Curcuma woodii (Zingiberaceae), a new species from Thailand

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Abstract

Curcuma woodii, a new species of Curcuma subg. Ecomata (Zingiberaceae) from Thailand is described and illustrated here. It differs from C. rhomba by the leaf blades abaxially pubescent, the bracts whitish green, the labellum white with orange bands at the center, the lateral staminodes white with orange dots at the apex, and the ovary nearly glabrous.

Key words: Curcuma, Thailand, new taxa, Ecomata, molecular diagnosis, DNA barcode

Introduction


When many plants from Thailand were introduced by Tom Wood (ginger curator from US) to South China Botanical Garden, the Curcuma species “Band of Gold” (which is named for its distinctive bicolored flowers of orange and white) attracted our attention. Early in 1992, the second author bought them from the local wild plant market in Sae Kaeow and planted them at Nong Nooch Tropical Botanical Garden. Tom Wood imported them from Nong Nooch Tropical Botanical Garden to South China Botanical Garden in 2010. Under cultivation at South China Botanical Garden in Guangzhou, the vegetative growth started in May, maturing to about 60 cm tall in late August. The first inflorescence emerging from the base of the pseudostems as in C. bicolor consists of white floral bracts. The flowers are one of the showiest in the genus Curcuma. Further studies confirmed that this plant represented a new species which is described and illustrated below.

Taxonomy

Curcuma woodii N. H. Xia & J. Chen, sp. nov.

Similar to Curcuma rhomba J. Mood & K. Larsen (subgen. Ecomata) in several characters but differs in the leaf blades ab-
axially pubescent, the bracts whitish green, the labellum white with orange bands at the center, the lateral staminodes white with orange dots at the apex, and the ovary nearly glabrous.

Type:—China, Guangdong, Guangzhou, South China Botanical Garden (cultivated, introduced from Thailand), 28 September 2010, J. Chen & T. Wood 201010 (holotype: IBSC). Figs. 1 & 2.

Herbs ca. 40–60 cm alt., perennial. Main rhizome slender, fibrous, multi-branched, 0.6–1 cm in diam., cream-colored inside; lateral rhizome creeping, slender, 0.6–1.0 cm in diam., white inside; root tubers ovate, white inside. Leafy shoots up to 60 cm tall, leaves 5; leaf sheaths green, pubescent; petioles 16–23 cm long, pubescent; ligules ca. 3 mm long, hairy on the margin; blades 26–30 × 9–12 cm, ovate to elliptic, green on both sides, adaxially glabrous, abaxially pubescent, base rounded, apex acuminate. Inflorescence terminal, ca. 4.5–5 × 4.5–5 cm; peduncles 2–3 cm long, pubescent; bracts ca. 2.5–3 × 3–3.5 cm, ovate to elliptic, whitish green, pubescent on both sides, apex obtuse; bracteoles absent. Flowers 4–4.7 cm long, exserted from the bracts, white. Calyx ca. 2 cm long, white, glabrous, 2-teethed. Corolla tubes ca. 3 cm long, white, pubescent; lateral corolla lobes ca. 1.4 × 0.5 cm, white to pinkish, glabrous; dorsal lobe ca. 1.5 × 0.6 cm, white, densely villous at throat. Lateral staminodes petaloid, ca. 1.5 × 0.9 cm, elliptic, white, deep orange dots at the top and deep purple dots at the base; labellum ca. 1.6 × 1 cm, suborbicular, unilaterally split for ca. 6 mm long, white, two deep orange bands at the center with deep purple lines at the base, 2-teethed. Filament broad, flat, white; anther ca. 9 mm long, white, crest ca. 1 × 1 mm, spur short, ca. 1 mm long, white. Ovary 2–4 mm long, nearly glabrous; stigma white, glabrous; epigynous glands 2, ca. 7 mm long, linear. Capsule subglobose, 3-valved, dehiscent; Seeds obovate, light brown, with white laciniate aril.

Molecular diagnosis:—The new species differs from all other species of Curcuma at the following nucleotide positions in the plastid matK gene, position 1008: Adenine not Guanine; in the plastid trnH-psbA spacer, position 102: Adenine not Thymine; 103: Guanine not Thymine; 109: Guanine not Thymine; 110: Adenine not Thymine; 184: Adenine not Cytosine; (Coordinates from Curcuma rhomba complete trnK region, GenBank accession no. JQ409668.1, matK gene from 780-2327; C. rhomba partial trnH-psbA spacer, Genbank accession no. JQ409783.1) (Table 1).

