DFID

Identifying Tropical *Prosopis* Species









A Field Guide

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Identifying Tropical *Prosopis* Species

A Field Guide

NM Pasiecznik[1], PJC Harris[1,2] and SJ Smith[2]

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[1]International Research Department
HDRA
Ryton Organic Gardens
Coventry CV8 3LG
UK

Tel: +44 (0)24 7630 8200
Fax: +44 (0)24 7663 9229
Email: npasiecznik@hdra.org.uk
Website: www.hdra.org.uk

[2]School of Science and the Environment
Coventry University
Priory Street
Coventry CV1 5FB
UK

Tel: + 44 (0)24 7688 8349
Fax: +44 (0)24 7688 8702
Email: p.harris@coventry.ac.uk
Website: www.coventry.ac.uk

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Front cover photographs
top left – mature *P. pallida*, Piura, Peru (G Cruz);
top right – *P. juliflora* leaves (PJC Harris);
bottom left – *P. pallida* leaves and pods (G Cruz);
bottom right – multistemmed *P. juliflora*, Gujarat, India (NM Pasiecznik).

Back cover photographs
top left – *P. pallida* leaves (LN Harsh)
top right – *P. glandulosa* and unripe pods (LN Harsh)
middle left – *P. juliflora* leaves (PJC Harris),
middle right – *P. chilensis* leaves and thorns (HDRA)
bottom left – *P. juliflora* interfoliar gland (PJC Harris)
bottom right – *P. juliflora* pods (PJC Harris)

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Tewari, JC, PJC Harris, LN Harsh, K Cadoret and NM Pasiecznik. 2000. **Managing *Prosopis juliflora* (Vilayati Babul): A Technical Manual**. CAZRI, Jodhpur, India and HDRA, Coventry, UK. 94p. (English and Hindi versions). ISBN 0 905343 27 1.

Cadoret, K, NM Pasiecznik and PJC Harris. 2000. **The Genus *Prosopis*: A Reference Database** (Version 1.0): CD-ROM. HDRA, Coventry, UK. ISBN 0 905343 28 X.

Glossary

Acuminate. Tapering toward the end into a long and sharp point.
Acumen. The point of an acuminate leaf.
Acute. Having a sharp point.
Apex. The tip of a leaf, at the opposite end from the stalk.
Apiculum. A sharp point at the end of the pod.
Ciliate. With regularly arranged hairs projecting from the margin.
Compressed. Flattened.
Elliptic. Broadening at about the centre and narrowing equally towards each end.
Emarginate. Having a shallow notch at the apex.
Falcate. Curved, sickle shaped.
Glabrous. Without hairs.
Interfoliar gland. Gland between the leaflets on the secondary rachis.
Internodal. Between two adjacent nodes.
Interpetiolar gland. Gland located where secondary rachis joins the petiole or primary rachis.
Lanceolate. Long and thin and broadest below the middle, tapering to a sharp point.
Oblong. Longer than it is broad, and having mostly parallel sides.
Obtuse. Having a blunt or rounded end.
Ovate. Egg shaped.
Petiole. The main stalk of a leaf, taken here as the distance from the junction with the stem to the tip of the leaf, i.e. petiole plus primary rachis.
Pinna. (*Pl* pinnae) First division of the leaf. Each single *Prosopis* leaf is divided into pinnae, and each pinna is divided into leaflets.
Pinnate. A leaf composed of more than three leaflets arranged in two rows along a common stalk or secondary rachis.
Pubescent or **Puberulous.** Covered with a down or fine hair.
Raceme. A flower head composed of individually stalked flowers that are arranged along a single main axis.
Secondary rachis. The axis of a pinna in a multi-pinnate leaf.
Stipe. Stalk of pod.
Stipitate. Having a short stalk or stalk like base.
Subacute. Having a fairly sharp point.
Sub-compressed. Almost, but not quite, flattened.
Sub-cylindric. Almost, but not quite, cylindrical.
Subfalcate. Only slightly curved or sickle shaped.
Subterete. Almost cylindrical and rounded in cross section or only slightly, ridged, grooved or angled.
Torulose. With small swellings, beaded.
Undulate. Having wave-like undulations.

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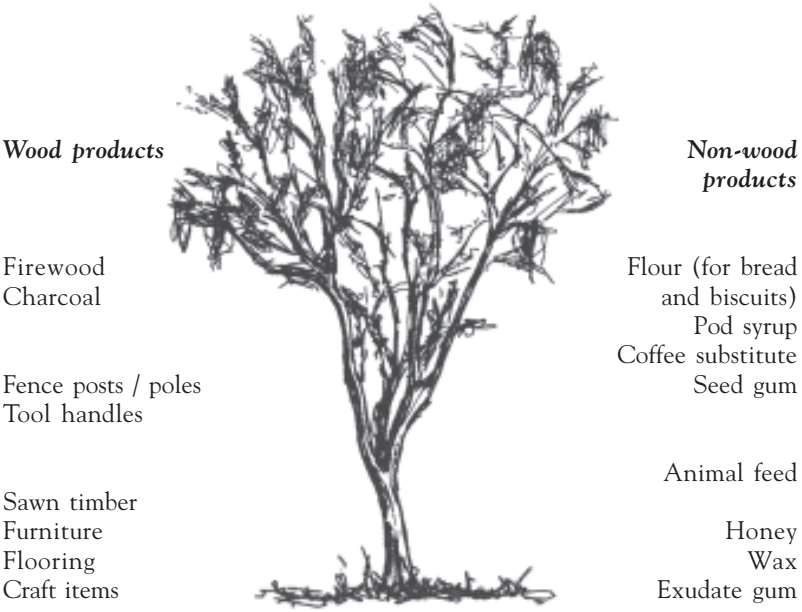


Figure 1. **Prosopis** ***products commercialised in their native ranges and occasionally where introduced.***

Introducing *Prosopis*

The need for a field guide

There are many problems facing foresters, farmers, development workers, researchers, ecologists and politicians when deciding what to do with exotic *Prosopis* in their country. Is it a valuable resource requiring promotion and planting, or an invasive weed worthy only of wholesale eradication? This apparent paradox is only touched upon here, but the debate has certainly become a heated one, with millions spent each year on both planting and pulling up *Prosopis*. However, before any strategy is decided, it is necessary to be absolutely certain which *Prosopis* species is being dealt with in each case.

There are many *Prosopis* species, each with its own characteristics. Where they were introduced, few records and poor identification have led to many populations being incorrectly named. In several regions, errors made at the time of introduction persist today due to continued taxonomic confusion even amongst the experts. This has created countless problems in planning eradication and biological control programmes, carrying out further introduction, selection or genetic improvement, and improving management and utilisation of the trees.

Knowing which species is present is very important, particularly with *Prosopis*, but this is not always easy. If it were so simple, there would be no mis-identification and no need for this field guide. Foresters have mixed up some of the names, and some taxonomists can't agree. Several species look very similar, others may adopt different habits or tree shapes depending on the site, or if they are cut or browsed. Also, leaves from a single tree or species can vary considerably in size. Finally, many species cross with each other creating hybrid populations with intermediate characteristics.

Taxonomists can tell the difference by looking very carefully at the flowers and leaves, and recently scientists have accurately identified species by analysing the DNA. However, while these methods are helpful to the experts in their laboratories, they are not much use to the forester, who needs to be able to identify *Prosopis* trees quickly in the field. This guide aims to do just that, by allowing a comparison of leaves and other useful morphological characters of the eight most frequent tropical species, and a key to differentiating the two most common, and most often confused species, *P. juliflora* and *P. pallida*.

There will always be exceptions, hybrids and peculiar trees that don't seem to 'fit', but this field guide will at least resolve some of the long standing *Prosopis* mis-identifications, where the trees have been introduced across Africa, Asia and Australia. Linked with increased knowledge from their respective native ranges, it is hoped that this will then help to lay the foundations on which future management strategies can be based.

A valuable tree with multiple uses

Prosopis are amongst the most common tree species to be found in the dry tropics. They are native to arid and semi-arid zones of the Americas, Africa and Asia, with several American species widely introduced throughout the world over the last 200 years. In recent decades these 'exotic' *Prosopis* have attracted much attention. They are extensively planted as fast-growing and drought tolerant fuel and fodder trees, but in many countries they have also spread out of control as invasive weeds. However, because they grow wild and in abundance on common lands, they are a 'free' resource, especially important to poor farmers and the landless.

The wood is an excellent fuel, and the use and trade of firewood and charcoal is an important part of the rural economy in many parts of the native range and some countries where introduced. Trees harvested for fuel are coppiced, and resprout vigorously after cutting, leading to the formation of a bushy habit. Straight branches are used for fence posts and poles in construction of shelters and homes. Sawn timber has a pleasant colour and grain, and shrinks little on drying. It is used for making furniture and flooring, notably in the USA and Argentina. The wood is also used for tool handles and other household items.

