

# On the Identities of Thai Sugar Palms

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1. *Arenga pinnata* in Thailand.

Recent fieldwork in Thailand focusing on economic botany of sugar palms, which is here used as a collective term for the arborescent species of *Arenga*, (Fig.1) has revealed a number of useful fruit and seed morphological characters that we hope will help clarify species limits.

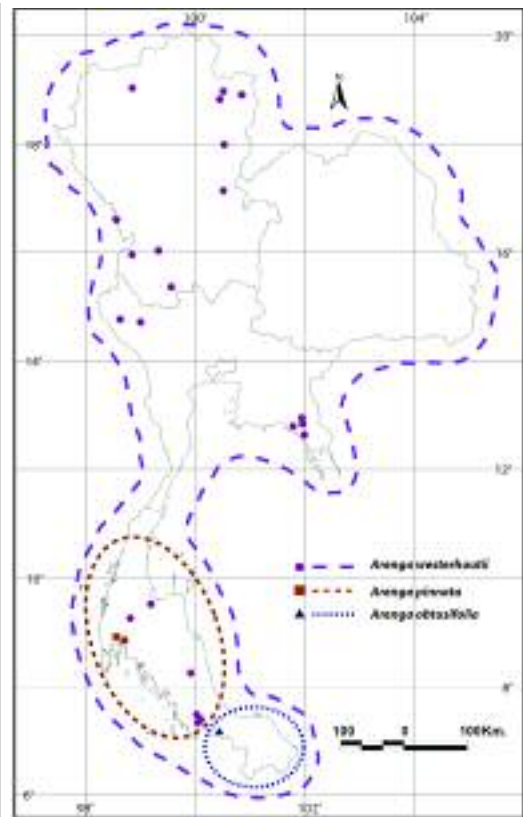
The genus *Arenga* is distributed in South China, the Ryukyu Islands and Taiwan in the north to Christmas Island in the south and from India in the west to Queensland, Australia in the east. The greatest diversity is found in Sumatra, Peninsular Malaysia and Borneo (Dransfield & Mogeia 1984, Uhl & Dransfield 1987). In his recent revision the genus, Mogeia (1999) described 22 species, two subspecies and four varieties. Five species are distributed in Thailand (Hodel 1998, Dransfield et al. subm.) of which three are arborescent, viz. *A. obtusifolia*, *A. pinnata* and *A. westerhoutii* (Fig. 2). The identity of the latter two species, which are both solitary, is often confused in Thailand. *Arenga pinnata* and *A. westerhoutii* are separated based on their leaf morphological characters in the identification keys. *Arenga pinnata* is separated from *A. westerhoutii* by having clustered pinnae that arise from the rachis in several planes (Dransfield & Mogeia 1984, Hodel 1998). The problem is that this character shows age dependent variation and is not well represented on herbarium sheets.

Recently, we have initiated a study of the economic botany of sugar palms in Thailand. The name 'Sugar Palm' is used here in the broad sense for all the arborescent members of the genus *Arenga*. Several authors have stressed the economic importance of sugar palms in Thailand (Hoare et al. 1998, Jintana et al. 2001, Subansenee et al. 1999, Juiprik & Kijte-wachakul 2001). The uncertainties relating to species delimitation, however, must be overcome to enable precise mapping of distributional ranges and to provide a scientific basis for resource management. Based on observations made on a large number of natural, semi-cultivated and cultivated populations we have extracted a number of characters that we believe are particularly useful for identification of Sugar Palms in Thailand.

#### Distinctive characters for arborescent species of *Arenga* in Thailand

An overview of the vegetative and reproductive characters of the three arborescent species of *Arenga* in Thailand is given in Table 1. In the following we describe the differences in more detail.