Cytology:—Chromosome numbers were counted in actively growing root tips from the cultivated plants at South China Botanical Garden. The root tips were pretreated with 0.002 M 8-hydroxyquinoline for 6 h and fixed in Carnoy I, then macerated in 1N HCl at 60°C for 5 min, and stained in Carbol fuchsins. Metaphase chromosomes were observed and photographs were taken under the OLYMPUS BX41 microscope (Olympus, Tokyo, Japan).

The metaphase chromosomes were counted to be 2n = 42 (Fig. 2A). The chromosomes of C. woodii were very small, ca. 1.5 μm in lengths. As a result of the small chromosome sizes, no clear morphological differences were observed. Centromeres were difficult to detect; thus, karyotype analysis was not performed.

Distribution and Habitat:—This species was purchased at the local wild plant market in Sae Kaeow, just at the border of Cambodia. Its natural range is unknown.

Phenology:—Flowering from July to September at South China Botanical Garden.

Etymology:—The specific epithet, ‘woodii’, was named after Tom Wood, who brought this species to South China.

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**TABLE 1.** Curcuma-specific substitutions in chloroplast and nuclear DNA regions as compared to 96 other accessions representing 49 species of Curcuma.

<table>
<thead>
<tr>
<th>Position</th>
<th>Specific substitution</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plastid matK region</strong>¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1008</td>
<td>G → A</td>
<td>Curcuma woodii-specific</td>
</tr>
<tr>
<td><strong>Plastid trnH-psbA spacer</strong>²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>102</td>
<td>T → A</td>
<td>Curcuma woodii-specific</td>
</tr>
<tr>
<td>103</td>
<td>T → G</td>
<td>Curcuma woodii-specific</td>
</tr>
<tr>
<td>109</td>
<td>T → G</td>
<td>Curcuma woodii-specific</td>
</tr>
<tr>
<td>110</td>
<td>T → A</td>
<td>Curcuma woodii-specific</td>
</tr>
<tr>
<td>184</td>
<td>C → A</td>
<td>Curcuma woodii-specific</td>
</tr>
</tbody>
</table>

¹ coordinates from Curcuma rhomba complete trnK region (GenBank accession no. JQ409668.1), matK gene from 780 to 2327.
² coordinates from Curcuma rhomba partial plastid trnH-psbA spacer (GenBank accession no. JQ409783.1)
Botanical Garden. Tom Wood made a great contribution to collecting gingers from South Asia, Australia, America and Arica to South China Botanical Garden.

Notes:—This species is similar to *C. rhomba* by the inflorescence emerging from the base of the pseudostems and anther shape. Their major differences lie in the bracts color, the flower parts color and shape (Table 2, Figs 1 & 2).

The flower shape of *C. woodii* is similar to *C. pierreana* Gagnepain (1907: 405) and *C. peramoena*. But this species is different from them by the leaf blades larger, the bracts whitish, the lateral staminodes white with orange dots at the apex and the ovary nearly glabrous (Table 2).

**TABLE 2.** Characters comparison of *Curcuma woodii*, *C. rhomba*, *C. pierreana* and *C. peramoena*

<table>
<thead>
<tr>
<th></th>
<th><em>C. woodii</em></th>
<th><em>C. rhomba</em></th>
<th><em>C. pierreana</em></th>
<th><em>C. peramoena</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height (cm)</td>
<td>40–60</td>
<td>ca.110</td>
<td>ca. 20</td>
<td>Up to 35</td>
</tr>
<tr>
<td>Petiole length (cm)</td>
<td>16–23</td>
<td>6–27.5</td>
<td>9–11</td>
<td>10–17</td>
</tr>
<tr>
<td>Leaves length (cm)</td>
<td>26–30 × 9–12</td>
<td>29–46 × 9–18.3</td>
<td>15–20 × 6–8</td>
<td>15–19 × 5–8</td>
</tr>
<tr>
<td>Purple cloud in the upper side of Lamina</td>
<td>absent</td>
<td>absent</td>
<td>present</td>
<td>absent</td>
</tr>
<tr>
<td>Lamina</td>
<td>adaxially glabrous, abaxially pubescent</td>
<td>glabrous</td>
<td>glabrous</td>
<td>adaxially glabrous, abaxially pubescent</td>
</tr>
<tr>
<td>Peduncle length (cm)</td>
<td>2–3</td>
<td>ca. 2</td>
<td>sessile</td>
<td>4–6</td>
</tr>
<tr>
<td>Fertile bracts color</td>
<td>whitish green</td>
<td>red</td>
<td>pink</td>
<td>light brown to red at the base to light green at the apex</td>
</tr>
<tr>
<td>Corolla color</td>
<td>white to pinkish</td>
<td>white</td>
<td>white</td>
<td>red</td>
</tr>
<tr>
<td>Labellum color</td>
<td>white with two wide deep orange bands at the center</td>
<td>orange</td>
<td>white with yellow bands at the center</td>
<td>white with two wide yellow bands at the center</td>
</tr>
<tr>
<td>Lateral staminode color</td>
<td>white with orange dots at the apex</td>
<td>orange, dotted dark red at the base</td>
<td>white with purple at the apex</td>
<td>white</td>
</tr>
<tr>
<td>Epigynous glands Length (mm)</td>
<td>ca.7</td>
<td>ca. 9</td>
<td>unknown</td>
<td>ca. 9</td>
</tr>
<tr>
<td>Ovary</td>
<td>nearly glabrous</td>
<td>pubescent</td>
<td>pubescent</td>
<td>densely pubescent</td>
</tr>
</tbody>
</table>