Prosopis produce abundant quantities of often sweet fruit pods, readily consumed by all manner of livestock and wild animals. This can result in widespread dispersal of seeds. Mature trees produce 20-100 kg of nutritious pods every year. These are a valuable fodder and can be either browsed or collected and fed whole, or processed as a feed for all livestock from chickens to camels. The fruit of several native species is made into various foods and drinks, some 'rustic' foods and delicacies, and these are important in local nutrition and trade. Industrial processing of the pods can produce seed gums for use as a thickening agent in food preparation, dietary fibre and ethanol as a biofuel.

Honey produced from the trees, which have long and abundant flowering, is of the highest quality. The exudate gum produced from wounds in the bark is comparable to commercial gum arabic (from *Acacia senegal*) and can be found in large quantities. The leaves of most introduced species are rarely browsed by livestock, an advantage in establishment, with only native Indian, African and a few American species valued for leaf fodder. Leaves are occasionally gathered and used as a mulch or compost on agricultural fields, with some noted fungicidal and insecticidal qualities. The bark is a source of tannins, dyes and fibres, and various plant parts are used in the preparation of medicines, mostly for eye, skin and stomach problems.

Prosopis can survive on inhospitable sites where little else can grow, tolerating some of the hottest temperatures ever recorded, and on poor, even very saline or alkaline soils. Because they are nitrogen-fixing trees, *Prosopis* have also been noted to improve the fertility and physical characters of soils in which they grow. They are deep-rooted, allowing trees to reach water tables and grow and fruit even in the driest of years providing an invaluable buffer during droughts. Many species appear to require access to a water table to survive, and some people believe they are responsible for the depletion of ground water reserves.

An invasive weed, an unwelcome guest

There are reports, from almost every country where they are introduced, of exotic *Prosopis* invading agricultural and pasture land, nature reserves, waterways, roadsides and wasteland. It is ironic that the positive characteristics that lead to their widespread introduction are the same ones that have also enabled them to escape from cultivation and rapidly colonise large areas. The stout thorns of some species and the tendency to become bushy in form when cut or browsed can lead to the formation of impenetrable thickets.

Seed can be spread by water, but animals eating the pods are the main means of spread. Seeds survive passage through the guts of most animals and the hard seed coat is softened in the process, aiding germination. This is seen especially with cattle, which will spread viable seed widely, whereas goats and pigs kill many of the seeds eaten. On fertile sites, *Prosopis* seedlings may be out-competed by grasses and other plants or removed during cultivation. However, on degraded, bare, overgrazed land of low fertility, *Prosopis* has a competitive advantage, and will quickly spread. Dense, impenetrable thickets are often formed, severely reducing the growth and availability of palatable forage plants.

Both man and animals dislike the thorns and these make *Prosopis* a particularly undesirable weed. Thorns of common species are in pairs, commonly 1-5 cm long and with a thick base, though some species have thorns over 20 cm long while others are thornless. A broken branch on the ground will always have thorns pointing upwards, which are able to pierce car tyres and all but the stoutest of footwear, and are a danger to the feet of all animals. *Prosopis* pollen has also been reported to cause allergic reactions.

Some *Prosopis* species in the Americas have become serious weeds in their native ranges. Millions of hectares of land have been invaded, especially in the Chaco region of Argentina and Paraguay (notably *P. ruscifolia*), and in the south-western USA and Mexico (*P. glandulosa* and *P. velutina*), Native shrub species are also weeds in the Americas (numerous) and the Middle East (*P. farcta*). Where introduced into sub-tropical zones, there are major invasions in dry regions of South Africa and Australia (mainly *P. glandulosa* and/or *P. velutina*), where they are declared a noxious weed. In tropical regions, *P. juliflora* and/or *P. pallida* have also become weeds in the Caribbean, the Sahel (notably Sudan), East and southern Africa, India, Pakistan, Sri Lanka and several Atlantic and Pacific islands.

Eradication programmes have been attempted in many countries, using manual, mechanical, chemical and biological techniques, but with only limited success to date. However, in other countries, *Prosopis* continues to be an important arid zone plantation species, and the principal source of firewood and fodder in dry rural areas of India, Pakistan, Mauritania, Cape Verde, Haiti, and important in many others. There is an emerging consensus that weedy stands are best controlled by conversion to productive agroforestry systems - improved management and utilisation, or control through exploitation. Still, the identity of the invading species in many of these countries is not always certain, hampering development.

The spread of *Prosopis*

The first records of *Prosopis* introduction are those to West Africa and Pacific islands in or before the 1820s, to India and Pakistan in the 1870s, and to Australia and South Africa before 1900. There have been, however, many other unrecorded introductions before and since, evident by the fact that *Prosopis* is now found in dry regions of most African and Asian countries. For a full history of *Prosopis* introductions, see Pasiecznik et al (2001).



***Figure 2. Approximate native and present distribution of the genus* Prosopis**
Black - approximate natural distribution (at 1500)
Grey – Approximate spread of introduced* Prosopis *species by the year 2000
N.B The figure doesn't show the reduction in the range of many native species due to deforestation in some areas such as North Africa and South America.

In the dry tropics, of all introduced *Prosopis*, only *P. juliflora* and *P. pallida* perform well, consistently and significantly better than all other species. Both are now naturalised wherever they have been introduced and are by far the most common *Prosopis* species in tropical desert regions. Trials show, however, that *P. pallida* is generally faster growing, more erect in habit and less thorny than *P. juliflora*.

In sub-tropical and Mediterranean zones world-wide, several frost tolerant species, notably *P. glandulosa* and *P. velutina* from North America, and *P. alba* and *P. chilensis* from South America have exhibited good growth and survival, though only the North American species appear to have escaped from cultivation. Several other species have shown promise, and other potentially useful species remain untested.

In recent decades, of the many species of *Prosopis* that have been introduced in performance trials around the world, some are notable by their very poor survival and growth. It appears that *P. africana*, *P. cineraria*, *P. pubescens* and *P. tamarugo* are generally not suitable for planting outside of their respective native ranges.

Taxonomy of the genus *Prosopis*

Prosopis is a genus of trees and shrubs in the legume family (Leguminosae, sub-family Mimosoideae), native to arid and semi-arid regions of the Americas, Africa and Asia. They are characterised by feathery foliage like acacias or mimosas and tiny yellow (or white) flowers gathered into spikes (or balls). They are mostly thorny and have thick pods (from long and yellow to short and black), which never split naturally, either on the tree or once fallen.

The last complete taxonomy of the genus by Burkart (1976) described 44 species and numerous varieties, divided into five distinct sections (see below). Within each section, it appears that most species can interbreed, leading to the creation of hybrid populations, more and more of which continue to be described as new species, varieties or forms. The vast majority of *Prosopis* species (40 out of 44) and varieties described are American, including 30 from section Algarobia, which has most of the common and confused species.

Species of the genus *Prosopis* Linnaeus emend. Burkart (from Burkart 1976), with trees (i.e. species which can attain a height of at least 7 m) marked in bold, most of which are of economic importance.

I. Section PROSOPIS
- ***P. cineraria* (L.) Druce**
- *P. farcta* (Solander ex Russell) MacBride
- *P. koelziana* Burkart

II. Section ANONYCHIUM
- ***P. africana* (Guill., Perr. & Rich.) Taubert**

III. Section STROMBOCARPA
- *P. strombulifera* (Lam.) Bentham
- *P. reptans* Bentham
- *P. abbreviata* Bentham
- *P. torquata* (Cavanilles ex Lagasca) DC.
- ***P. pubescens* Bentham**
- *P. palmeri* S.Watson
- *P. burkartii* Muñoz
- *P. ferox* Grisebach
- ***P. tamarugo* F. Philippi**

IV. Section MONILICARPA
- *P. argentina* Burkart

V. Section ALGAROBIA
- *P. sericantha* Gillies ex Hooker & Arnott
- ***P. kuntzei* Harms**
- ***P. ruscifolia* Grisebach**
- ***P. fiebrigii* Harms**
- ***P. vinalillo* Stuckert**
- ***P. hassleri* Harms**
- *P. denudans* Bentham
- *P. ruizleali* Burkart
- *P. castellanosii* Burkart
- *P. calingastana* Burkart
- *P. humilis* Gillies ex Hooker & Arnott
- *P. rojasiana* Burkart
- *P. rubriflora* E.Hassler
- *P. campestris* Grisebach
- ***P. pallida* (H. & B. ex Willd.) H.B.K.**
- ***P. affinis* Sprengel**
- ***P. articulata* S.Watson**
- *P. elata* (Burkart) Burkart
- *P. tamaulipana* Burkart
- ***P. chilensis* (Molina) Stuntz emend. Burkart**
- ***P. juliflora* (Sw) DC.**
- ***P. nigra* (Grisebach) Hieronymus**
- ***P. caldenia* Burkart**
- ***P. laevigata* (H. & B. ex Willd.) M.C.Johnston**
- ***P. flexuosa* DC.**
- ***P. glandulosa* Torrey**
- *P. alpataco* R.A.Philippi
- ***P. alba* Grisebach**
- ***P. velutina* Wooton**
- *P. pugionata* Burkart

The problem of identifying *Prosopis* in the tropics

Hybridisation and genetic variation. Prosopis species are mostly self incompatible, meaning they must cross with another tree to produce fruit. This is a strategy to increase genetic variability and adaptability to a wide range of sites. A single *Prosopis* species may exhibit a tree or a bush form, and be thorny or thornless, with larger or smaller leaves, straight or curved pods depending on inherent genetic variability or just where it is growing. The wide variation is compounded by the fact that many species can hybridise.

