sand and compost media all seeds were cleaned with detergent and flushed with running tap water for about 10 minutes. Prior to germination *in vitro* seeds were cleaned using detergent, followed by 70% ethanol, 20% clorox, then washed three times with sterilized water. Media used for *in vitro* germination was MS media supplemented with Benzyl Amino Purine (BAP) at 2 or 4 ppm, and 2,4-Dichlorophenoxyacetic acid (2,4-D) at 0.4, 1.0 and 1.5 ppm.

In vitro propagation was conducted using 1 cm² leaf section and 1 cm length of the nodal explants taken from the trees growing in the conservation park. The explants were cultured in MS media supplemented with activated charcoal at 2 g.L⁻¹ and BAP at 1, 2 or 3 ppm.

Results

A tree species with unique stem morphology (Figures 1 and 2) has been found growing at the Sam Poo Kong Temple, Gedung Batu, Semarang City. The same species has also been found growing in the Pager Wunung Darupono Conservation Park, Central Java, about 30 km from the temple. Based on plant key reference data by Ding Hou et al. (1996), De Wit (1956), Sari et al. (2010), and Tjitrosomo (1994), the botanical name of this tree species is *Bauhinia scandens* Willd, and its local name is 'pohon rantai'. The systematics of the tree as described by De Wit (1956) are given below:

Family: Leguminosae Juss.
Sub-family: Caesalpinioideae DC.
Tribe: Cercideae Bronn
Sub-tribe: Bauhiniinae (Benth.) Walp.
Genus: *Bauhinia* L.
Species: *Bauhinia scandens*

Location

B. scandens trees were found in Section 25 of Pager Wunung Darupono Conservation Park (8° 30' - 5° 40' "S 108° 30' E) Central Java, Indonesia, on April 19, 2015, and in Sam Poo Kong Park, Gedung Batu (6.9963° S, 110.3980° E), Semarang City, Central Java, Indonesia. The Conservation Park is located in Darupono village, Kaliwungu district, Kendal regency, Central Java. In 2004, an area of 33.2 ha

was designated as a natural reserve by a decree of the Ministry of Forestry.

Sam Poo Kong Temple is one of the oldest temples in Indonesia. It is also known as Gedung Batu Temple (Setiakusuma, 2006). The foundation of the temple was established by a Chinese explorer, Zheng He, from mainland China, on an area of 3.2 ha (Muljana, 2005). Zheng He arrived in the western part of Central Java, an area now known as Semarang city, via the Garang River (Priambudi, 2006). The year of the arrival of Zheng has been disputed, but it is suggested to have been between 1400 to 1416 (Priambudi, 2006). The temple is now a place of worship which is shared by multiple faiths, including Muslims and Buddhists, and it has a shrine in honour of Zheng Ho.

Only one *B. scandens* tree, with a stem diameter of about 90 cm, has been found in the Sam Poo Kong temple complex. It is believed that the plant was brought from mainland China and it has been estimated to now be about 600 years old, although this has yet to be verified.

Seven *B. scandens* trees found in the Pager Wunung Conservation Park are younger, with stem diameters of about 15 cm. They are growing close together in Section 25 of the park. The conservation park is located about 30 km from the Sam Poo Kong temple complex. The author explored another conservation park in Mount Prau, Central Java, but did not find any *B. scandens* trees growing in this park. It is suspected that seeds of *B. scandens* from the Sam Poo Kong temple complex were dispersed by birds that had eaten the fleshy parts of the fruit and then dropped the seeds in the conservation park.

Morphological Characteristics Stems

Bauhinia scandens are lianas and the morphology of the old stems is illustrated in Figures 1A and 1B. The stem is cylindrical when young, and forms into a 'monkey ladder' when older. *B. scandens* is a tendrilled liana with the tendrils growing in pairs on the stem nodes. *B. scandens* differs from other *Bauhinia* species by having entire leaves that are shaped like cow's paws (Figure 2). The stem colour of the old trees differs from that of the younger trees, with the trees growing in the conservation park being darker than the single tree growing in the Sam Poo Kong temple (where the tree is light brown).



