

Short communication

Morphological keys for four Australian *Acacia* species grown in Kerala, India

M. Neethu Lakshmi and S. Gopakumar*

Department of Forest Management and Utilization, College of Forestry, Kerala Agricultural University, KAU PO, Thrissur 680656, Kerala, India.

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Abstract

Several species of phyllodinous acacias have been introduced to Kerala, India. Examples include *Acacia mangium* Willd., *A. auriculiformis* A. Cunn. ex Benth, *A. crassicarpa* A. Cunn. ex Benth and *A. aulacocarpa* A. Cunn. ex Benth, which are used for raising social forestry plantations and afforestation of degraded lands. Although morphological variations abound among these species, the similarity of the phyllodes often confuses the planter. Morphological keys to identify the four species are presented.

Keywords: Australian acacias, taxonomy, morphological variations, identification key.

The genus *Acacia* (Mimosoideae, Fabaceae) with over 1350 species is native to Australia. The botanic garden networks, 'acclimatisation' societies, and private enthusiasts have moved large quantities of its seeds for scientific, decorative, and economic goals to different parts of the world (Cronk and Fuller, 1996). The earliest documented transfers of Australian acacias to other continents occurred in the late 1700s with British and French exploration of the Australian coast (Christian and Rangana, 2008). Numerous Australian wattles are now grown around the Mediterranean basin, as well as in California, South Africa, Madagascar, India, Brazil, and Hawaii (Richardson and Cambray, 2003). There is also recorded information on the early introductions of *Acacia auriculiformis* A. Cunn. ex Benth (first introduced in 1946, in West Bengal) and *A. mangium* Willd. (in the 1980s) to India (Rai, 1995). Indeed, phyllodinous *Acacia* species have been taken up for planting in all types of ecosystems in India (Kodira and Kushalappa, 1991) including the degraded forest tracts. In Kerala (southern India), *A. auriculiformis* and *A. mangium* are popular because of their fast growth and superior wood qualities and there is a growing market for furniture, doorframes, window frames and cabinets

made of these (Shukla et al., 1990; Shanavas and Kumar, 2006). The high calorific values also make them excellent fuel woods (Shanavas and Kumar, 2003).

In the genus *Acacia*, especially in the phyllode group, considerable morphological, ecological and biological variations exist. Beckett (1993) documented the variations in leaf and phyllode morphology of 35 wattle species. McDonald and Maslin (2000) reported differences in pod dehiscence of *A. aulacocarpa* A. Cunn. ex Benth and *A. crassicarpa*. Susilawati and Setiadi (2003) illustrated the seed morphological variations of *A. mangium* and *A. auriculiformis*. Despite morphological differences, all phyllodinous acacias look strikingly similar to the untrained eye. User friendly taxonomic keys will therefore be handy in identifying the right species for planting (Maslin, 2002). Hence, an attempt was made to profile the basic morphological variations of the four potentially important phyllodinous *Acacias* grown in Kerala, India (*A. mangium*, *A. auriculiformis*, *A. crassicarpa*, and *A. aulacocarpa*) and to develop taxonomic keys for these species.

The experimental material consisted of ten trees each of

*Author for correspondence: Phone 91 487 237 0050 Extn 219; Fax 91 487 237 1040; Email <gopankau@gmail.com>.

the four species grown at Vellanikkara, Thrissur, India, since 1996. Samples of phyllodes, inflorescences, fruits, and seeds were collected from the lower, middle and top branches of the canopy of each tree. Morphological characteristics like bark colour, shape of rhytidome (outer bark), branch angle relative to main stem (measured using a protractor), internode length of twigs on the lowest branch, phyllode characteristics (shape, size, phyllode arrangement, venation, leaf surface characteristics and leaf texture), inflorescence characteristics (type, colour, position, length and number of whorls), fruit characters (shape, length and width, and number of seeds per pod), seed morphology (shape, length, width, and presence of furrow), and funicle characters (shape, colour, and length) were observed with the help of Labomed Stereozoom Microscope and DigiPro Image Analyzer software. Seed weight (weight of 1000 seeds) was recorded, besides shape, length, and width of seeds. Presence or absence of furrows on the seeds was observed using a Labomed Stereozoom Microscope and DigiPro Image Analyzer software (10 x).