Changing taxonomical 'ranks' and names. Is a distinct population of trees a species, subspecies, variety, form or just a landrace? Doubts about this create numerous problems which also continue to trouble *Prosopis* taxonomists. There are two main schools of thought. The predominant one to date has been 'rank-raising', where populations may be called species even if differences are slight, leading to an ever-increasing number of species and varieties being described. The older, 'rank-reducing' concept referred to the same populations as only varieties, forms or races of a few, over-arching species.

Don't always trust the given name or old books. Some older, now rejected botanical names or synonyms still continue to be used. While they were likely to be corrected in the native range, where introduced, people tended to continue to use confusing synonyms.

Some common mis-identifications

1 *P. glandulosa* / *P. velutina* / *P. juliflora*. The North American *P. glandulosa* and *P. velutina* used to be called *P. juliflora* var. *glandulosa* and *P. juliflora* var. *velutina*. When they were introduced, the variety name may have been omitted and the seed sown as '*P. juliflora*'. Without correction, this error persisted in many countries, notable particularly in areas with winter frosts where *P. juliflora* is unlikely to survive. Also, hybrid stands of *P. glandulosa* and *P. velutina* have been identified in the USA, Australia and South Africa.

2 *P. chilensis* / *P. juliflora*. Early taxonomists gave the name *P. chilensis* to several other *Prosopis* species in the native Americas including *P. glandulosa* and *P. pallida* as well as *P. juliflora*, but which has since been corrected. Throughout Africa, however, the name *P. chilensis* was also given to early introductions of several *Prosopis* species, and this misidentification persists. The problem continues, notably in Sudan and the Sahel, exacerbated by botanical and field guides merely repeating the original name in use, and further distribution of *P. juliflora* seed which is still incorrectly called *P. chilensis*.

3 *P. pallida* / *P. juliflora*. Many foresters and taxonomists still appear uncertain of the morphological distinction between these two species, seen with the continued misidentification of large areas of introduced *Prosopis*. Naturalised stands of *P. pallida* in Brazil, Cape Verde, Senegal, Mauritania and possibly elsewhere are still incorrectly classified as *P. juliflora*. However, there are parts of the native range where the exact identity of the species (or hybrids) present is also in question and research is in progress.

Identifying *Prosopis*

Using this guide

Identifying Prosopis species - first steps

It is the objective of this field guide to aid in the identification of tropical *Prosopis*, in particular *P. juliflora* and *P. pallida*, by comparing leaves, thorns, pods and tree form. For distinguishing *Prosopis* from other species of *Acacia, Leucaena, Mimosa, Parkinsonia* etc, refer first to general forestry or botanical fields guides. If there is an accepted botanical name given for the *Prosopis* in the area, compare the naming authority found after the species name with the lists of common synonyms given in the species descriptions. Also, check the countries where each species have been noted to occur, but this can only give an indication of the species present due to changing names and previous mis-identification.

Simple comparisons of leaves and other characters

Leaves picked from any *Prosopis* tree can be held against the life-size examples of the leaves of the eight most common tropical species found in this field guide. While this provides a guide, the wide variation in leaf size requires further comparisons to confirm such simple identification. Tree form can also be compared to the examples in this guide as a further indication, as can a comparison of the simple descriptions given.

Taking and analysing plant measurements

It is recommended that leaf samples be taken from the population to be identified, also pods, flowers etc., and measured, for comparing with the comparative morphology tables and / or the species keys to confirm which species is present. This requires that some plant material must be collected and stored in the right way.

Collecting material in the field

1. Ensure that any tree sampled is representative of the surrounding population; preferably taking from several trees, each separated by at least 50 m.
2. Take only healthy, fully mature and open leaves; preferably from halfway up the crown. Never pick juvenile leaves from seedlings, young trees or coppice regrowth, as these have characteristics different from adult leaves from the same tree.
3. Immediately press the leaves flat between two pieces of paper, marking date, location and any details regarding the tree and its environment. Preserve samples if possible, with full collection details.
4. If available, also collect a few pods, flowers and thorns. Note tree form, possibly making a simple sketch.

Measuring and analysing

For each character (e.g. number of leaflets, pod length etc.), take the average value from as many different measurements as possible from samples of a single tree.

***Separating species from different sections of* Prosopis**

The sole native African species *P. africana* (section II, Anonychium) is completely thornless, with broad, flat black pods and large leaves and leaflets, while the native Asian species *P. cineraria* and *P. farcta* (section I, Prosopis) have short prickles like roses, short round brown/black pods and very small leaves and leaflets. In contrast, most American species (sections III-V), especially those that have been widely introduced, have straight, paired thorns, long yellow pods, but a range of leaf and leaflet sizes. Species in section III (Strombocarpa), though very rarely introduced, can be differentiated from those in section V (Algarobia) by having very thin and sometimes curved spines, short spiralled pods and generally smaller leaves and leaflets.

Identifying sub-tropical and truly tropical species

Having eliminated species of other sections, we are left with section Algarobia, containing the bulk of the economically important and frequently mis-identified species. While it may be possible to tentatively identify species from comparison with the examples of life-size leaves, this can be checked by taking measurements and looking at the data in the comparative morphology tables. Leaf measurements will generally provide the best basis for differentiating species, but this should be confirmed by comparing measurements of the flowers, pods and the trees in general.

Differentiating P. juliflora and P. pallida

This is the principal and final problem addressed by this field guide, in an attempt to confirm the presence of *P. pallida* in many regions where only *P. juliflora* is recorded. A page of comparative descriptions is provided which highlight the main differences between the two species. While *P. juliflora* leaves are generally larger, there is so much variation that simple keys are also given that allow for accurate identification. The first key requires the counting of interfoliar glands, only possible with a x10 hand lens. If a lens is unavailable, use leaf measurements alone with the second key to ensure correct identity.

Identity of Prosopis species uncertain – re-assess or take further samples

Even after using all the descriptions and keys in this field guide, it may not be possible to correctly identify the species present in all cases. This may be due to one of several reasons:

- It is not a *Prosopis* after all, but belongs to another genus. Refer to a general tree identification book.
- It is one of the minor / sub-tropical *Prosopis* species not detailed in this field guide. Refer to the keys of Burkart (1976) or Burkart and Simpson (1977).
- It is a hybrid, possibly with charactersitics intermediate between its parents. Take further samples from other trees in the area and try to assess the parent species.
- Juvenile or unrepresentative leaves were used, giving uncertain results. Take further samples from other trees and re-assess.

If still in doubt, particularly with a *P. juliflora* / *P. pallida* identification problem, a sample of leaves and seeds, illustrations of tree habit, thorns and pods, with collection details, can be sent to the authors.

Taxonomic terms

It is not the aim of this field guide to provide a comprehensive list of taxonomical terms, but the following examples will allow the user to compare the samples taken with the information provided in the tables and keys. For more detailed descriptions of specific terms, please refer to the glossary.

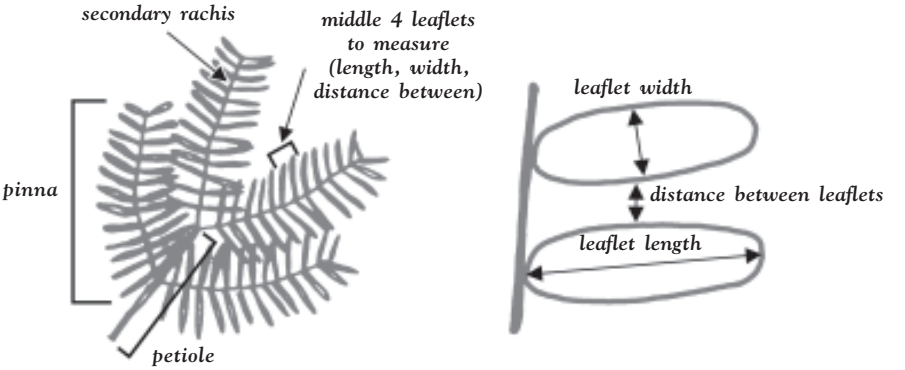


Figure 3. A representative* Prosopis *leaf, showing correct botanical names and places to measure for leaf parts.