Figure 1. Pohon Rantai (*Bauhinia scandens*) found in the Pager Wunung Conservation Park, Central Java, Indonesia. The trees have stems about 15 -18 cm in diameter, with a height of 25 m, and they climb onto teak trees. Stems showing different aspects of development: (A) stems erect at the base; (B) stems with diameters of 15-18 cm; (C) fully developed stem that has formed chains.



Figure 2. An old Pohon Rantai (*Bauhinia scandens*) tree found in Sam Poo Kong temple, Gedung Batu, Semarang, Central Java, Indonesia. The tree has a stem about 60-90 cm in diameter and a height of 25-35 m; it is climbing onto a mango and a kecacil tree. (A) Stems that have started forming chains; (B) basal stems of the tree; and (C) aerial roots at the base of the old tree that grew onto rocks.

Leaves

The leaves of *B. scandens* (Figure 2) are simple; ovate lamina, 50-90 mm in length and 40–80 mm in width, and are relatively thin. Both leaf surfaces are glabrous with seven to nine venations. The leaf margin is entire, the apex acuminate or caudate, and the base rounded to truncate or cordate.



Figure 3. Leaf morphology of *B. scandens* from a plant found in the Pager Wunung Darupono Conservation Park (A); and a young shoot taken from the tree at the Sam Poo Kong temple, Central Java, Indonesia (B).

Inflorescences

The Inflorescences of *B. scandens* (Figure 3) are racemes or panicles, are terminal, between 15-25 cm in length, and have linear bracts and bracteoles. The trees in Pager Wunung flower in the period August to October. Pedicels are 3-4 mm long, floral buds are oblong or elliptic, 1.8-2.0 mm in length. The flowers have five sepals with a satin-like surface. The petals are white and oblong or elliptical, and sometimes shaped like butterflies, about 3 mm in length.

B. scandens differs from the other described species of *Bauhinias* that usually have flowers that are red, pink, purple, orange, or yellow in colour (Lin et al, 2015; Sinou et al, 2009). According to Lau (2003), in the liana species of *Bauhinia* the fruiting rate and seed-set are generally highest following artificial crossing. No fruit or seed have been obtained from selfing and/or geitonogam. Studies of the plant morphology have shown that the structure associated with the reproductive organs has not significantly changed during evolution when compared to the vegetative organs (Tjitrosoepomo, 1984).

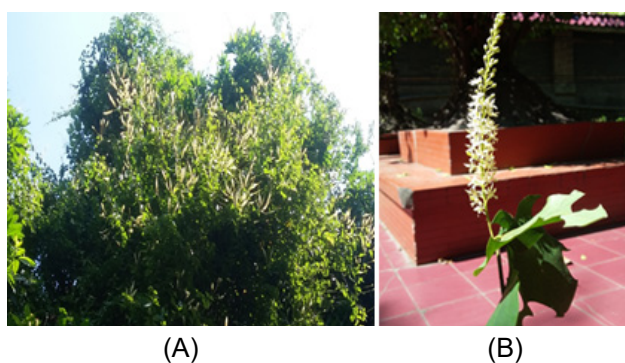


Figure 4. Inflorescences of *B. scandens* on the tree at Sam Poo Kong Temple, Central Java, Indonesia (A), and a close-up of an inflorescence (B).

Fruits and Seeds

The fruit of *B. scandens* (Figure 4A) are brown in colour and pea shaped. The fruit pod is 1.8-3 cm long and 1-1.6 cm wide (Figure 4A). The pods contain one or two ellipsoid to obovoid seeds about 8 mm long (Figure 4B). The plants in the Conservation Park flower in the period August to October, with the fruit maturing in October.

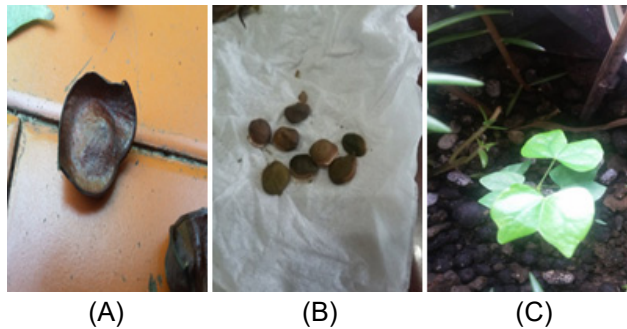


Figure 5. *B. scandens* fruit (A), seeds (B), and a four-week-old seedling with five true leaves (C). Seeds were sampled from a tree growing in the Pager Wunung Conservation Park, Central Java, Indonesia.

