



Ethnobotany of the genus *Piper* (Piperaceae) in Thailand

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Abstract

Thailand is located in the tropical rain forest zone above the equator. This geographically supports very rich biodiversity, including the genus *Piper* (Piperaceae). Thirty-eight species of *Piper*, from out of over 1,000 species in the world, have been discovered recently (1998-2006) by the authors. Plant morphology and plant use information were recorded via observation, market surveys, and interviews with traditional healers and local peoples. In this paper we provide ethnobotanical and botanical descriptions and illustrations of eight *Piper* species that are popularly used among Thai people as vegetables, spices, decoration and medicines and for traditional ceremonies. These species consist of *P. betle* L., *P. longum* L., *P. nigrum* L., *P. pendulispicum* C.DC., *P. retrofractum* Vahl, *P. sarmentosum* Roxb., *P. wallichii* (Miquel) Handel-Mazetti and a newly described *Piper* sp.

Introduction

The genus *Piper* consists of more than one thousand species, which are distributed mainly in tropical regions of the world. Most members of the genus *Piper* are climbers although some are shrubs and a few are trees. The stem has a conspicuous stout node with strictly one simple leaf on each node. The inflorescence spike develops on the node of the branching stem opposite the leaf and is erect or pendulous, monoecious or dioecious. Flowers are very small with absent sepal and petal, orbicular bracts, and the stalk is sessile or connected to the rachis. The stamen and stigma number 2-6 and the stigma may be covered with very short hair. The ovary is inferior and sessile or with a short pedicel. The fruit is fleshy, sessile or with a pedicel, and globose or ellipsoid (Cheng *et al.* 1999).

Our studies show that each species often has three plant forms which include creeping, climbing and branching stems. Plants with creeping and climbing stems have a

few different leaf forms or are all the same. Leaf morphology (e.g. color and shape) for all plant forms is very different. These qualities make it quite challenging to correctly identify *Piper* species without an inflorescence. However, *Piper* with an inflorescence can be easily identified by number and shape of stamen and stigma, bract morphology, and leaf form characteristics, such as the number and arrangement of veins, decorative design and colors (Chaveerach *et al.* 2006, 2007, Chaveerach *et al.* n.d. a).

Presently, thirty-eight species have been identified and botanically reported in Thailand. Members of *Piper* are often found cultivated in home gardens, which suggests that Thai people have had a long relationship with them and are familiar with their uses. *Piper* leaves contain distinctively aromatic and acrid volatile oils that contain such compounds and elements as cadinene, carvacrol, caryophyllene, chavibetol, chavicol, eugenol, terpinyl, acetate (Dyer *et al.* 2004), piperine, piperlongumine, pyridine alkaloids, sesamin, tannins, oxalic acid and iron (de Waard & Anunciado 1999, Teo & Banka 2001). Several species have great economic and cultural importance among Thai

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people and are used in complex spice mixtures and as medicines, stimulants, antiseptics and antioxidants.

Methodology

Our ethnobotanical study was carried out across all regions of Thailand over an eight year period (1998-2006). *Piper* diversity was surveyed in fifty-one different locations, thirty-two markets, and one hundred and sixty-six home gardens. Interviews and free-listing techniques were used with sixty-seven traditional healers, fifty-eight local families, and market sellers. These generated ethnobotanical data of *Piper* plants in many different areas of each province (Figure 1). Literature review of studies conducted among ethnic groups in Thailand also provided ethnobotanical data on the medicinal use of *Piper* in traditional medicine. Important values of useful plants were identified with a ranking technique, using different criteria for each type of use-

ful plant, including use-frequency. For medicinal plants the importance value was simply identified by use-frequency of the local traditional healers.

Results and Discussion

In each region of Thailand, local people use *Piper* plants in different ways depending on religious belief, culture, ceremony, topography, vegetation and species diversity for each community. We found that eight species were most popularly used. These are *P. betle* L., *P. longum* L., *P. nigrum* L., *P. pendulispicum* C.DC., *P. chaba* Hunt., *P. sarmentosum* Roxb., *P. wallichii* (Miquel) Handel-Mazetti and a new species *Piper maculaphyllum* A. Chaveerach & R. Sudmoon (Chaveerach *et al.* n.d. b). All of these plants are used for vegetables, spices, decorations, medicines and for traditional ceremonies. Plant parts and methods of use are described below.



Figure 1. The investigated sites (*) throughout the seven floristic regions of Thailand: Northern (I), North-eastern (II), Eastern (III), South-western (IV), Central (V), South-eastern (VI) and Peninsula (VII).