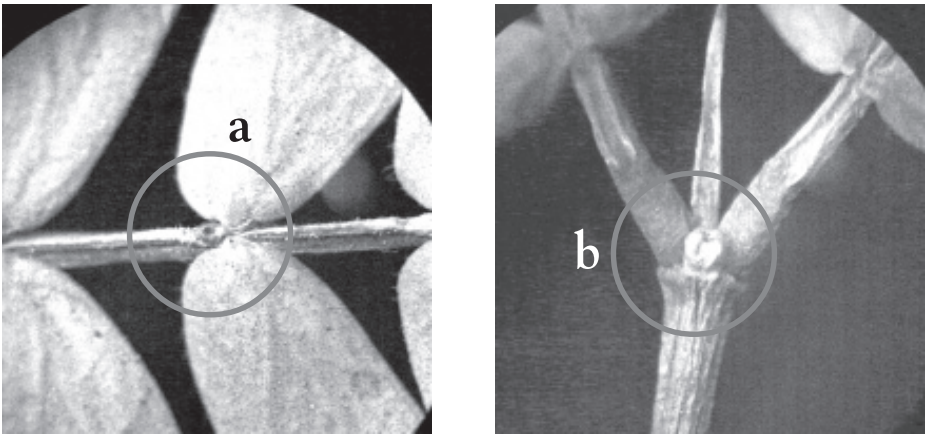
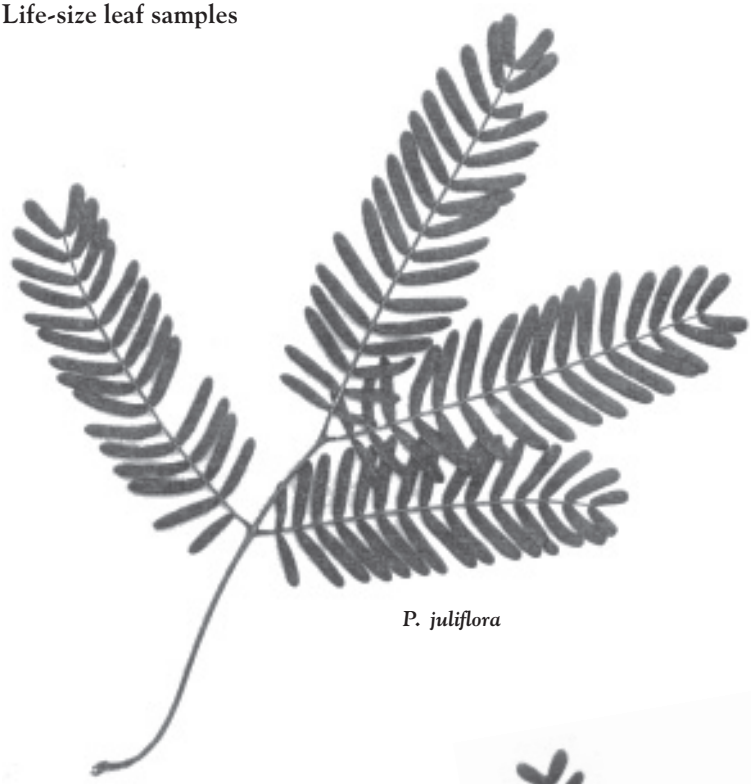
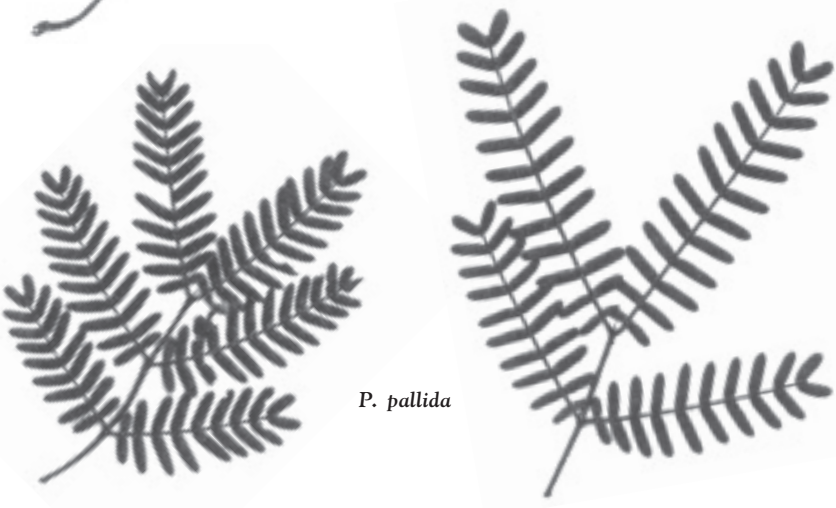


Figure 4. Enlarged view of a) an interfoliar gland and b) an interpetiolar gland on a* P. juliflora *leaf (x 20)