Ecology

The plants of *B. scandens* in the Pager Wunung Conservation Park grow in a dense forest at an elevation of 150–275 m above sea level. The soil type in the growing area is a latosol, while the topography of the area is slightly hilly. The climate of the area has been classified as type C according to Schmidt and Ferguson with an annual rainfall of 3,092 mm and average temperature of 28°C (BKSDA, 2009).

B. scandens trees in the conservation park are surrounded by different species of trees, including teak (*Tectona grandis*), ficus (*Ficus* sp.), gambir (*Uncaria scheb*), broto wali (*Tinospora crispa*), walikukun (*Schoutenia ovata*), and ademati (*Ficus microcarpus*). The *B. scandens* tree growing in the Sam Poo Kong temple has climbed on to mango (*Mangifera indica*), kecacil (*Schleichera oleosa*) and gambir (*Uncaria scheb*) trees.

Propagation

From 30 seeds of *B. scandens* collected, only one seed germinated over a period of 12 weeks. A further 30 seeds that were sown *in vitro* did not germinate. Brown compounds appeared on the germination medium which turned completely black (Figure 4) after

about 4 weeks, possibly due to phenolic compounds being released by the seeds. It is possible that the seeds may have been stored for too long prior to being tested for viability, or that the seeds were just not viable. A further study will be conducted in October 2017 to evaluate the viability of fresh seeds.

None of the explants from leaf and nodal sections survived *in vitro*, all showing yellow and red bacterial contamination after 4 weeks in culture (Figure 4 B). Further research needs to focus on sterilization methods of the explants taken from the field-grown trees, as this is a common problem for explants from field-grown woody species (Giri et al., 2004).

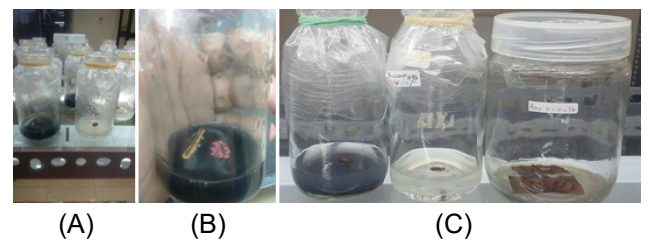


Figure 6. *In vitro* culture of *B. scandens*; (A) the media turned brown after 4 weeks; (B) leaf and nodal explant with yellow and red bacterial contamination after 4 weeks in culture; (C) leaf explant that were not contaminated did not grow during 12 weeks in culture.

Factors that influence the success of *in vitro* culture include the explants and environmental components of the culture medium (Gunawan, 1984; George and Sherrington 1984). Size, age, genotype and explant source also determine the success of *in vitro* culture. Explants that were very small tend to have low endurance and low survival, whereas explants that are too large tend to be easily rolled and contaminated (George and Sherrington, 1984). Good sized explants range from 0.5 to 1 cm, but this can vary depending on the plant parts used as explants and the plant species (George and Sherrington, 1984).

BAP has been reported to stimulate *in vitro* shoot growth, but did not have an effect on *B. scandens* in this study. Similar results have been reported for hazelnut culture (Xi, 2014). The *in vitro* hazelnut culture was found to have a very high contamination rate and, when not contaminated, grew very slowly on the various media (Xi, 2014). Improved disinfection methods and the addition of antibiotics will be tested in future studies to examine whether or not these treatments can potentially reduce contamination and browning of the *B. scandens* culture.

Acknowledgement

The author thanked Mr Gunawan, Mr Budi, and Mr Sodik, Pager Wunung Darupono forest rangers of Central Java BKSDA, the management of SamPoo Kong temple for their generous assistance during exploration and plant identification, and Dr Krisantini for her valuable comments and suggestions for the study.

