Vegetative Description of Three Aquilaria (Thymelaeaceae) Saplings in Malaysia

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ABSTRACT
Plants’ reproductive parts are most important for species identification. However, trees such as Aquilaria species take many years to mature and produce flowers and fruits. Inconsistent and infrequent flowering periods may cause additional hindrance to classical identification. In this study, descriptions were made based on vegetative parts such as leaf, branch and bark for saplings of three Aquilaria species found in Malaysia. It was found that A. hirta sapling can be recognized through the densely hairy twigs, young shoots and axillary buds, undersurface of leaf, margin, petiole and midrib besides the strongly raised midrib, and usually unbranched habit; A. malaccensis through the many branches and white spots along main axis, entire leaf margin, slightly hairy leaf undersurface and midrib, and glabrous petiole; Aquilaria sp.1 from the lower branches that are nearly perpendicular to the stem and wavy leaf margin. These vegetative characters can serve as a basis for the correct identification of Aquilaria saplings when growers need to confirm their planting materials.

Keywords: Aquilaria, identification, sapling, vegetative characteristics

INTRODUCTION
Aquilaria Lam., a genus from the family Thymelaeaceae, is endangered tree taxa endemic to the Indo-Malesia regions (Mabberley, 2008). Aquilaria produces ‘gaharu’, a valuable forest product that is sought for its uses in perfumery, incense and religious purposes (Barden et al., 2000). Aquilaria species are listed in the IUCN Red List Appendix II, and regarded as highly endangered (IUCN 2011). Demand for conservation is increasing to restore their diversity in nature. In Malaysia, Aquilaria has attracted a great number of local planters, entrepreneurs, and individuals who planted the trees on a large scale (Lok et al., 1999). Many of these plantations cultivated...
Aquilaria species of foreign origins because they are believed to be of better in producing quality ‘gaharu’ (Nor Azah et al., 2008; Rompoei et al., 2009). The genetic diversity of Aquilaria species in the country at present has been greatly multiplied with cultivated Aquilaria trees. With the introduction of foreign species from the neighbouring countries, there is a risk of losing the native genetic diversity (Adams, 1997).

Information on the taxonomy and morphology of mature Aquilaria trees in the wild is currently available. However, descriptions of saplings are lacking. Tropical trees are usually identified together with their reproductive parts, which are the flowers and fruits. Aquilaria, however, takes several years to bear flowers and fruits (Kumeto & Ito, 2011). Hence, in the absence of their reproductive parts, identification of saplings can only be done through their vegetative parts, including leaves, branches and bark (Whitmore, 1973; Keller, 2004). The first description of the genus Aquilaria was done by Lamarck in 1783 based on A. malaccensis. Following works on Aquilaria include Ridley and Hutchinson (1924), and the revision by Hou (1960). To date, five Aquilaria species have been found in Malaysia, viz., A. malaccensis Lam., A. hirta Ridl., A. beccariana Van Teigh., A. rostrata Ridl. and A. microcarpa Baill (Chua, 2008), and Aquilaria sp.1 (Tawan, 2004). The two former species are vulnerable to over-exploitation and habitat loss while the remaining species are known from single herbarium specimens (Lau & Chua, 2012). The distribution and ecology of different Aquilaria species in Malaysia were also undertaken by Faridah-Hanum et al. (2009), while Lau and Chua (2012) carried out conservation assessments of Aquilaria for Peninsular Malaysia.

This work was undertaken to provide a vegetative description of three Aquilaria saplings, which is deemed necessary for individuals or growers to confirm their planting materials before establishing Aquilaria plantations.

**MATERIALS AND METHODS**

**Plant Materials**

Three selected local Aquilaria species were brought back as wildings from the following places viz. A. malaccensis (Lentang Seed Centre, Karak, Pahang), A. hirta (forest near Ladang Merchang, Terengganu) and Aquilaria sp. 1 from Semenggoh Forest, Sarawak. They were planted in polybags in a mixture of soil forest and red soil (1:1) and grown in the shade house at the Faculty of Forestry, Universiti Putra Malaysia (UPM). Saplings were watered and fertilized periodically with organic compound fertilizer (HumicFert+) to ensure the growth of leaves and branches.