Life-size leaf samples



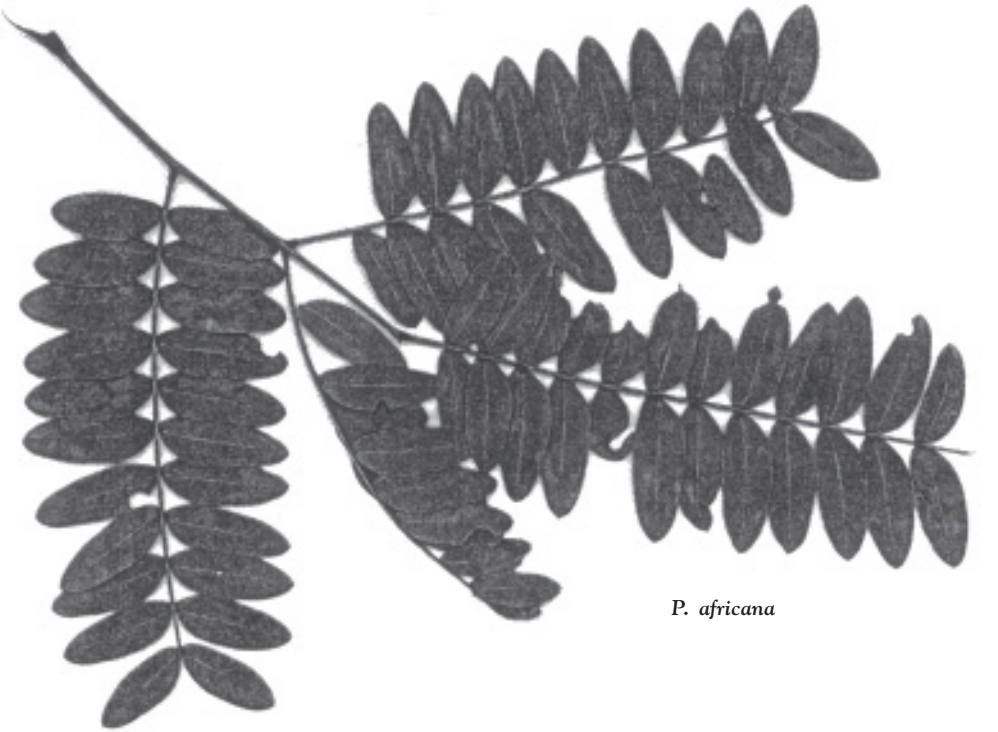
P. juliflora



P. pallida

Figure 5. Life sized leaf samples

Life-size leaf samples



P. africana



P. cineraria



P. farcta

Figure 5 continued

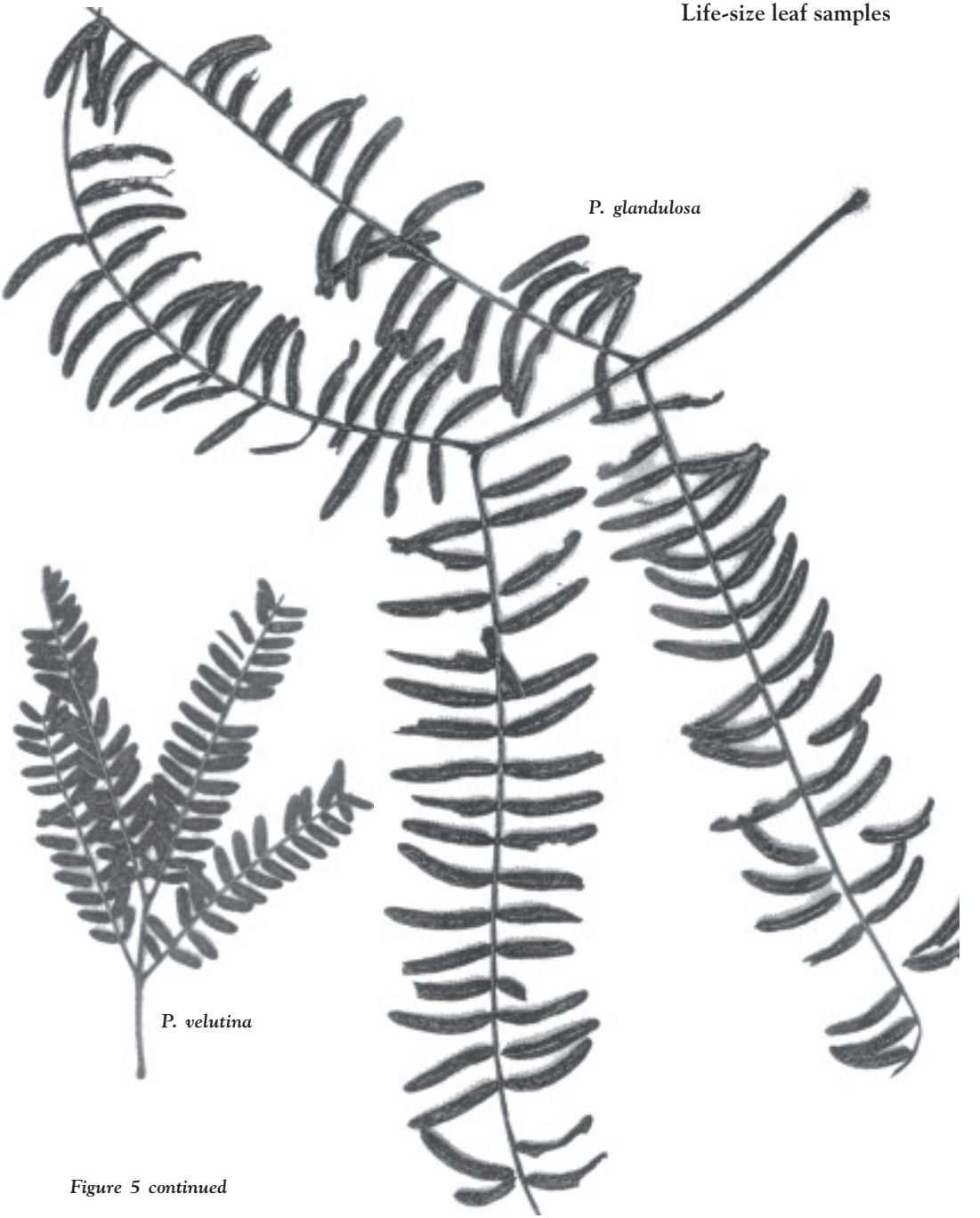


Figure 5 continued

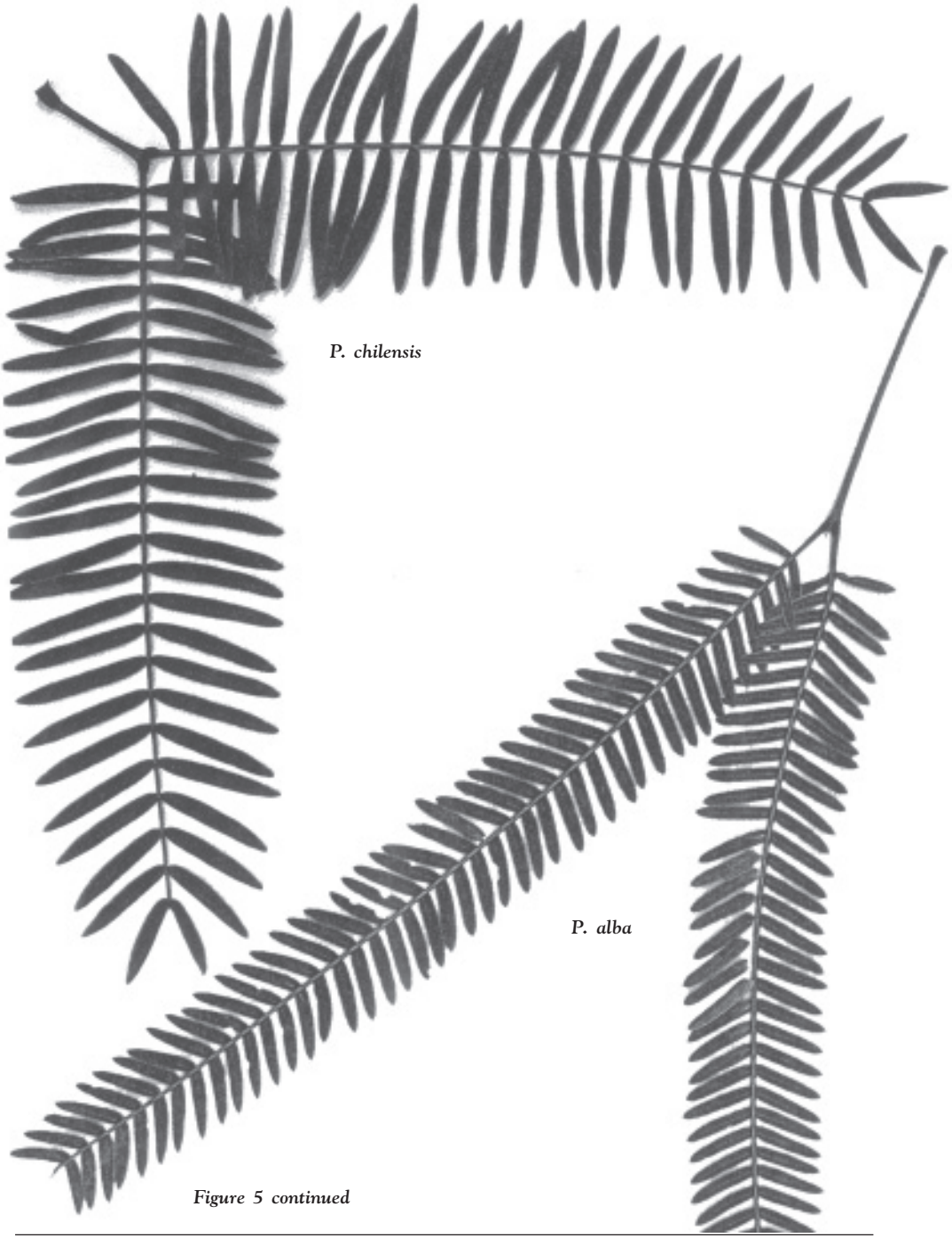


Figure 5 continued

Typical tree forms

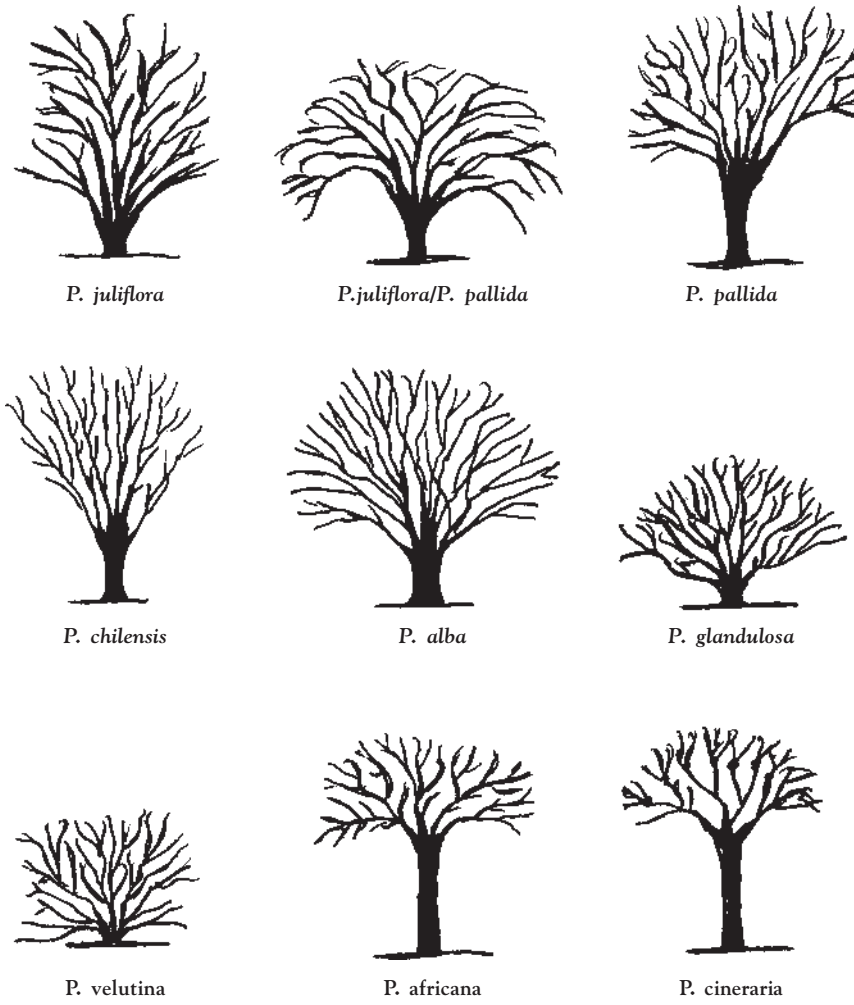


Figure 6. Typical tree form of* Prosopis *species during early establishment (2-12 years). Adapted from Lima* et al *(1996)

While tree form is very variable, depending on a host of environmental and management factors, notable differences are observed between species on the same site, protected from browsing and cutting (see above).