References

- BKSDA Jawa Tengah. (2009). "Buku Informasi Kawasan Konservasi". Balai Konservasi Sumber Daya Jawa Tengah, Semarang, Indonesia.
- Chatan, W. (2013). A new species of *Bauhinia* L. (Caesalpniioideae, Leguminosae) from Nakhon Phanom Province, Thailand. *PhytoKeys* **26**, 1-5.
- Ding Hou, K. and Larsen, S.S. (1996). Caesalpiniaceae, Flora Malesiana. *Spermatophyta* **12**: 409-730.
- De Wit, H.C.D. (1956). A Revision of Malaysian Bauhinieae. Reinwardita Vol 3 part 4. Herbarium Bogoriense, Kebun Raya Indonesia. pp 381-539
- Filho, V.C. (2009). Chemical composition and biological potential of plants from the genus *Bauhinia*. *Phytotherapy Research* **23**, 1347-1354.
- George, E.F. and P.D. Sherington. (1984). "Plant Propagation by Tissue Culture". Hand Book and Directory for Commercial Laboratories. Exegetic Ltd. England.
- Giri, C.C., B. Shyamkumar, and Anjaneyulu, C. (2004). Progress in tissue culture genetic transformation and application of biotechnology to trees: an overview. *Trees* **18**, 115-136.
- Gunawan, L.B. (1987). "Teknik Kultur Jaringan". Laboratorium Kultur Tanaman Tanaman PAU Bioteknologi IPB, Bogor.
- Hazra, A.G. and Chatterjee, P. (2008). A nontoxic anti-tumour compound from the leaves of *Bauhinia scandens* characterized as 1-O-alkyl glycerol by gas-liquid chromatography and evaluation of its antitumour property by Brine Shrimp bioassay. *Industrial Crops and Products* **1**, 39-43.
- Lau, P. (2003). "Reproductive biology of *Bauhinia* (Leguminosae: Caesalpiniioideae) in Hong Kong". Thesis. University of Hong Kong, Pokfulam, Hong Kong SAR. http://dx.doi.org/10.5353/th_b3124551 [May 1, 2016].
- Lin, Y., Wong, W.O., Shi, G., Shen, S. and Li, Z. (2015). Bilobate leaves of *Bauhinia* (Leguminosae, Caesalpiniioideae, Cercideae) from the middle Miocene of Fujian Province, southeastern China and their biogeographic implications. *BMC Evolutionary Biology* **15**, 252-259.
- Muljana, S. (2005). "Runtuhnya Kerajaan Hindu-Jawa dan Timbulnya Negara-negara Islam di Nusantara". PT LKIS Pelangi Aksara. p. 61.
- Sari, R., Ruspandi and Ariati, S.R. (2010). "An Alphabetical List of Plant Species Cultivated in the Bogor Botanic Gardens, Republic of Indonesia". Indonesian Institute of Sciences Center for Plant Conservation Bogor Botanic Garden. pp 40-41.
- Setiakusuma, P. (2006). Klenteng Agung Sam Poo Kong (The Great Temple Sam Poo Kong, in Indonesian). Sam Poo Kong Foundation, Semarang, Indonesia.
- Sinou, C., Forest, F., Lewis, G.P., and Bruneau, A. (2009). The genus *Bauhinias*.I. (Leguminosae): a phylogeny based on the plastid *trnL-trnF* region. *Botany* **87**, 947-960.
- Van Steenis, C.G.G.J. (1981). "Flora untuk Sekolah di Indonesia". Pradnya Paramita, Jakarta.
- Ying, L.P. (2003). "Reproductive Biology of *Bauhinia* (Leguminosae: Caesalpiniioideae) in Hong Kong". Thesis. University of Hong Kong.
- Tjitrosoepomo, G. (1994). "Taksonomi Tumbuhan". Gadjah Mada University Press, Yogyakarta.
- Tjitrosomo, S.S. (1984). "Botani Umum 3". Penerbit Angkasa, Bandung.
- Xi, D. (2014). "Effects of culture media and plant growth regulators on micropropagation of willow (*Salix matsudana* 'Golden Spiral') and hazelnut (*Corylus colurna* 'Te Terra Red')". Thesis. University of Nebraska, Lincoln, USA.