Morphology

Although prominent variations could not be observed in the bark colour of the four species, shape of the rhytidome or outer bark varied widely. In *A. aulacocarpa* and *A. crassicaarpa*, rhytidome was square in shape (Fig. 1) whereas in *A. auriculiformis* and *A. mangium*, it was rectangular. In all the four species, branches were arranged on the stem at acute angles. Internode length was highest in *A. crassicaarpa* and lowest in *A. mangium*.

Phyllodes of the four species showed notable variations. While phyllodes of *A. auriculiformis* and *A. crassicaarpa* were sickle shaped, the phyllode of *A. aulacocarpa* was longer and pointed. *A. mangium* phyllode looked more like an “entire leaf” (Fig. 2). In all the four species, phyllodes were arranged alternately and the veins emerged from the base, running parallel to each other before finally converging near the tip. In *A. mangium*, there were four nerves on the dorsal side of the phyllode, which could be prominently felt by touch. All the other three species had only three prominent nerves. Phyllodes

of *A. crassicaarpa*, *A. aulacocarpa*, and *A. auriculiformis* were smooth textured whereas the presence of four prominent nerves in the phyllode of *A. mangium* made it rough. *A. crassicaarpa* had thicker and greyish phyllodes which were very distinct from all other species (Fig. 2).

Inflorescence type in all the four species was spike. Flowers of *A. aulacocarpa* and *A. auriculiformis* were yellow in colour. *A. crassicaarpa* had greenish yellow florets whereas *A. mangium* had creamy white florets. In all the four species, number of whorls was four, namely, calyx, corolla, androecium, and gynoecium justifying its inclusion in polypetalae, and stamens were numerous.

Fruit characteristics of the four species varied substantially. *A. auriculiformis* and *A. mangium*, possessed highly coiled pods whereas *A. aulacocarpa* and *A. crassicaarpa* had flat and uncoiled pods (Fig. 3). Size of the pod and number of seeds per pod also varied considerably. The average length of uncoiled pod (Table 2) was highest in *A. crassicaarpa*, followed by *A. aulacocarpa*. Coiled pods of *A. auriculiformis* was longer than that of *A. mangium*. Pods of *A. aulacocarpa* were wider than that of *A. crassicaarpa* (Table 2; Fig. 3). Between the other two species, *A. auriculiformis* had wider pods compared to those of *A. mangium*. On an average, the number of seeds did not vary widely in the four species (Table 2). Seeds of *A. crassicaarpa* were distinct from those of other species due to the presence of a prominent protrusion in the middle portion. There were also considerable size variations among the seeds of these four species (Table 2; Fig. 4).

Characteristics of the funicle are a useful tool in distinguishing the four species. *A. auriculiformis* was distinct from all other species as it had curved funicle enclosing more than half of the seed. Funicles of other three species were coiled but did not cover the seeds (Fig. 5). Colour of the funicle was greyish white in *A. aulacocarpa*, creamy white in *A. crassicaarpa*, reddish orange in *A. auriculiformis*, and orange in *A. mangium* (Fig. 5). Length of funicle also varied widely (Table 2), with the highest values for *A. aulacocarpa* and lowest for *A. mangium*.

Table 1. Morphological profile of four Australian *Acacia* species in Kerala, India.

Characteristics	Species			
	<i>Acacia aulacocarpa</i>	<i>A. auriculiformis</i>	<i>A. crassicarpa</i>	<i>A. mangium</i>
Bark colour	greyish brown	greyish brown	greyish brown	greyish brown
Shape of rhytidome	square	rectangular	square	rectangular
Branching pattern (angle)	acute	acute	acute	acute
Internode length (cm)	2.4	2.2	3.3	1.5
Phyllode arrangement	alternate	alternate	alternate	alternate
Length of phyllode (cm)	16.5	12.6	13.1	14.2
Width of phyllode (cm)	2.1	2.3	4.2	5.4
Phyllode texture	smooth	smooth	smooth	rough with prominent nerves
Shape of phyllode	long and pointed	sickle shaped	sickle shaped	looks like an “entire leaf”
Type of inflorescence	spike	spike	spike	spike
Position of inflorescence	phyllode axils	phyllode axils	phyllode axils	phyllode axils
Colour of florets	yellow	yellow	greenish yellow	creamy white
Length of inflorescence (cm)	8.3	9.7	7.3	6.2
Average number of florets per inflorescence	124	135	113	102
Number of whorls	four	four	four	four

Table 2. Seed characteristics of four Australian *Acacia* species in Kerala, India.