Table 1. Tree characteristics. *Adapted from Burkart (1976)*

	Height (m)	Trunk	Branches	Thorn type & length	Foliage	Flower/ raceme length (cm)
P. juliflora	3-12	-	spreading, sometimes shrubby	solitary or paired 0.5-5.0 cm	glabrous, somewhat pubescent	7-15
P. pallida	8-20	to 60 cm girth	-	thornless or thorns < 4.0 cm	pubescent or at least ciliate	8-15
P. glandulosa	3-9	-	-	mostly solitary, 1-4.5 cm	glabrous	5-14
P. velutina	to 15	short, to 1 m girth	drooping, rounded crown	1-2 cm	pubescent, more or less on all parts	5-15
P. alba	5-15	short, to 1m girth	rounded crown	thornless or scarce, 2-4 cm	glabrous	7-11
P. chilensis	3-10	short	rounded crown	conical, to 6 cm	glabrous, rarely ciliate	7-12
P. africana	4-20	-	-	entirely thornless	glabrous or finely pubescent	5-9
P. cineraria	to 6.5	-	-	internodal prickles (as in *Rosa* spp.)	glabrous or puberulous	5-13

Table 2. Leaf characteristics. *Adapted from Burkart (1976)*

	Pairs of pinnae	Pinnae length (cm)	Leaflet pairs per pinna	Leaflet length & width (mm)	Distance apart	Leaflet shape
P. juliflora	1 to 3, rarely 4	3-11	6-29	6-23 x 1.6-5.5	adjacent, or leaflet width apart	emarginated or obtuse
P. pallida	2 to 4, rarely 1	1.5-6	6-15	2.5-8.3 x1.4-4.0	adjacent but not touching, or a little distant	oblong-elliptic to ovate
P. glandulosa	1 or 2	6-17	6-17	20-63 x 1.5-4.5	distant, 7-18 mm apart	linear or oblong
P. velutina	1 or 2, sometimes 3	2-9	12-30	4-13 x 2.0-4.0	adjacent	obtuse
P. alba	1 to 3	6-14	25-50	5-17 x 1.0-2.0	adjacent	linear, acute or subacute
P. chilensis	1 or 2, sometimes 3	8-24.5	10-29	11-54 x 1.1-3.0	distant, 4-12 mm apart	long-linear
P. africana	1 to 4	6-15	4-13	13-35 x 4.0-15.0	-	ovate-lanceolate
P. cineraria	1 to 3	2-7	7-14	4-15 x 2.0-4.5	-	ovate

Table 3. Pod characteristics. *Adapted from Burkart (1976)*

	Colour	Pod length & width (cm)	Seeds per pod	Pod shape	Margins, cross-section	Tip shape
P. juliflora	straw-yellow to brown	8-29 x 0.9-1.7	to 25	straight or curved	parallel, compressed	stipitate and acuminate
P. pallida	straw-yellow	10-25 x 1.0-1.5	to 30	straight or curved	parallel, sub-compressed	long or short stipitate, acuminate
P. glandulosa	straw-yellow or tinged violet	8-20 x 0.7-1.3	5-18	straight, rarely subfalcate	compressed to subterete	short stipe and strong acumen
P. velutina	yellow, sometimes reddish	8-16 x 0.6-1.0	10-17	straight or falcate	shallowly undulate, flattened	stipe 2-10 mm, beak 2-11mm
P. alba	straw-yellow	12-25 x 1.1-2.0	12-30	falcate to ring-shaped	parallel, compressed	stipitate and acuminate
P. chilensis	straw-yellow	12-18 x 1.0-1.8	20-32	nearly straight, falcate or subfalcate	parallel, compressed	stipitate and acuminate
P. africana	brown to blackish, shiny	10-20 x 1.5-3.3	many	-	subterete, ovate-compressed	-
P. cineraria	-	8-19 x 0.4-0.7	-	elongate, slender	sub-cylindric-torulose	stipe 8-20 mm long

Identifying *P. juliflora* and *P. pallida*

Tree form varies from erect with few branches to distinctly shrubby and multi-stemmed. Erect forms are more common in Ecuador and Peru, and also in inland sites throughout the native range. *P. pallida* appears somewhat more erect than *P. juliflora* but significant site effects blur any distinction. Variations in height and branch form are not consistent.

Bark of *P. juliflora* is rough and fissured while that of *P. pallida* is noted as finely fissured, and the inner bark of *P. juliflora* becomes yellow after exposure and is slightly bitter to taste, while that of *P. pallida* is orange-brown and bitter.

Thorns exhibit large variations in their size and presence. The thornless *P. juliflora* var. *inermis* and *P. pallida* forma *pallida* occur only in Peru and Ecuador, overlapping in range with other thorny forms and varieties, including *P. juliflora* var. *horrida* with the longest thorns of all. In the common Caribbean and Central American *P. juliflora* var. *juliflora*, thornlessness is rare and longer, stouter thorns are common, particularly in coastal areas.

Leaves of *P. pallida* tend to be smaller than those of *P. juliflora*, seen clearly when compared with their flower spikes or racemes (which are approximately the same length in both species). *P. juliflora* leaves are often the same length as the racemes, but in *P. pallida* the leaves are generally half the length of the racemes.

Leaflet length of *P. pallida* is less than 11 mm, typically 5-8 mm, while *P. juliflora* leaflets are generally longer. There is also noted variation within *P. juliflora*, with the largest leaflets from Central American material (> 15 mm long), 10-15 mm long in *P. juliflora* from Colombia, Venezuela and the Caribbean, and *P. juliflora* from Peru and Ecuador intermediate between *P. pallida* and Colombian *P. juliflora*. Leaflet length is a good indicator but the wide variation observed in the field requires the use of other characters.

Space between leaflets is greater in *P. juliflora*, which tend to be spaced apart, up to a little more than their own width, while those of *P. pallida* are adjacent.

Pubescence is variable, but foliage of *P. pallida* tends to be more pubescent than that of the commonly glabrous *P. juliflora*, with intermediate pubescence seen in *P. juliflora* in Peru and Ecuador and in introduced material. It is also known to vary in different environments.

Glands are present at the junction of the pinnae in both *P. juliflora* and *P. pallida*, but *P. juliflora* also has many more glands at the junction of the leaflets, but with some variation.

Pods are similar in both species, but in northern Peru, those of *P. pallida* tend to have straight edges (parallel margins), while *P. juliflora* pods often do not. *P. pallida* pods usually have a curved apiculum about 5-15 mm long, whereas in *P. juliflora* such an apiculation is shorter or absent. It is also thought that *P. pallida* pods are generally sweeter than *P. juliflora*.

Keys to differentiating *P. juliflora* and *P. pallida*

These keys were developed following the positive identification of certain trees as *P. juliflora* or *P. pallida* using DNA (RAPDs) and chromosome numbers (ploidy). Statistical analysis of leaves from these trees could then be used to group almost all the other leaf samples taken as belonging to one species or the other, which was confirmed by further molecular analysis. Data from all the samples was then used to derive the keys given below, with the aim of using as few characters as possible that are easy to measure in the field. There will, however, still be exceptions, including material from Ecuador and neighbouring regions that has intermediate characters, possible hybrids between *P. juliflora* and *P. pallida* or hybrids including other species.

The first key uses number of interfoliar glands as the first principal character for differentiating the two species. This, however, requires the use of a x10 hand lens or microscope, which may not be available. Also, *attention!*, these glands are not present in juvenile material. Number of leaflet pairs, leaflet length and petiole length (taken here as the distance form the junction with the stem to the tip of the leaf; i.e. petiole plus primary rachis), then complete the key, allowing for accurate identification. The second key uses only characters that can be measured easily in the field, possibly using only the rulers and grid squares in the back of this guide; leaflet pairs per pinna, leaflet length and petiole length. Such a key, however, is only as good as the samples on which it is based, and it can be expected to be improved with the on-going analysis of many additional samples.

Key 1 - Lens key (requiring use of x10 hand lens)

1a Interfoliar glands per pinna < 2	*P. pallida*
1b Interfoliar glands per pinna > 6	*P. juliflora*
1c Interfoliar glands per pinna 2 - 6	2
2a Leaflet pairs per pinna ≥ 15	*P. juliflora*
2b Leaflet pairs per pinna < 15	3
3a Leaflet length ≤ 9.6 mm	*P. pallida*
3b Leaflet length > 9.6 mm	4
4a Petiole length ≤ 50 mm	*P. juliflora*
4b Petiole length > 50 mm	*P. pallida*

Key 2 - Non lens key

1a Leaflet pairs per pinna ≥ 15	*P. juliflora*
1b Leaflet pairs per pinna < 15	2
2a Leaflet length ≤ 9.6 mm	*P. pallida*
2b Leaflet length > 9.6 mm	3
3a Petiole length ≤ 50 mm	*P. juliflora*
3b Petiole length > 50 mm	*P. pallida*

***Figure 7. Keys to differentiating* P. juliflora *and* P. pallida**

Species descriptions

***Prosopis juliflora* (Sw.) DC.**
Synonyms: Acacia juliflora (Sw.) Willd., *Algarobia juliflora* (Sw.) Benth. ex Heyne, *Mimosa juliflora* Sw., *Neltuma juliflora* (Sw.) Rafinesque, *Prosopis vidaliana* A. Naves, *Prosopis cumanensis* (H.&B. ex Willd.) H.B.K., *Prosopis dominguensis* DC., *Prosopis dulcis* var. *dominguensis* (DC.) Benth.