**Habit and leaf morphology.** *Arenga pinnata* (Fig. 1) and *A. westerhoutii* (Fig. 3) are both single-stemmed palms. They are similar in stem diameter and both have persistent leaf sheaths for a long distance below the crown. *Arenga obtusifolia* (Fig. 4) is distinguished by being



2. Distribution of Thai sugar palms.

multi-stemmed. The loosely clustered stems are slender and tall (Zakaria et al. 1999, 2000). The leaf sheaths only persist for a short distance underneath the crown.

All three species of *Arenga* have 12–30 leaves that are gathered in a rather loose crown. Leaf dimensions depend on the age of the palm, e.g., the length varies from 6 to 15 m. The leaves are imparipinnate with opposite to subopposite pinnae (leaflets). The individual pinnae are ensiform (sword-shaped) with more or less revolute to undulate margins. They are dark lustrous green above and mealy below. The distal margins are jaggedly toothed. The bases are unequally auriculate.

In *A. pinnata* the pinnae are often arranged irregularly along the leaf rachis in several planes, a character that becomes more distinct with age. (vouchers: Barfod et al. 41546 and Pongsattayapipat et al. 24). The mealy undersides of the pinnae often have a ferruginous tinge. The leaflets of *A. westerhoutii* are regularly arranged and arising from the leaf rachis in one, rarely several planes. The mealy covering of the undersides is silvery to rusty brown (voucher: Barfod et al. 41104 and

**Table 1** Vegetative and reproductive characteristics of the three arborescent *Arenga* species.

	<i>Arenga obtusifolia</i>	<i>Arenga westerhoutii</i>	<i>Arenga pinnata</i>
<b>Vegetative</b>			
Leaflets	leaflets in several planes, evenly distributed	leaflets in one plane, evenly distributed	leaflets in several planes, unevenly distributed
Leaf sheath fibres	not present in older leaves	persistent in older leaves	not present in older leaves
Phenology	pleoanthetic, acropetal	hapaxanthic, basipetal	hapaxanthic, basipetal
<b>Male inflorescences</b>			
Length	0.8–1.0 m	1.2–1.5 m	1.8–2.5 m
<b>Male flowers</b>			
Stamen connective	yellow, narrow	yellow, wide	yellow with brown stripe, wide
Filament	short	longer	short
<b>Female inflorescence</b>			
Density of flowers on the rachillae	compact (in contact)	loose (separated, not touching)	compact (in contact)
<b>Fruits</b>			
Shape	longer than wide	equal in length and width	wider than long
Color at maturity	yellowish green	dark green	greenish yellow to orange
Color of perianth	black	calyx black, corolla green	calyx black, corolla yellowish green
Carpel keels	absent	present	absent
Locules	separated by mesocarp	not separated by mesocarp	not separated by mesocarp
Mesocarp thickness	moderate	thick	moderate
Stigma remnant	narrow, with 3 slits	wide, with 6 slits	narrow, with 3 slits
<b>Seed</b>			
Shape	elongate, with rounded keel	elongate, with sharp keel	rounded
Funicular scar	conspicuous, light colored	inconspicuous, dark	inconspicuous, dark
<b>Distribution</b>	peninsula	widely distributed	semi-cultivated in the south
<b>Ecology</b>			
Habitat	limestone and steep slopes	limestone and steep slopes	semi-cultivated
Altitudinal range	0–200	0–900 (1200)	0–200



3 (left). *Arenga westerhoutii* in habitat. 4 (right). *Arenga obtusifolia*, in its natural habitat.

*Pongsattayapipat et al.* 26). In *A. obtusifolia* the leaflets are usually regularly arranged as well; however, they arise from the leaf rachis in several planes. The leaflets are silver-grey below. The auricles at the leaf base are not quite as unequal as is the case with the former two species (voucher: *Barfod et al.* 141643 and *Pongsattayapipat et al.* 25).

