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An unusual development of flowers in *Aquilaria malaccensis* J. Lamarck (Thymelaeaceae) growing in Meghalaya, Northeast India

N. Venugopal[1] and **Ester Jones Marbaniang**
Department of Botany, Centre of Advanced Studies in Botany, North Eastern hill University, Shillong-793 022, Meghalaya, India
E-mails: nvenugopal3@gmail.com; estermarg@gmail.com.
[1]*Corresponding author*
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Abstract

Aquilaria malaccensis J. Lamarck [syn. *A. agallochum* (Loureiro) Roxburgh *ex* Finlayson] of Thymelaeaceae is an economically important tree for the production of agar oil. The species has been placed on Appendix II of CITES and belongs to the "Threatened" category of the IUCN Red List. The flowers are small, yellowish green, and arranged in clusters on the leaf axis. In the normal flower of *A. malaccensis* there is a single gynoecium with ten stamens in two whorls alternating with scale-like appendages of petals. The authors came across in 10 % of the flowers having 2 to 3 gynoecia with 20 stamens borne on a single receptacle. It has been postulated that this type of unusual flower is due to the effect of low prevailing temperature (8 – 14° C), light and differential expression of homeotic genes.

Key words: *Aquilaria malaccensis;* Agarwood; unusual flower development; Meghalaya; Northeast India

INTRODUCTION

The genus *Aquilaria* Lamarck (Thymelaeaceae) [syn. *A. agallochum* (Loureiro) Roxburgh ex Finlayson; *A. agallocha* Roxburgh] is commonly known as agar tree and consists of 15 tree species (Chang & Kadir 1997). This is an economically important tree for the production of good-quality agar wood. The causative organism for the production of resin in the heartwood is a parasitic ascomycetous mold, *Phaeoacremonium parasitica* W. Gams, Crous *et* M.J. Wingf. This resin is valuable for its uses in medicine, perfumery and other aromatic products (Persoon 2007). Because of its immense value and rarity, indiscriminate killing of trees, in search of finding the treasured resin, has lead to the much depletion of *A. malaccensis* in nature. This has its natural populations diminishing into critical minimum level (Broad 1995) and now the trees are found only in few protected pockets in the NE India (Barden *et al.* 2000). Hence the species was placed on Appendix II of the Convention on the International Trade in Endangered Species (CITES) and belongs to the "Threatened" category according to the IUCN Red List (Oldfield *et al.* 1998; CITES 2005; Saikia & Khan 2012).

STUDY AREA

The study was carried out during 2012 – 2014 in Mawlyngroh village, South East Khasi Hills District, Meghalaya, which is under the Bhowel Syiemship. This area lies at 25°14‘48.6“ North latitudes and 91°24‘57.90“ East longitudes at an altitude of about 487m AMSL

MATERIALS AND METHODS

Flowering twigs of *Aquilaria malaccensis* J. Lamarck (Thymelaeaceae), were collected from 10 randomly selected trees of about 40 – 60 years old, during the months of March end to the middle of April for three consecutive years 2010 – 2014. Floral characters were observed in 100 flowers from each tree. The normal and unusual flowers were studied and photographs were taken with Magnus MSZ-TR stereo microscope. The voucher specimen (Accession No. NEHU-11844) is deposited in the NEHU Herbarium, Shillong.