Common names: Mesquite, mexican thorn, cashaw (English); algarrobo, mezquite, trupillo, espino real, cuji yaque (Spanish); bayahonde (French Caribbean), vilayati babul (Hindi, Punjabi).

Importance: It is probably the most widespread and infamous species of *Prosopis*, being both an invasive weed and a major source of fuel and fodder. In hot, arid regions where little else will grow, *P. juliflora* is highly valued, providing 70-90% of the fuelwood needs in parts of Central America, the Sahel and India, and its pods are an important fodder.

Distribution: P. juliflora is native to Central America, the Caribbean and northern South America, occupying an intermediate region between North and South American 'centres', where most species are concentrated. The limits of the range are, however, uncertain, and may change with new classifications at either extreme. *P. juliflora* in Mexico overlaps with *P. glandulosa* and *P. laevigata*, while in Colombia, Ecuador and Peru it overlaps with *P. pallida*. Molecular studies are needed to resolve the inter-relationships of these populations. It has become naturalised in most dry, frost-free regions of Africa, Asia and Australasia.

Habitat: Native Central American and Caribbean populations are generally coastal, with some extensions inland along rivers or dry valleys, and are sometimes found at higher elevations. It is often abundant, in thickets on sand dunes or coastal flats, up to 200 m altitude. Above this, it becomes rare dry thorn scrub, but occasionally weedy above 600 m. Where introduced, it occupies a wide range of sites including highly saline / alkaline soils.

General description: P. juliflora is generally thorny, often branching close to the ground, with a shrubby appearance, spreading branches and a wide, flat-topped crown.

Variation: This species probably has the largest genetic variation of all *Prosopis*, if all present populations continue to be described as *P. juliflora*. Coastal forms are generally very thorny and spreading in habit, unsuitable for plantations, but unfortunately, may have been the source for much of the material introduced world-wide. There appears to be several races, with the Central American *P. juliflora* different from that in the Caribbean, Colombian and Venezuela, but also wide variation within. Also, in Ecuador and Peru, *P. juliflora* var. *inermis* (thornless), *P. juliflora* var. *horrida* (very thorny) and a *P. juliflora* X *P. pallida* hybrid have been described. A detailed and systematic study is urgently required.

Prosopis pallida (H. & B. ex Willd.) H.B.K.

Synonyms: Acacia pallida H. & B. ex Willd., *Mimosa pallida* (Willd.) Poiret, *Prosopis limensis* Bentham.

Common names: Algarrobo (Spanish); huarango, guarango, thacco, taco (Quechua - Peru); kiawe (Hawaii), algarobeira (Portuguese), caroubier (French Pacific islands).

Importance: Common names in native Peru translate as 'the tree' or ' the one', and recorded exploitation of *P. pallida* dates back 4500 years. While use as a timber (beams, sleepers) has decreased, it is still a major source of firewood and charcoal, and pods are browsed or gathered, stored and traded as a valuable dry-season livestock fodder. Very sweet pods are also made into flour for cakes and bread, and a thick, molasses-like syrup in Peru. Peru is the origin of the accessions that have shown the fastest growth and most erect form in tropical arid zone field trials. *P. pallida* has been introduced for fuel and cattle fodder, but has also become a noxious weed, especially in Brazil, Australia and South Africa. In its native range, deforestation threatens the as yet little studied genetic base.

Distribution: Native from southern Peru, to Ecuador and southern Colombia. The widespread forests of recorded history have, however, largely disappeared, and remaining pockets of ancient woodland (some with trees over 1000 years old) are still being cut for charcoal. Where introduced, it has often been confused with *P. juliflora*, notably in north east Brazil, Cape Verde, and parts of Senegal and Mauritania.

Habitat: It is a species mostly of the arid, coastal belt in Peru and Ecuador, including large inland areas of low elevation in the north. Rainfall is very low but there is permanent groundwater from the Andes, coastal fogs and occasional high rainfall ('El niño') years that aid establishment. It extends up river valleys into dry, isolated, montane regions, and shares similar habitat preferences and floral and faunal associations with *P. juliflora*.

General description: Old *P. pallida* trees may be thorny or thornless, young trees often erect, with one or two clear trunks or multi-stemmed, while older trees develop a broad crown and pendulous branches that can touch the ground.

Variation: There is considerable variation in *P. pallida*, which has been very little studied in terms of production and silviculture. Very thorny and completely thornless populations are noted as distinct forma *pallida* and forma *armata*, while other different populations have also been identified in north Peru and Ecuador as different forms of *P. pallida* or different varieties of *P. juliflora*, or hybrids. There is also wide variation in terms of tree habit, with erect trees with few branches, to spreading forms crawling along the ground. Pod quality is also highly variable. Some trees yielding pods with 50% sugar, erect form and thornlessness have recently been selected and cloned. Further detailed study is urgently required.

Prosopis glandulosa Torrey

Synonyms: Prosopis juliflora var. *glandulosa* (Torrey) Cockerell, *Prosopis juliflora* var. *torreyana* (Benson), *Prosopis juliflora* var. *constricta* Sargent.

Common names: Honey mesquite (English), mezquite (Spanish).

Importance: This is the most widespread North American *Prosopis*. Native to the USA and Mexico, *P. glandulosa* was a valuable source of food, fodder, fuel and timber to Amerindians and early colonists, while today it is only occasionally exploited for charcoal, hardwood timber and forage. It is, however, much better known where native or naturalised, as an aggressive invader of pasture land, and the brunt of decades of failed attempts at eradication, notably in Texas. It is not recommended for further introduction.

Distribution: P. glandulosa has the widest range of *Prosopis* species native to North America, with var. *glandulosa* found in Texas and north east Mexico, and var. *torreyana* in the south west USA, Baja and Sonora. The varieties overlap in eastern Texas and western Chihuahua. It has been widely introduced in field trials around the world, and while not well adapted to tropical regions, *P. glandulosa* may have become naturalised in parts of North and Sahelian Africa, the Middle East and South Asia. It has invaded large parts of Australia and Southern Africa.

Habitat: P. glandulosa is found on a variety of soils, but is particularly common along valleys, and on better sites almost pure woodlands are found. *P. glandulosa* is a pioneer species with other woody legumes (e.g. *Acacia farnesiana*, *Parkinsonia aculeata*), invading disturbed or degraded land. Northerly accessions are essentially temperate while those at the southern extreme are sub-tropical. *P. glandulosa* var. *glandulosa* is native to the more humid eastern part of the native range towards the Gulf of Mexico, while var. *torreyana* prefers the drier climate found in the western part approaching the Pacific.

General description: Some trees can reach 20 m tall, most 3 to 9 m, with a twisted bole up to 1 m in diameter. In closed stands, trees have a short trunk with numerous branches, sometimes drooping. Trees are almost always thorny.

Variation: Such a wide natural range brings with it large variations in environmental preference and morphology. Within the range of the smaller leaved var. *torreyana* lies *P. velutina*, with smaller leaves still, and shrubby, thorny *P. articulata* and *P. juliflora* to the south. Within the larger leaved var. *glandulosa* there are populations that differ only in their very spreading and thorny habit, classified as var. *prostrata*. To the south of both in central Mexico lies *P. laevigata*. Hybrid populations are found in areas where any two species co-exist, which have a range of intermediate morphological characteristics, and continued hybridisation has been recorded. Superior accessions in terms of rapid growth, high pod yield or high pod sugar have been selected in the USA.

Prosopis velutina Wooton

Synonyms: *Prosopis juliflora* var. *velutina* (Wooton) Sargent

Common names: Velvet mesquite (English)

Importance: Accessions of *P. velutina* have been identified that produce pods with over 30% sugar content. Pods were an important source of human and animal food, and the trees provided fuel and small timber in native American cultures; but today it is of limited use. It is recorded as an invasive weed throughout its native range and everywhere where it has been introduced, and is not recommended for any further introductions.

Distribution: P. velutina is native to the Sonoran desert and neighbouring areas, southern Arizona in the USA, Sonora in Mexico and neighbouring states. *P. velutina* has been introduced to many countries but does not appear adapted to truly tropical environments, with poor growth and high mortality. In sub-tropical and Mediterranean regions, however, it performs well, and naturalised populations are recorded. It is occasionally widespread and weedy, for example in southern Africa and Australia.

Habitat: P. velutina is native to some of the hottest and driest parts of North America, and its native range appears to be expanding, with the tree showing adaptability to other environments. Like many other *Prosopis*, it is often found along dry river beds and is thought to require a water table to survive the long dry seasons.

Description: It is a shrub or small tree, occasionally up to 15 m, generally multi-stemmed. Leaves and leaflets are considerably smaller than neighbouring *P. glandulosa* and are distinctly hairy, like velvet, giving rise to its common and scientific names. It has a very extensive root system, recorded as deep as 40 m.