**Phenology.** Both *A. pinnata* and *A. westerhoutii* (Fig. 5 & 6) are hapaxanthic with a basipetal flowering sequence of the inflorescences in which emergence proceeds opposite to the order of formation. All the functional flowers of the first-produced inflorescences are female, whereas the last-produced inflorescences near the base contain only male flowers. *Arenga obtusifolia* (Fig. 7) differs by being pleoanthic and having an acropetal flowering sequence in which emergence follows the order of formation of the inflorescences. Dransfield and Mogege (1984) did not observe any trees where both sexes were represented, and they suggested that this species may functionally be dioecious. On female individuals, even the oldest inflorescences are entirely composed of female flowers, and male trees never bear infructescences.

**Inflorescence.** All three species of arborescent *Arenga* in Thailand are monoecious with flowers grouped in sympodial clusters of three,

the so-called triads. The clusters are composed of one female flower flanked by two male flowers. The morphological differences between male and female flowers are

5. *Arenga pinnata* with inflorescence in staminate anthesis.



pronounced. All the flowers of one sex are usually suppressed during the development of the inflorescence so that it becomes functionally unisexual. In *A. pinnata* and *A. westerhoutii* a bisexual inflorescence is sometimes produced in between the female and male phases of flowering.

**Flowers.** The three imbricate sepals of the male flowers are about one fourth the length of the corolla. The corolla is smooth and fleshy. In *A. pinnata* it is red-brown to red-purple, in *A. westerhoutii* yellowish-red and in *A. obtusifolia* purplish (Fig. 8).

In all three species compared there are numerous stamens in the male flowers. The elongate anthers are borne on a short filaments. The connective of *A. pinnata* stamens is distinctly different from those of the other two species of Thai sugar palms by being reddish brown.

**Fruits.** The fruits of the three species of Thai Sugar Palms are similar in size. They are more or less angled and two- or three-seeded. The mesocarp is fleshy and full of irritant needle

shaped crystals (raphides) released from ideoblasts. Fruit shape, fruit colour and seed morphology differ between the species and offer excellent distinctive characters.

The mature fruits of *A. pinnata* (Fig. 9 and Back Cover) are obovoid to sub-globose, smooth, about 3 cm long and 4 cm wide, with a depression on the upper surface. They are green to yellowish green ripening to yellowish brown or red. On the distal part of the fruits three lines radiate more or less distinctly from the stigmatic remains and along the middle of the carpels.

Fruits of *A. westerhoutii* (Figs. 10, 12) are rounded, obovoid to oblong-turbinate, approximately 4 cm both in length and in width. They are light bluish green when immature ripening to bluish green or dark green. The apex is rounded to slightly depressed. Three characteristic keels are often visible radiating from the stigmatic remains and along the middle of the carpels.

*Arenga obtusifolia* (Figs. 11, 13) has oblong-turbinate to ellipsoid fruits about 4.5 cm long

6 (left). *Arenga westerhoutii* with infructescence and staminate inflorescences past anthesis. 7 (right). *Arenga obtusifolia* with infructescences.





8. Staminate flowers of *Arenga*. Top: *A. pinnata*. Middle: *A. westerhoutii*. Bottom: *A. obtusifolia*.

and 3 cm wide. The apex is rounded and adorned with three lines that radiate along the middle of the carpels. The fruits are light green when mature to yellowish green at maturity.

*Seeds.* The seeds of all three species of arborescent arengas are black (Fig. 14). In *A. pinnata* the seed is round to shortly elliptic in outline. The outer face is convex whereas the

inner face is bifacial with a blunt keel. The seeds of *A. westerhoutii* are elongate to elliptic, convex-bifacial with a sharp keel to subtrigonal. The seeds of *A. obtusifolia* are similar to the latter in size and shape, however the keel is not quite as sharp. The best distinguishing feature is the white scar from the funiculus (ovule stalk) at the base.

#### Notes on distribution

*Arenga pinnata* is widespread throughout South East Asia as a cultivated or semi-domesticated tree (Dransfield & Moguea 1984). According to Hodel (1998) it is rare in Thailand and always seen around human habitation. The other two species of Sugar Palms occurring in Thailand, *A. westerhoutii* and *A. obtusifolia*, are widespread in evergreen and semi-evergreen forests in Peninsular Malaysia and Thailand (Zakaria et al. 1999 & 2000) where they occur from sea-level to 900 m elevation.