Only a single specimen (D. J. Middleton *et al.* 1220, barcode No.: E00196143) deposited at Royal Botanical Garden Edinburgh (E) and collected from Kui Buri National Park in Prachuap Khiri Khan in Thailand on 19th August, 2002, is a possible match for *C. woodii*. However, to confirm the identity of this specimen, re-collection from Kui Buri National Park is needed.

**Additional specimens examined (paratypes):**—China, Guangdong, Guangzhou, South China Botanical Garden (cultivated, introduced from Thailand), 9 September 2013, *J. Chen 201343* (IBSC).

**Discussion**

We initially thought *Curcuma woodii* might be an artificial hybrid. After molecular-phylogenetic work and blasting in NCBI website, we are confident that *C. woodii* is a new species. Sequencing of 96 accessions of *Curcuma* representing 49 species (plus relevant outgroups) for the nuclear ITS2 region, and the plastid *rbcL*, *matK*, *trnH-psbA* and *trnL-F* spacer region revealed that *C. woodii* has its specific DNA barcode and represents a new species (Chen *et al.* 2015). Our molecular phylogeny study of *Curcuma* showed that *C. woodii* is closely related to *Smithatris supraneanae* W. J. Kress & K. Larsen (2001: 226), which were nested within subgen. *Ecomata* (see Figure 3 in this paper, Figure 2 in Chen *et al.* 2015: 344). The phylogeny study also supported that *Curcuma* and *Curcuma*-like genera were paraphyletic, which was in conjunction with earlier investigations (Kress *et al.* 2002, Ngamiabsakul *et al.* 2004, Záveská *et al.* 2012). Based on the molecular phylogeny study of *Curcuma*, Zaveska *et al.* (2012) suggested *Curcuma*-like genera must be transferred to the genus *Curcuma*. Later, the *Curcuma*-like genera are formally sunk to *Curcuma* by Leong-Škorničková *et al.* (2015). But we did not get enough samples of *Curcuma*-like genera to reconstruct the phylogeny of these genera, which need further study to make it success.
FIGURE 3. Neighbor-joining tree for *Curcuma* and closely related genera using the ITS2 DNA barcode. Accessions were suffixed by voucher numbers, and corresponding subgenera were color-coded. Blue color, subg. *Curcuma*; green, subg. *Ecomata*. Clade nomenclature followed Záveská *et al.* (2012).
The different ploidy levels in *Curcuma* were indicated in many cytological studies (Chen et al. 2013). The widely accepted basic chromosome number \( x = 21 \) (Ramachandran 1961, Chen and Chen 1984, Joseph et al. 1999, Islam 2004). However, Leong-Škorničková et al. (2007) suggested that \( x = 7 \) should be considered a primary basic chromosome number, at least for the majority *Curcuma* species belonging to subgenus *Curcuma*. The basic number \( x = 21 \) appeared too high to be the primary one. Raghavan and Venkatusubban (1943), Venkatusubban (1946), and Ramachandran (1961) (1946) believed that this basic number might have been derived either by dibasic amphidiploidy (by combination of lower basic numbers of nine and 12 found in some genera in the family) or by secondary polyploidy. Nevertheless, based on the common basic number of \( x = 21 \), this species corresponds to 2x cytotypes.

The position of the inflorescence was very important characters to distinguish different *Curcuma* species, especially in 19th century. *Curcuma* species have terminal, or lateral inflorescences or both in the same species. For example, *C. longa* L. (1753: 2) only produces typical terminal inflorescences; *C. aromatica* Sablisbury (1807: pl. 96) produces typical lateral inflorescences; Santapau (1945) reported that *C. pseudomontana* Graham (1839: 210) can produce both early lateral and later central inflorescences. However, *C. woodii* produced non typical terminal inflorescences. Its terminal inflorescences with very short peduncles emerge at ground level, pushing the leaf sheaths apart centrally or out to side, as in *C. bicolor*, and *C. rhomba* J. Mood & K. Larsen (2001: 213). This characteristic of inflorescence position may represent a third inflorescence type in *Curcuma* species.

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