THAI FOREST BULL., BOT. 44(1): 6–10. 2016.
DOI: 10.20531/TFB.2016.44.1.02

Phenology, seed germination and some vegetative features of *Strobilanthes fragrans* (Acanthaceae), a recently described unusual species, found only in a single Forest Park in Thailand

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ABSTRACT

Strobilanthes fragrans is an uncommon plant which occurs only in Tham Phet-Tham Thong Forest Park (Chonduea mountain), in Nakhon Sawan province. The present study fills in gaps in the knowledge of this species, since it was described on the basis of limited material in 2009. It has a plietesial flowering cycle and during the past 11 years it has flowered synchronously throughout all populations only twice, at an interval of 7 years. Flowering occurs when plants have shed all their leaves and after seed production all plants die, demonstrating they are monocarpic. A new cycle begins with germination of the seeds. Its prop roots, characteristic internodal/nodal regions and a possible bee pollinator are described and illustrated. Seeds germinate readily without pre-treatment and do not undergo dormancy.

KEYWORDS: *Strobilanthes fragrans*, rare and endangered Thai plants, limestone regions, phenology, seed germination, monocarpy.

Published online: 16 August 2016

INTRODUCTION

Strobilanthes is a genus in the Acanthaceae, with about 350–500 species (Daniel, 2006; Wood & Scotland, 2009; Wood, 1995, 2001) and it is probably the second largest in this family. A plietesial flowering cycle has been recorded for some species, in which plants that grow for a number of years, flower gregariously (synchronously), set seed and then die. The length of the cycle can vary between 5 and 16 years in *Strobilanthes* (Daniel, 2006; Wood & Scotland, 2009; Wood, 1995, 2001; Scotland & Vollesen, 2000) This form of monocarpy, with the death of a plant after flowering, has been recorded for some species of other genera in the family, for example the neotropical plant *Stenostephanus chiapensis* (Daniel, 2006).

Strobilanthes fragrans was first discovered by Mr Khaw Tessuka, local volunteer in Tham Phet-Tham Thong Forest Park (Chonduea mountain), in Nakhon Sawan province, Takhli district, in 2005, who drew it to the attention of the senior author, who asked Martin van de Bult, assistant researcher, to look for more material. He found four populations of 5 to 25 individuals. Material was sent to Mr J.F. Maxwell, CMU Herbarium, Chiang Mai University, who identified the genus and sent material to Dr J.R.I. Wood, Department of Plant Sciences, University of Oxford, U.K. He described it as *Strobilanthes fragrans* J.R.I.Wood (Wood & Scotland, 2009). The aim of the present study is to fill gaps in our knowledge of this endemic plant of Tham Phet-Tham Thong Forest Park, subsequent to Wood & Scotland (2009). These authors noted in their paper on little known species of *Strobilanthes* in India and South-East Asia, that because of the difficulty of obtaining additional collections of many species, they had decided to describe well-marked species on less material than is normally desirable, in order to record the plants, including *Strobilanthes fragrans*. Although some abundant species had been seldom collected, but because of their plietesial habit, in which they may

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flower only once in about 12 years, lose their leaves and appear dead, they can be easily overlooked. We have observed *Strobilanthes fragrans* for 11 years and have found further sites in Tham Phet-Tham Thong Forest Park, each with more than 200 individuals; it grows only on limestone. This has enabled us to collect information on their frequency of flowering, phenology, seed germination, as well as recording unpublished and previously unknown information, including information on their aerial (prop) roots.

MATERIALS AND METHODS

During the past 11 years several hundred plants were observed in the Forest Park. One plant grown from seed was taken to the senior author's home for observation.

Phenology

Phenological studies were carried out primarily to determine the seasonal availability of seeds and the time of flowering. Leaf flushing and leaf fall were also recorded. Individual shrubs (5 replicates) were observed from January 2005 until 2015.

Seed collection

Fruits were collected only when the enclosed seeds were properly developed and mature. Collected fruits were transported to Nakhon Sawan Rajabhat University's (NSRU's) nursery for removal of seeds. At least 300 seeds were collected to allow for the treatments and adequate replication.

Seed treatment

Seeds which had already been cleaned and dried were planted as controls. Treatment was by soaking: seeds were soaked in water overnight and sown immediately after soaking.

Sowing the seeds

Two hundred and fifty seeds were divided into five replicate batches of 50 and were watered daily. Germination numbers and percentages were recorded.