Vegetable and spices

Piper plants are most commonly used as food by local Thai people in all regions of Thailand. Two species, *P. nigrum* and *P. sarmentosum*, are the most famous ethnoeconomic species. They are common nationwide for cuisine flavoring and are grown in many home gardens and crop plantations. Thai people and chefs use the fleshy and mashed dried fruits of *P. nigrum* as a food spice. Black pepper is the unripe dried fruit; white pepper is obtained by removing the outer coating (pericarp). Black and white peppers are used cracked, coarsely ground, or finely ground. They have numerous culinary uses, including flavoring of soups, meat, fish, eggs, salads and sauces. Additionally, they are employed commercially in the preparation of processed meats that are used in many kinds of foods including soups, sauces, and salad dressings. Fresh leaves of *P. sarmentosum* are used to improve the flavor and smell of soups. Moreover, the leaves are generally eaten as vegetables.

In the northern and northeastern provinces with high mountains and evergreen forests, a characteristic environment for *P. pendulispicum* is found. This species is often used in soups. For instance, in Loei province of northeast Thailand, mature female plant stems that are not too young or old are a very important component of a local soup called **kaeng khae**. Stem pieces are mixed with other plant materials including young leaves of *P. sarmentosum*, chilies, long peas, mushrooms, coconut leaf shoots, egg plant fruit and *Sesbania grandiflora* Desv. flowers. The name of this soup is based on the northern local name for *P. sarmentosum*, **phak khae**.

Male plants of *P. pendulispicum* are called **sakhan daeng** by northern Thai people. Dried or fresh roots are soaked in a bottle of Thai white whisky for 5 minutes until the color of the whisky becomes red. Local men often drink a small

glass of this whisky each day to improve blood circulation and virility. In Loei province, close to the P.D.R. Lao border, local people of Loa, Pakhoy, Nongphua, Pakkan villages in Talee district collect *P. maculaphyllum* **jakan** from the wild and mix it with *P. pendulispicum* to include in a local variety **kaeng khae** soup.

Native ceremonies

Thai ceremonies are variable in each region depending on the ethnic groups, beliefs, religion and culture. However, for the most part, most ceremonies intend to appease and demonstrate respect and worship towards spirits of ancestors and ghosts in order to benefit the villagers' health, fortune and happiness, and remedy illness. *Piper betle* leaf is one of the most important materials used in Thai ceremonies. This stems from the popularity of betel chewing among Thai people. Elder people often use a quid prepared in a mortar by mixing *P. betle* leaves with calcium carbonate, *Areca chetachu* L. fruit, and small pieces of *Shorea roxburghii* G. Don heartwood.

In weddings, the bridegroom's family participates in a parade which includes placing money with *P. betle* leaves in a bowl, altogether called **khun maak**. This is given to the bride's parents.

"Spirit dancing" among the Kui ethnic group in southern part of the northeastern Thailand it is called **raam phi taan**. It involves a variety of the **khun maak** that includes the use of **P. betle**. **Sadohchroh** literally, "send away bad luck" is a ceremony officiated by spirit mediums and exorcists who have the ability to chase away and protect people from evil spirits or send away bad luck from a single patient, family or village. The patients may organize a ceremony when they feel that they have a lot of bad luck. They do this by giving the spirit medium or exorcist a bowl of candles, white cotton strings, flowers, betel leaves and some money to worship for ancestors and spirits (Virapongse 2006).

Traditional medicine

Members of the genus *Piper* are often used as medicines to treat illness and as tonics. Traditional medicinal knowledge is often concentrated among expert traditional healers whose knowledge is transmitted between generations. Evidence of *Piper* for medical use is recorded in some ancient Thai traditional medicine textbooks and from interviews with traditional healers. There are many different types of traditional healers in Thailand that are named according to their different methods of treatment. For example herbal healers use herbs and other natural substances to treat illness, blowing healers use blowing methods to treat mostly acute injuries and some illnesses caused by spirits, masseuses use massage techniques to treat aching muscles and some employ the use of herbal

compress and oils. Some popular species of *Piper* used in traditional medicine species are described below.

Piper betle leaves are chewed with betel nut and lime to act as a gentle stimulant and exhilarant. Those accustomed to its use feel a sense of languor without it. The leaves have antiseptic and antioxidant properties. Betel leaves can be used to alleviate kidney inflammation and thirst resulting from diabetes. The leaves are thought to impart strength to stomach. They can be used as an expectorant effect for coughs, asthma and bronchitis. In Thailand, the fresh leaves are used as an antifatulent material.