Characteristics	Species			
	<i>Acacia aulacocarpa</i>	<i>A. auriculiformis</i>	<i>A. crassicarpa</i>	<i>A. mangium</i>
Shape of pod	flat	coiled	flat	coiled
Average length of pod (cm)	7.5	4.6	9	4.1
Average width of pod (cm)	3.4	1.7	2.1	0.7
Average number of seeds per pod	15	12	12	15
Average length of seed (mm)	5.83	4.53	4.12	3.87
Average width of seed (mm)	2.75	3.55	3.33	2.62
Colour of funicle	greyish white	reddish orange	creamy white	orange
Weight of 1000 seeds (g)	19.52	17.54	19.66	11.56
Length of funicle (mm)	7.52	curved and covers more than half of seed	4.03	3.64

Keys to morphological characters

Acacia aulacocarpa: rhytidome, square; phyllode, long (~16.5 cm) and pointed among all the four species; pod, flat and uncoiled; funicle, greyish white in colour.

Acacia auriculiformis: rhytidome, rectangular in shape; phyllode, short (~12.6 cm), sickle-shaped; pod, highly coiled; funicle, curved and enclosed more than half of the seed, reddish orange in colour.

Acacia crassicarpa: rhytidome, square in shape; length of internode, long (~3.3 cm) which means that leaves are arranged more compactly on the branchlets; phyllode, thick with greyish tint and sickle-shaped; flower, greenish yellow in colour; pod, flat and uncoiled; prominent protrusion in the middle of the seed; funicle, creamy white in colour.

Acacia mangium: rhytidome, rectangular in shape; length of internode, short (~1.5 cm; leaves most

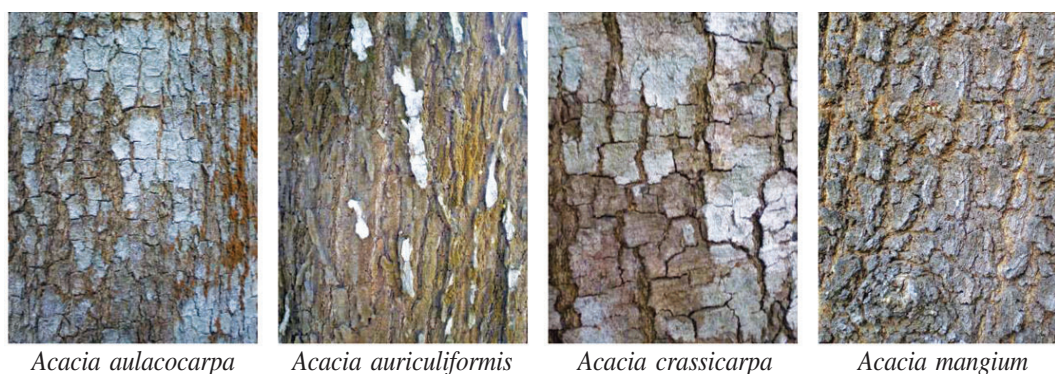


Figure 1. Bark colour and rhytidome shape of four *Acacia* species grown in Kerala, India.

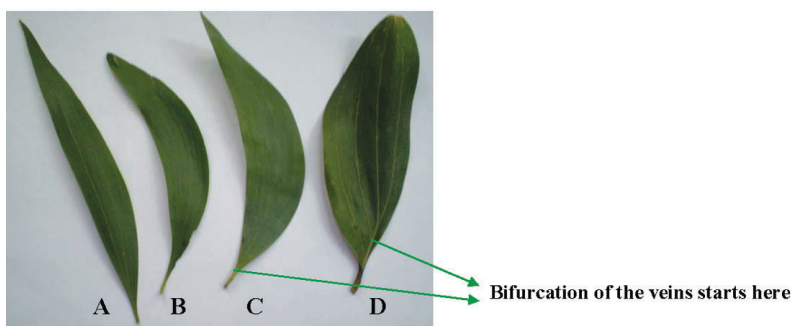


Figure 2. Phyllode shapes of *Acacia aulacocarpa* (A), *A. auriculiformis* (B), *A. crassicaarpa* (C), and *A. mangium* (D) grown in Kerala, India.