Variation: P. velutina has no varieties and is quite distinct from neighbouring species. However, due to its ability to freely hybridise with other Algarobia species, notably the neighbouring *P. glandulosa*, individuals with intermediate characteristics are found where the native ranges overlap. Hybrid populations of *P. velutina* X *P. glandulosa* are also recorded where both are exotic invasive species in Australia and South Africa. Molecular studies confirm the very closely relationship between these and other North American species, and it has been suggested that speciation has been a relatively recent event.

Prosopis alba Grisebach

Synonyms: Prosopis siliquastrum (Cav.) DC var. *longispina* Philippi, *Prosopis atacamensis* Phil.

Common names: Algarrobo blanco (Spanish).

Importance: It is regarded as a high quality timber for furniture and flooring in Argentina, and sweet pods are made into flour and beverages, and are a valuable fodder.

Distribution: It is found in northern Argentina and parts of Uruguay, Paraguay and southern Peru and Bolivia, but over-exploitation has reduced its native range.

Habitat: It is found from sub-tropical plains in the south, to montane regions in the north.

Genetic variation: A variety has long been recorded, that of *P. alba* var. *panta* Grisebach, which according to molecular studies, is more closely related to other *Prosopis* species than to *P. alba* itself, suggesting considerable genetic variation. Many completely thornless, high yielding and high pod sugar accessions have been selected from field trials in Argentina and the USA.

Prosopis chilensis (Mol.) Stuntz emend. Burkart

Synonyms: Prosopis chilensis (Mol.) Stuntz, *Prosopis siliquastrum* (Lag.) DC.

Common names: Algarrobo de Chile, algarrobo (Spanish).

Importance: *P. chilensis* is an importance source of timber in its native range.

Distribution: It is native to both sides of the Andes, from central and northern Chile, southern Peru and Bolivia, to north western Argentina. Some plantations have been established in Africa and India, but it is not thought to have naturalised outside of its native range.

Habitat: It is native to a broad range of altitudes and climates.

Variation: A variable species, mostly very thorny but can also be completely thornless, with shrubby and erect tree forms and considerable variation in leaf size.

Prosopis africana (Guill., Perr. & Rich.) Taubert

Synonyms: *Prosopis lanceolata* Bentham, *Prosopis oblonga* Bentham

Common names: Abu suruj, abu surung (Arabic), pau carvão (Portuguese), iron wood (English), gele, gouele (Bambara), kiryia (Haussa), kohi, rimajogaahi (Peulh), som (Serer), her (Wolof).

Importance: The wood is hard and durable with a fine grain, easy to carve and turn. It is a valuable fuel, with charcoal equivalent to coal in heating value. Unlike most American *Prosopis*, foliage is a palatable, sought-after dry season fodder, and seeds are fermented for use as a seasoning. Almost all parts of the tree are used in medicine.

Distribution: P. africana is the only *Prosopis* species native to tropical Africa, in a zone between the Sahel and savanna forests, from Senegal to Ethiopia in the north, Guinee to Cameroon in the south, and from Egypt to Uganda in the east. It has, however, disappeared from extensive parts of its native range due to over-exploitation. There are no records of any successful introductions.

Habitat: It is a tree of open savannas, often found in association with those species sharing the same range, e.g. *Parkia biglobosa* and *Vitellaria paradoxa*. Unlike other *Prosopis* species, *P. africana* will not tolerate habitually dry sites, preferring 600-1500 mm annual rainfall. It is found in moist but well-drained soils though it will tolerate seasonally waterlogged sites. It is thought to depend on water tables in the dry season. It is frequently found on fallow land. Cases of sudden death of mature trees in Cameroon are possibly due to falling water tables.

Description: It is a tree, between 4 and 20 m high, with dark, scaly bark. Foliage is drooping and similar to tamarind (*Tamarindus indica*) but lighter in colour. Pods are shorter and thicker than those of Algarobia species, each containing around 10 rattling seeds. The species is completely thornless.

Variation: This species is very different from all other *Prosopis*. No varieties, forms or land races have been described, although some differences in pod shape have been noted, indicating some variation. Being so different from other *Prosopis*, some taxonomists have even considered whether it will remain a part of the genus.

Prosopis cineraria (L.) Druce

Synonyms: *Prosopis spicigera* L., *Prosopis spicata* Burmann.
Common names: Ghaf (Arabic), jand, kandi, khejri (Hindi, Urdu).

Importance: The tree is most valued for its foliage as a high quality fodder, being lopped several times a year. Also, the pods are made into various foods, many being local delicacies such as 'sangri' in India. *P. cineraria* is often found at wide spacing in agricultural fields and forms an important part of dry zone agroforestry systems in India. It is a much slower growing species than other *Prosopis*, has performed poorly in field trials outside its native range and is not known to have become naturalised.

Distribution: The native range is broad, centring in the Thar desert of India and Pakistan, but stretching south and east to Tamil Nadu and West Bengal respectively, and west to Afghanistan and Iran, with large but isolated populations in Oman and Saudi Arabia.

Habitat: It is a tree of very dry conditions, often found on dunes or sandy plains. It has a deep tap root, which reaches the water table, and some studies have suggested that it can absorb moisture through its leaves. It tolerates light frosts, more so than the frost-sensitive exotic *P. juliflora*. Recent cases of the sudden death of many mature *P. cineraria* in India are thought to be due to over-exploitation of ground water for irrigation.

General description: Small tree up to 7 m tall, often with a straight bole to a height of 2 m and a round crown, resulting from repeated lopping for fodder.

Variation: Studies have indicated considerable variation in growth rates and pod size and composition, and range-wide seed collections and provenance trials have been conducted, mostly in the north west of India.

Prosopis farcta (Solander ex Russell) MacBride

Synonyms: Lagonychium farctum (Solander ex Russell) EG. Bobrov, *Prosopis stephaniana* (M. Bieb.) Kunth ex Sprengel.

Importance: It is a minor fodder, but generally viewed as not more than an invasive weed.

Distribution: The range of *P. farcta* is similar to that of *P. cineraria* from India to Iran, but then stretches much further west and north. It is widespread in the Middle East, and occurs also in Cyprus, Turkey, Ukraine (and other ex-USSR) and along the north African coast as far as Algeria. No specific habitat preferences noted, with a broad climatic range.

General description: This is the only *Prosopis* shrub species native to some tropical regions. Leaves and thorns are very similar to the closely related *P. cineraria*, the principal difference being size. *P. farcta* often less than 1 m in height, rarely up to 3 m.

Other introduced *Prosopis* species

P. affinis. This species is native to Uruguay, eastern Argentina, and southern Brazil only. Reports of it being native to Peru are incorrect. It has also been stated as introduced to tropical zones in Brazil and India, both of which are unlikely.

P. articulata. High yielding accessions producing very sweet pods were selected in the USA, and some have been included in field trials world-wide. It is not suitable for tropical regions, and the large thorns and spreading habit suggest that this species should not be further introduced.

P. caldenia. A sub-tropical to temperate tree native to Argentina, it has been planted in tropical zones but while surviving, has not performed well. In its native range it can be snow-covered in winter.

P. flexuosa. A sub-tropical species from Argentina, that has performed only poorly when introduced to tropical regions.

P. kuntzei. Very rarely introduced, notable for its very long thorns (or spiny branches), which, like those of the very weedy 'vinal' (*P. ruscifolia*) in Argentina, can exceed 30 cm in length. No movement of seed of these species should be permitted.

P. laevigata. Another sub-tropical species from Mexico, it also performs poorly when introduced to tropical regions.

P. nigra. This species has shown promise in field trials in tropical arid zones of India and Cape Verde. There are, however, large variations in growth rate, form and thorniness of the accessions tested, but this indicates that selection may yield promising material for further planting.

P. pubescens. The American 'screwbean' is a strombocarpa species, identified by small, dark spiralled fruit, and cannot interbreed with the bulk of the common Algarobia *Prosopis* species. While there are records of it being planted in South Africa and India, other trials have recorded 100% mortality.

P. tamarugo. Another strombocarpa species, native to the Atacama desert in northern Chile, one of the most inhospitable regions of the world. Decades can pass without any rainfall, and salt pans can be 10 m deep, while the tree appears to live on atmospheric moisture and/or deep water tables. Massive deforestation of the native woodlands were countered with large plantations established. Unfortunately, it appears to be specifically adapted to only this environment, as almost all recorded introductions around the world have failed. It does occasionally survive in greenhouses, but further introductions are not recommended.

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Notes

mm
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scale of millimetres
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above, top: **P. pallida *leaves (Harsh)***
middle: **P. juliflora *leaves (Harris)***
bottom: ***Interfoliar gland***
(P. juliflora) *(Harris)*

above, top: **P. glandulosa *leaves***
and unripe pods (Harsh)
middle: **P. chilensis *leaves and thorns (hdra)***
bottom: ***Variation in pods of***
P. juliflora *(Billington)*