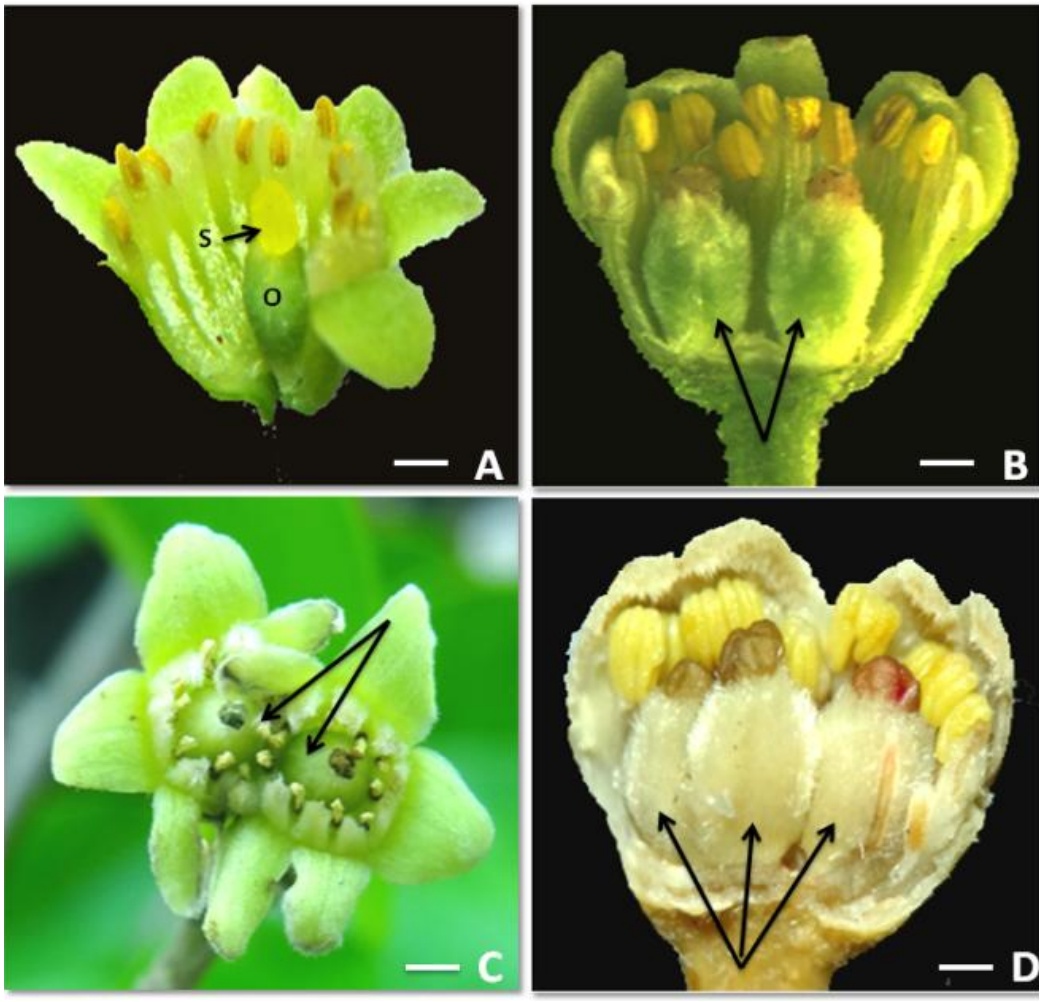

Figure 1: ***Aquilaria malaccensis*** **J. Lamarck (A)** Open normal young flower showing single gynoecium with 11 stamens and 7 sepals. Note the yellowish stigma and indistinct style. O-ovary; S-stigma (Bar = 2 mm). **(B, C & D)** Front view and half opened mature flowers showing two and three gynoecia respectively (arrows). In mature flowers stigma turns brownish; number of stamens, sepals and petals are double the number of normal flower. Note the gynoecia covered with dense hairs in B & D. [Bars: B = 2.5 mm; C = 3 mm & D = 4mm].

Fluorochromatic Reaction (FCR) Test was used to study the viability of pollen grains (Shivanna & Rangaswamy 1993; Heslop-Harrison & Heslop-Harrison 1970).

RESULTS AND DISCUSSION

Aquilaria malaccensis is a relatively slow-growing, medium-sized tree, on average 15 – 25 m tall with a moderately straight stem. The bark is smooth, thick, pale gray; dark dense foliage and shiny elliptical leaves. Flowering starts during the last week of March which lasted only for 10- 20 days only. Fruiting started during the first week of April and matured fruits can be seen in the month of May and lasted till June. Seedlings can be seen in the month of July and August where the seeds can be blown only a few meters from the mother plant by wind or dispersed by ants and wasps (Manohara 2013).

The flowers of *Aquilaria malaccensis* are small, yellowish green and borne in clusters on the leaf axis. Flowers are bisexual, ebracteate and about 8 - 10 mm in diameter. In a normal flower, sepals are 5 - 7, gamosepalous, larger than petals, persistent, petaloid and pubescent. Petals are 10 - 11, free, highly pubescent and reduced to scale like appendages. The androcium consists of 10 - 11 epipetalous stamens; anthers dorsifixed and hypogynous; pistil 1, ovary superior, obovoid, massive and densely pubescent, biloculate with single bitegmic ovule in each; style less than 3 mm; stigma capitate, wet.

During the three consecutive years of study from 2012 and 2014, the authors came across nearly 10 % of flowers of *A. malaccensis* on the twigs facing the bright sunlight having 2 or 3 pistil on one receptacle. These flowers produce 9 – 10 sepals; 18 – 20 stamens and petals, which are double the number as of the normal flowers. Pollen grains produced from these anthers showed viability up to 80 % by Fluorochromatic reaction (FCR) Test (Shivanna & Rangaswamy 1993; Heslop-Harrison & Heslop-Harrison 1970), which is around 78 % in normal flowers. May be lower temperature which ranges from 8 – 14 ^{0} C and long-day photoperiod induce differential genetic expression which may lead to the multiple floral parts development.

Similar phenomenon has also been reported in *Arabidopsis thaliana* (Linnaeus) Heynhold where the floral development and identity of floral organs are controlled by the operation of homeotic genes. However, in mutants of *Arabidopsis* additional floral organ development is due to the meristematic activity in the center of the floral meristem and generates additional stamen primordia as well as increased the number of carpels (Huang & Ma 1997).

CONCLUSION

The multiple flower parts development in *Aquilaria malaccensis* may be due to the synergistic effect of low temperature and long-day photoperiod, which induce the homeotic genes to express the multiple floral organs. Temperature conditions are known to influence the development of floral organs and sex expression in most of the angiosperm species (Ojiewo *et al.* 2007). The same phenomena has also reported in tomato and pepper plants that exposure to low temperatures resulted in the production of flowers showing alterations in the number, morphology and patterns of fusion of floral organs (Sawhney 1983; Polowick & Sawhney 1985; Lozano *et al*. 1998).

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