RESULTS

General features

Strobilanthes fragrans is a weakly anisophyllous shrub, as previously recorded (Wood & Scotland, (2009), extending up to 4 m with a spreading, but shallow, root system. It has aerial (prop) roots, a feature until now apparently unreported for this species (Fig. 1A). These roots are important in anchoring the plant to bare limestone rock, a feature which is a common character for many limestone plants, including *S. chiangdaoensis* (Santisuk, 1998; Pooma, 2004). The first of these roots to form on the transplanted plant, which was growing in rich soil, is shown in Fig. 1B. A second prop root, which has only just been initiated, is arrowed. The woody stems are greyish brown to greenish brown and up to 4 cm in diameter. Figure 1C shows the prominent white pustules noted by Wood & Scotland (2009) and lenticels, which are narrow, but axially elongated and greyish-white. The stems become hollow as the central pith cells degenerate. They have prominent nodal/internodal regions, with expanded nodes and the leaves are initiated at the nodes in a decussate arrangement (Figs. 1D, 1E). Each half of an individual leaf is frequently a little different in size and shape as shown by the central young leaf in Fig. 1D. There are prominent white hairs (Fig. 1E) and sometimes pink hairs also, around the margins of young leaf blades and on parts of their upper surfaces. Additional features of the leaves have already been described (Wood & Scotland, 2009).

Phenology

We observed the phenology of *Strobilanthes fragrans* during the past 11 years. We confirm it has a plietesial flowering cycle. It had synchronous flowering on leafless branches in year 1 of our observations [February to April 2005] (Fig. 1 F). Synchronous flowering occurred at exactly the same time at 5 well-separated sites in Tham Phet-Tham Thong Forest Park, each site containing more than 200 plants. Fruits formed during this time with the last fruits maturing in May and then the plants died by December, confirming monocarpy. In year 2 [from June 2006 at the beginning of the wet season until November] seedlings germinated from the seeds, which were distributed near the dead plants. Then, in year 7, in January 2011, after the plants had once again lost their leaves, synchronous flowering began in late January, at all of the observed sites, until the end of April. After fruiting and dispersal of seeds, the plants died. As we have observed only one 7 year cycle for this plant, further long-term observations are needed to determine how much, if at all, the flowering cycle varies. Although occasional flowers sometimes occur between synchronous



Figure 1. *Strobilanthes fragrans* J.R.I.Wood: A. Lower stem with aerial roots growing in limestone in Tham Phet-Tham Thong Forest Park. Stem diameter about 3 cm; B. Plant grown from a seed showing a young prop root which has recently entered the soil. Arrow indicates a recently initiated prop root; C. Stem of a forest plant showing white pustules and axially elongated lenticels and a young prop root; D. Young leaves on the seed-grown plant; E. Young leaves on the seed grown plant, showing white hairs; F. Leafless flowering plants, February 2011.

flowering times in some species of *Strobilanthes* (Daniel, 2006), no flowers were observed on this species between the synchronous flowering years. Figure 2A illustrates the flowers and flower buds which are in short axillary spikes. A possible bee pollinator (species unknown) was observed visiting flowers (Fig. 2B). Flowers have 5 lobes and are light purple with white and orange honey guides for pollinators on their lowest lobe (Figs. 2A, 2B). Further photos of flowers and leaves are in Vongkamjan & Sampson (2015). Additional details of the flowers and a SEM of its pollen have been published (Wood & Scotland, 2009). Fruits are capsules (Fig. 2C) and each contains 2, almost spherical seeds, about 1.2 mm wide.

Seed germination

Table 1. Seed germination in *Strobilanthes fragrans*

Treatments	means	% germination
control	41.80±5.26ns	83.60
soaking	42.80±2.59ns	85.60

ns = non significant ($p<0.05$)

As the table shows there are no significant differences between seeds, which were soaked as a pre-treatment, and those which were not pre-treated. The percentage of seeds which germinated as shown



Figure 2. *Strobilanthes fragrans* J.R.I.Wood: A. An inflorescence with two flowers; B. An inflorescence with a flower probably being pollinated by an unnamed species of bee, arrowed. February 2011; C. Capsular fruit (black arrow) with another fruit opposite to it. February 2011; D. Leafless plant in February 2016. (Photos by the authors).

in the table, was high within 20 days of sowing, and sowing took place a month after seeds were collected. They therefore do not undergo a period of dormancy. Germination was epigeal, as has been recorded for some other Acanthaceae. Tests on the longevity of seeds have not been carried out.

DISCUSSION

If the flowering cycle is constant, we would expect flowering of *Strobilanthes fragrans* to take place in the Forest Park, in February 2017. However, unusual dry weather in the Nakhon Sawan region over the past 5 months (October 2015 – February 2016) may delay the next time of flowering. Because the species is so uncommon and apparently endemic species (Santisuk, 1998; Pooma, 2004), it would be useful to sow more seeds in Tham Phet-Tham Thong Forest Park. Further studies would be useful in relation to bee pollination and other pollinators in relation to fruit setting and population size but because of the long intervals between flowering this may not be possible in the near future.

Proposed IUCN conservation assessment.—Endangered (EN D). This species has been found only at the type locality in Tham Phet-Tham Thong Forest Park where it is restricted to a small population of around 200–250 mature individuals.

ACKNOWLEDGEMENTS

We sincerely thank Mr Khaw Tessuka who discovered the plant and Mr Khay Makramtet, staff member of Tham Phet-Tham Thong Forest Park, who assisted in the observation of the plants over several years. We also extend our thanks to the Head of the Forest Park, Mr Yuttana Tongbungua.

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