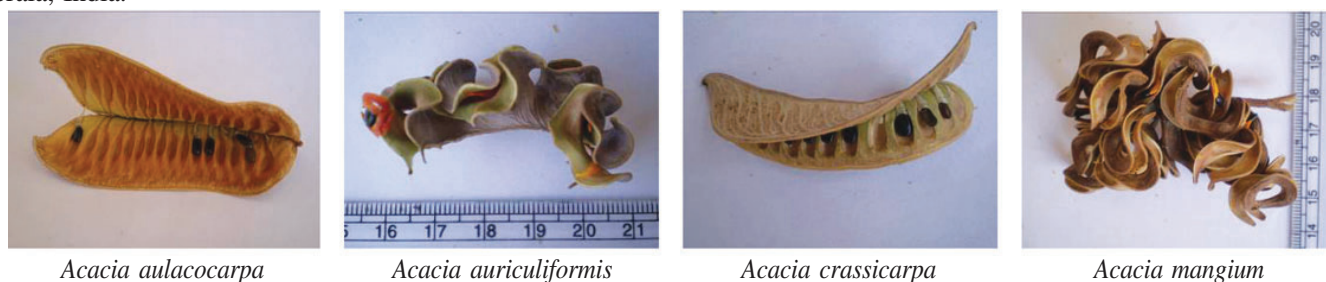


Figure 3. Fruit characteristics of four *Acacia* species grown in Kerala, India.

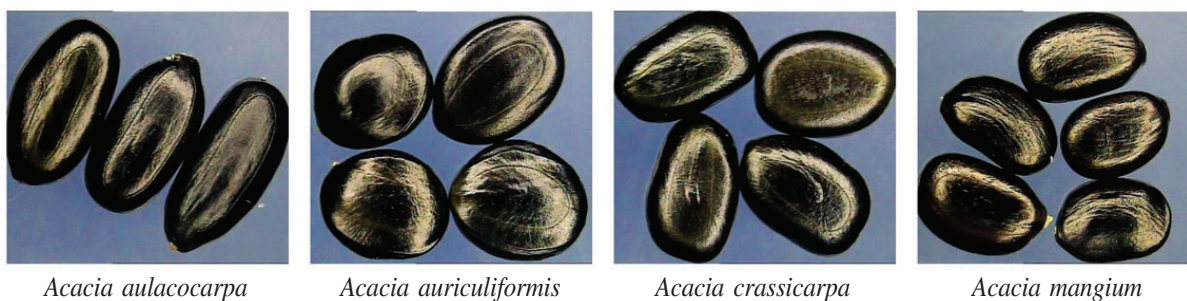


Figure 4. Seeds of four *Acacia* species under field of view of image analyzer (10 x magnification) grown in Kerala, India.

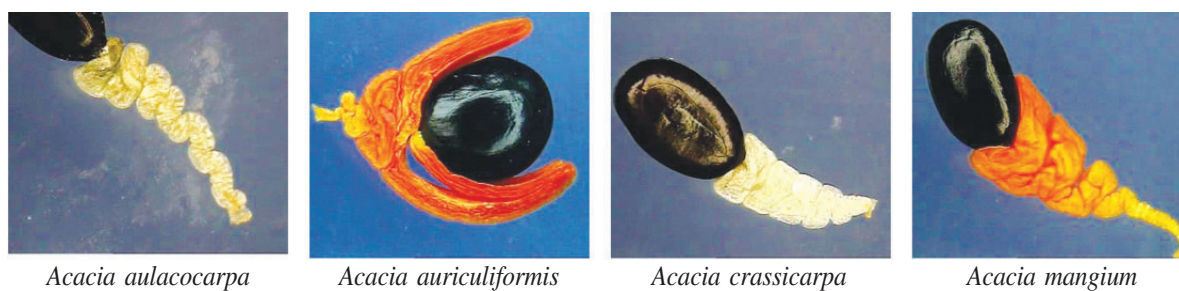


Figure 5. Funicle characteristics of four *Acacia* species grown in Kerala, India.

spaciously arranged); phyllode, broad (~5.4 cm) and looked more like an “entire leaf”, rough textured due to the presence of four nerves on the dorsal side of the phyllode, which can be prominently felt by touch; flower, creamy white in colour; pod, highly coiled; funicle, orange in colour.

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