**Herbarium Specimens**

Two specimens were taken after the saplings were planted for one year. All the specimens were pressed, dried and mounted, and kept as voucher specimens in the Herbarium, Faculty of Forestry, Universiti Putra Malaysia. Comparisons were made with the following specimens from matured trees:
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Results and Discussion

The saplings of the Aquilaria species examined are herein described by distinguishing the characters highlighted in bold as follows:

Aquilaria sp.1 (Fig.1a, Fig.2a-f)

Sapling with lower branches nearly perpendicular to the stem. Twigs slender, slightly hairy. Leaves oblong-oblanccolate, 6.0-10.4 x 2.2-3.4 cm, base obtuse, apex acuminate, acumen 0.9-1.6 cm; texture chartaceous, slightly hairy below; midrib channelled above, raised and hairy below; lateral veins conspicuous, 12-20 pairs; leaf margin wavy. Petiole hairy, 0.3 cm long. Young shoots and axillary buds hairy, light green, 0.4-1.0 cm long.

Aquilaria malaccensis UPM 8871, UPM 8872, UPM 8873, UPM 17460, KEP 37142, KEP 40707, KEP 37045, KEP 34553, KEP 31387; A. hirta KEP1679, KEP 71521, KEP 1188, KEP 26898, KEP 23836, KEP 69910, KEP 10542, KEP 2397, KEP 16972, KEP 8298, KEP10673, KEP 8330, KEP 25030, KEP 59689, KEP 59692, KEP 59675, KEP 59602, KEP 58682, KEP 59691, KEP 59601; Aquilaria sp. 1 S34204.

The vegetative parts of the saplings were photographed using Leitz MZ8 Low-range Microscope (Leica, Germany). A scale was then added into the photo to provide measurement references. The software Leica QWin Standard Y 2.8 was used to operate the microscope and to analyze the images.
Aquilaria hirta Ridl (Fig.1b, Fig.3 a-f)
Sapling rarely branching. Twigs densely hairy. Leaves acuminate-lanceolate, 8.5-13.8 x 3.7-6.5 cm, base acute, apex acuminate, acumen of 1.5cm long; texture coriaceous, glabrous above, densely hairy below; midrib strongly raised, densely hairy below. Lateral veins conspicuous below, 14-23 pairs; leaf margin entire, densely hairy. Petiole densely hairy, 0.4-
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0.7 cm long. Young shoots and axillary buds densely hairy, light green, 1.5-3.0 cm long.

Aquilaria malaccensis Lam. (Fig. 1c, Fig. 4a-f)

Sapling often branching with white spots along the main axis. Twigs greenish, glabrous. Leaf elliptic-lanceolate, 8.5-11.5 x 3.0-4.1 cm, base acute, apex acuminate, acumen of 1.8-1.9 cm long; texture thinly coriaceous, shiny green above, slightly hairy below; midrib slightly hairy; lateral veins conspicuous, 19-26 pairs; leaf margin entire. Petiole glabrous, 0.3-0.4 cm long. Young shoots and axillary buds hairy, light green, 0.5-0.7 cm long.

From the above descriptions, the distinguishing characters were tabulated (Table 1). The easiest sapling to identify is A. hirta due to the nearly unbranched habit, densely hairy throughout the plant besides the strongly raised leaf midrib. These characters differ remarkably from the saplings of the two other species. Meanwhile, the observations showed that matured A. hirta specimens differ from the saplings by having soft velvety hairs on the leaf undersurface, margin, petiole and midrib. Aquilaria sp.1 was reported as an incomplete species by Tawan (2004), who noted that it closely resembles A. beccariana through its vegetative characteristics. However, its taxonomic status is not confirmed as the reproductive characteristics of Aquilaria sp.1 tree do not match the reproductive characteristics of A. beccariana tree. Despite this, the Aquilaria sp. 1 sapling is easily recognisable from the wavy leaves and lower branches that are nearly perpendicular to the stem, unlike the branches of A. malaccensis sapling. The sapling of A. malaccensis has many branches.

Fig. 4: Vegetative characteristics of Aquilaria malaccensis: (a) leaf surface, (b) leaf bottom, (c) midrib, (d) petiole, (e) young shoot and (f) axillary bud. Reference scale as provided.
and white spots along the main axis, entire leaf margin, slightly hairy leaf undersurface and midrib, and glabrous petiole. However, adult trees of *A. malaccensis* have glabrous plant parts, with conspicuous shiny leaf upper surface, sunken midrib above but raised beneath.

**CONCLUSION**

Generally, identification of plant taxa relies more on the reproductive parts due to their inherent hence stable characters. However, in this study, young saplings were identified by observing their vegetative parts in the absence of reproductive parts. Like many other tree species, it is difficult to determine the identity of the saplings of *Aquilaria*, especially to inexperienced individuals. In this research work, it was demonstrated that by looking at vegetative parts, saplings could be identified correctly. This could be a quick solution for the general public to help determine the species identity of young saplings, especially when planning to plant the three *Aquilaria* species on plantations.

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