Piper nigrum is considered to be an aromatic, carminative, febrifuge, rubefacient and stimulant. Peperine in its leaf can be used for synthesizing heliotropin (Rocha & Ming 1999) which is an antiseptic and antipyretic. The root, in the form of ghee, powders, enemas, and balms, is applied to abdominal tumors. The powdered fruit is said to remedy superfluous flesh. White pepper can be used to treat cholera, malaria, and stomachache. Black pepper can be used to treat abdominal fullness, adenitis, cancer, cholera, cold, colic, gravel and headache. A heavy dose of pepper with bamboo shoots is said to produce abortion.

Piper longum is widely used in Ayurvedic and Unani systems of medicine, particularly for diseases of the respiratory tract. The root is used for bronchitis, stomachache, diseases of the spleen, and tumors. It also improves appetite. An infusion of the root is prescribed after parturition to induce the expulsion of the placenta.

Piper retrofractum is an important component of Ayurvedic medicine where it is called **pippali** meaning protection from disease or sickness. Its fruits have a "hot" flavor that is used for improve food digestion, blood circulation, asthma, overall health, reat influenza and hypertension, and act as an antifatulent. When combined with *P. nigrum* and **khing haeng** (*Zingiber* sp.), it is an important ingredient of **trikatu** medical prescriptions within Thai traditional medicine. **Trikatu** in Sanskrit means "Three hot flavored items". They are used for improve four body elements (earth, water, wind and fire), food digestion, and food nutrient absorption and to act as an anti-tussive and diaphoretic, and treat influenza and flatulence.

Piper wallichii is a very common wild species in Thailand. It is widely used in northeast traditional medicine by local healers. Its stem and root are used to treat influenza, asthma, and flatulence and as a stimulant, to improve blood circulation (Virapongse 2006).

Decoration

Plants of the genus *Piper* are popular for decorations because of their attractive shape, leaf color pattern, fruit spike color and plant habits. The climbing style and shrub shape can be used to decorate home gardens and fences

to create a comfortable and relaxing atmosphere. Appropriate species for decorating home gardens and fences are *P. nigrum*, *P. betle*, *P. longum*, *P. retrofractum* and *P. pendulispicum*.

Piper maculaphyllum is usually used to decorate salvers because of its beautiful creeping stem habit, leaf shape, conspicuous thick leaves, and color pattern of the leaf.

All *Piper* species in Thailand have high potential as decorative plants, but many species are wild plants and are not well known, especially among the general public. More studies on the biodiversity of *Piper* are needed to improve its economic botany status.

Species Descriptions and Distributions

1. *Piper betle* L. Figure 2.

Dioecious, climber. Stem stout with pinkish-stripe along, node dilated and rooting. Petiole 2-2.5 cm long; leaf blade fleshy coriaceous, glabrous, greenish or yellowish, broadly ovate, 7-8.5 cm wide, 9-11 cm long; apex acuminate; base cordate; veins 7-9, elevating beneath, two or three pairs basal, one pair arising from midrib. Male spike cylindrical, slender, pendulous, 3-12 cm long, ca. 0.5 cm in diameter; peduncle 2-3 cm long; bract orbicular, peltate; stamens 2. Female spike cylindrical, pendulous, 2.5-4 cm long, ca. 0.5 cm in diameter; peduncle 2-3 cm long; bract orbicular, peltate; stigmas 4-6, pubescent. Fruiting spike 3-5 cm long; drupe embedded on rachis. Flowering and fruiting on year round.

Thailand vernacular name: **Plu**

Distribution: Found in all investigated sites throughout the seven floristic regions of Thailand from 100-900 m altitude.

2. *Piper longum* L. Figure 3

Monoecious, climber, many parts finely powdery pubescent when young. Stem often flexuous. Petiole 1-3 cm long. Leaves on creeping branch and epiphytic branches blade ovate or elliptic. Leaves on free branches blade ovate to ovate-oblong. Leaf blade membranous, dark green, 3-5 cm wide, 7-10.5 cm long; apex acuminate; base cordate or oblique; veins 5, one pair basal, one pair arising 1.5 cm apart from base, opposite or alternate. Male spike straight up, 5-8 cm long, 0.3-0.7 cm in diameter; peduncle 0.5 cm long; bract orbicular, stalked; stamens 2. Female spike erect, 0.6-2 cm long, ca. 0.2 cm in diameter; peduncle 0.5 cm long; bract circular, peltate; stigmas 3. Fruiting spike straight up, 0.7-2.5 cm long; drupe globose, sessile, arranged densely on rachis. Flowering from May to September.