Our fieldwork conducted throughout Thailand has revealed that the traditional view on the distribution species of Sugar Palms in Thailand is not correct. It is true that *A. pinnata* is cultivated or semi-domesticated, but its

distribution in Thailand is restricted to the coastal plain and limestone foothills of the Peninsula in the provinces of Suratthani, Phangnga and Krabi. It occurs from sea level to approximately 200 m elevation. On rare occasions, trees are observed in forests, but these are probably either planted or escaped from cultivation. *Arenga westerhoutii* is common in moist or wet forest throughout Thailand from sea level to 900 m elevation. In Peninsular Thailand, *A. westerhoutii* is locally abundant on steep slopes often associated with limestone formations. *Arenga obtusifolia* is rare in the hill dipterocarp forest in the extreme south of Thailand. It has been observed only in the Khao Namkhang National Park, Province of Songkhla, where it occurs scattered on the slopes.

#### Uses

*Arenga pinnata* is an economically important resource that is exploited for multiple purposes. The most important use is tapping of sap from the inflorescence for sugar, wine or vinegar and extraction of starch from the stem for sago. Minor local uses include young

9 (left). Inflorescence of *Arenga pinnata*. 10 (right). Inflorescence of *Arenga westerhoutii*.





11. Infructescence of *Arenga obtusifolia*.

endosperms and cabbage for human consumption, leaves for thatch, leaf sheath fibers for blowgun darts and brooms (Miller 1964). Mogeia et al. (1991) claimed that *A. pinnata* is the most important sugar palm of the humid tropic and one of the most versatile multipurpose tree species in culture.

Very little information is available on the utilization of *A. westerhoutii* in Southeast Asia mainly because its identity has been confounded with that of *A. pinnata*. To our knowledge the economic botany of *A. westerhoutii* has never before been studied in Thailand, however we find it quite likely that several minor research projects have been conducted on populations misidentified as *A. pinnata*.

According to Burkill (1966), the pith of *A. obtusifolia* is sweetish and is prepared in various ways for curries by the Malays. Ethnic groups dwelling in the rainforest near the border with Malaysia consider the cabbage a delicacy.

Recent economic botanical studies of *Arenga pinnata* and *A. westerhoutii* in Thailand, have revealed that the young endosperms are the main product of *A. westerhoutii* in northern

Thailand as well as in adjacent Laos and Myanmar (Pongsattayapipat & Barfod in prep.) The endosperms, which are collected in the gelatinous stage, are consumed throughout Thailand as a dessert or for ice cream topping. *Arenga pinnata* is used both for sugar extraction and edible young endosperms. To our knowledge there is no record on utilization of *A. obtusifolia* in Thailand. Species of *Arenga* are gaining in popularity all over SE Asia as ornamentals (Miller 1964, Burkill 1966).

### Conclusion

A confused taxonomy has been an impediment for science-based management of Sugar Palm resources in Thailand. Recent fieldwork has revealed a number of diagnostic characters particularly relating to fruit and seed morphology that facilitates correct identification of the three species of Sugar Palms that occur in Thailand, viz. *Arenga pinnata*, *A. obtusifolia* and *A. westerhoutii*. A well established taxonomy makes it possible to produce precise maps of distribution ranges, which are important for future resource management and conservation efforts.

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12 (top).  
Fruits and  
cross-section  
of *Arenga  
westerhoutii*.



13 (bottom).  
Fruits of  
*Arenga  
obtusifolia*.

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14. Comparison of dissected fruits. Row 1. *A. obtusifolia*. Row 2. *A. westerhoutii*. Row 3. *A. pinnata*. Column 1. Distal view. Column 2. Basal view. Column 3. Cross section. Column 4. Longitudinal section. Column 5. Seed.

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