Figure 2. *Piper betle* L.



Figure 3. *Piper longum* L.

Thailand vernacular names: **Dipli, Prik-hang, Sa-kan**

Distribution: Found in all investigated sites throughout the seven floristic regions of Thailand from 200-300 m altitude. Common in central and northeastern Thailand.

3. *Piper nigrum* L. Figure 4

Monoecious, stout climber, rooting at nodes. Petiole grooved, 0.8-1.5 cm long; leaf blade fleshy coriaceous, ovate to elliptic, 4-6 cm wide, 9-11 cm long; apex acuminate; base rounded to oblique; veins 7, two pairs basal, one pair arising 1-2 cm apart from base, reaching leaf apex. Spikes with male and female flowers together, 5-13 cm long, 0.3-0.5 cm in diameter; peduncle 1-1.5 cm long; stamens 2; stigmas 3. Fruiting spike 7-10 cm long; drupe globose, sessile, arranged loosely on rachis. Flowering and fruiting on year round.

Thailand vernacular name: **Prik-thai**

Distribution: Found in all investigated sites throughout the seven floristic regions of Thailand from 200-900 m altitude.



Figure 4. *Piper nigrum* L.

4. *Piper pendulispicum* C.DC. Figure 5

Dioecious, woody climber on rocks and trees, much branching. Stem stout, warted, node rooting, swollen and zigzag joint. Petiole 0.5-1 cm long; leaf blade thin leathery to coriaceous leathery, shiny light green to dark green, reddish when dried, ovate, ovate-lanceolate, elliptic, 7.8-14 cm wide, 14-20 cm long; apex acute to acuminate; base broadly-cuneate or oblique; veins 6-7, abaxially prominent, apical pair arising 1.5-2 cm apart from base, alternate, two pairs basal or the one out of two pairs arising near base. On the flowering branch, veins might be unequal in each side of midrib, 2 in one side and 3 in the other. Male spike pendulous, yellowish, 7-15 cm long, 0.3-0.5 cm in diameter; peduncle 1-2 cm long; rachis pubescent; bract orbicular, abaxially pubescent, arranged spirally on a spike; stamens 2, mature at different time, filament length unequal. Female spike pendulous, 10-20 cm long, ca. 0.5 cm in diameter; peduncle 1-2 cm long, rachis and bract as in male spike; stigmas 3-4. Fruiting spike up to 30 cm long; drupe sessile, ovoid or ellipsoid. Flowering and fruiting from November to March.

Thailand vernacular names: **Sa-kan-nua, Ja-kan-jin, Sa-kan-daeng.**

Distribution: Found in north and northeast Thailand from 200-1200 m altitude.

5. *Piper retrofractum* Vahl Figure 6

Synonym *P. chaba* Hunt.

Monoecious, climber. Stem stout, node dilated and rooting. Petiole 0.8-1.2 cm long; leaf blade coriaceous, glabrous, entire, oblong, ovate, or lanceolate, 4-6 cm wide, 10-17 cm long; apex acuminate; base cordate, rounded,



Figure 5. *Piper pendulispicum* C.DC.



Figure 6. *Piper retrofractum* Vahl.



Figure 7. *Piper sarmentosum* Roxb.

or oblique; veins one or two pairs basal, the others arising alternately from midrib. Spike straight up, 3-5.5 cm long, 0.5-0.7 cm in diameter; peduncle 1-1.2 cm long; bract orbicular; stamens 2; stigmas 3. Fruiting spike stout, conico-cylindric, 3.5-6 cm long; drupe globose, embedded on rachis, red when ripen. Flowering on year round.

5-8 cm long, leaves on epiphytic branches blade longer; apex acute; base truncate, oblique or cordate; veins 7, two pairs basal, one pair arising 1-1.5 cm apart from base. Male spike straight up and curve down or pendulous, 1.5-6 cm long, 0.1-0.2 cm in diameter; peduncle ca. 1 cm long; bract orbicular; stamens 3. Female spike ca. 5 cm long, ca. 0.2 cm in diameter; stigmas 3. Fruiting spike drooping, 8-15 cm

Local name: **Dipli, Dipli-chueak**

Distribution: Found in all investigated sites throughout the seven floristic regions of Thailand from 50-700 m altitude.

6. *Piper sarmentosum* Roxb. Figure 7

Monoecious, normally small shrubs, 30 cm tall, sometimes climber, all parts glabrous. Petiole 1-2.5 cm long; leaf blade thin to thick chartaceous or papery, light to dark green, broadly ovate to elliptic, 4.5-6 cm wide, 7.5-9.5 cm long; apex acute; leaves on epiphytic branches base deeply equally cordate with rounded lobes, leaves on free branch base cuneate to subtruncate; veins 7, all basal. Spike with male and female flowers together straight up, cylindrical, 1-1.5 cm long, 0.3-0.5 cm in diameter; peduncle ca. 1.5 cm long; bract rounded; stamen 1; stigmas 3-4. Female spike white cylindrical, other characters are as above. Fruiting spike 1-2 cm long, 0.5-1 cm in diameter. Flowering on year round, many in rainy season.

Thailand vernacular name: **Cha-plu**

Distribution: Found in all investigated sites throughout the seven floristic regions of Thailand from 100-1000 m altitude.

7. *Piper wallichii* (Miquel) Handel-Mazzetti Figure 8

Synonym: *P. aurantiacum* Wall.

Monoecious, creeping on ground and climbing on trees. Stem glabrous rooting at node. Petiole 0.3-1.5 cm long; leaf blade coriaceous, ovate or lanceolate, 3-4.5 cm wide,



Figure 8. *Piper wallichii* (Miquel) Handel-Mazzetti.



Figure 9. *Piper wallichii maculaphyllum* A. Chaveerach & R. Sudmoon.

long; drupe globose, arranged loosely on rachis. Flowering on year round.

Thailand vernacular name: **Cha-plu-pa, Ja-kan-khao, Plu-gae, Plu-ka-toi, Sa-kan-nu**

Distribution: Found in all investigated sites throughout the seven floristic regions of Thailand from 800-2500 m altitude. It is very common in north and northeastern Thailand.

8. *Piper maculaphyllum* A. Chaveerach & R. Sudmoon Figure 9

Stout climber to several meters long on trees, monoecious, glabrous; stem stout, white short hairy, furrowed when dried. Petiole densely white-short hairy, 2-5 cm long. Leaf toward base of stem: leaf blade thick leathery, adaxial dappled with light green to dark pink, abaxial green, ovate to broad ovate, 7-15 cm wide 20-22 cm long; base cordate; apex acuminate. Leaf toward apex of stem: leaf blade thick leathery, scattered pellucid and brownish-red glandular, shape and size as same as in leaf toward base of stem; base subrounded or subcordate with basal lobes rounded-unequal and sometimes overlapping; apex acuminate. Vein 7-9, apical pair arising at 1-3 cm above base, often alternate reaching leaf apex, others basal, reticulate veins conspicuous, abaxial pink prominent. Male

spike pendulous, 2 cm long, 0.2 cm in diameter; peduncle 1 cm long; bract elliptic, peltate, stalk short and hairy, margin hairy; stamen 2, filament flatten unequal long. Female spike as same as male spike; stigma 4. Fruiting spike 2-10 cm long, 0.4-1 cm in diameter; peduncle 1.2-2.2 cm long; drupe hairy, partly connate to rachis. Flowering and fruiting on August to November.

The dappled adaxial leaf character is very similar to *P. crocatum*, but *P. crocatum* has a purple-reddish abaxial leaf and subpeltate leaf base.

Thailand vernacular name: **Plu-long-ya**

Distributed at altitudes of 100-200 m only in the Peninsula region in the areas of Poonyaban waterfall, Ranong province; Nam Tok Ngao National Park, Ranong province; Khlong Phanom National Park, Surat Thani province; Khao Lak-Lam Ru National Park, Phang Nga province; Khao Phra Thaeo Wildlife Conservation Development and the Extension Center, Phuket province.

Conclusion

Members of the genus have long been closely related to Thai lifestyle, culture, tradition, belief and religion. Many *Piper* species have high economic potential to be applied towards local and industrial uses, including pharmaceu-

tical botany, pharmacognosy, traditional medicine, landscape decoration, aromatic, food, and spice markets. The biochemical compounds found in this genus should be studied more in order to develop the potential economic and ethnobotanical applications of *Piper*.

Our future research will report chemical compounds and DNA composition of every botanically reported *Piper* species in Thailand. In this way, we can create a comprehensive picture of *Piper* that can be used to improve pharmaceutical, medical and perfume industries. This will also benefit Thai traditional medicine, culture and national resource conservation.

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