Transfer of Dyschoriste sinica H. S. Lo to Strobilanthes (Acanthaceae) Supported by the Morphological Characters

GAO Chun-ming, XIN Hai-jing, DENG Yun-fei

Abstract: After examining the type material and comparing to some other species of Dyschoriste Nees and Strobilanthes Blume on pollen and flower morphology, it reveals that Dyschoriste sinica H. S. Lo is a member of Strobilanthes as S. sinica (H. S. Lo) Y. F. Deng. Strobilanthes sinica belongs to Championella group of Strobilanthes and is related to Strobilanthes japonica (Thunb.) Miq., but differs in its procumbent habits, oblong-elliptic, subsessile leaves and solitary flowers in leaf axils. The genus Dyschoriste is no longer distributed in China.

Key words: Acanthaceae; Dyschoriste; Strobilanthes; Dyschoriste sinica, Strobilanthes sinica; Pollen; Taxonomy; China

Dyschoriste Nees is a genus of about 65 species in Acanthaceae lectotypified by D. depressa (L.) Nees and mainly distributed in tropical regions of the World. It is characterized by decumbent to erect perennial herbs, inflorescences of dichasia in leaf axils, calyx usually 5-lobed to the above of the middle, corolla bilabiate, upper lip 2-lobed, lower lip 3-lobed, stamens 4, didynamous, the filaments fused into two pairs on each side, the anthers 2-thecous with mucronate appendages at the base.
Lo\textsuperscript{[8]} described a new species, *Dyschoriste sinica* H. S. Lo, typified by Exped. Guizhou 5665 collected from Anlong Xian, Guizhou Province, China. This is the first time to record the genus in China. After examining its type material, we found that it is quite different from other species of *Dyschoriste* by its calyx 5-lobed almost to the base, symmetrical and 5-lobed corolla, and muticous anther-thecae. It suggested that *D. sinica* resembles Group *Championella* of *Strobilanthes* Blume and differs only in the filaments divided into two sections as indicated in the original description.

Pollen morphology plays a very important role in the systematic studies of Acanthaceae\textsuperscript{[9-15]}. In *Dyschoriste*, the pollen grains are subprolate or perprolate, tricolporate, irregularly poly-pseudocolpate, tectate perforate with supratectal microechinace and similar to those in *Hygrophi$a* R. Br. and *Chaetacanthus* Nees\textsuperscript{[13,16-17]}. Comparing to other genera of Acanthaceae, *Strobilanthes* includes a high level of pollen diversity\textsuperscript{[11,13-14,18-22]}. In *Championella* group, pollen grains are uniformly globose, tricolporate, having different size of the verrucae or echinulae on the surface of the exine\textsuperscript{[18,22-24]}. Obviously, the pollen of *Championella* is quite different from that of *Dyschoriste*.

To re-evaluate the position of *Dyschoriste sinica*, we observed the morphology of flowers of *D. depressa* (L.) Nees, *D. sinica* and *Strobilanthes japonica* (Thunb.) Miq., and pollen grains of *Dyschoriste depressa*, *D. oblongifolia* (Michx.) Kuntze, *D. sinica* and five species of *Championella* group of *Strobilanthes*.

1 Material and methods

Specimens of *Dyschoriste sinica*, *Championella* group of *Strobilanthes* and some other *Dyschoriste* kept in the following herbaria were examined: GH, IBK, IBSC, K, KUN, L, MO and PE.

Flowers of *Dyschoriste depressa* (Tatemi Shimizu et al. 18357, L), *D. sinica* (Exped. Guizhou 5665, IBSC) and *Strobilanthes japonica* (Thunb.) Miq. (Deng Yun-Fei 17950, IBSC) in this study were collected from dry specimens. They were dipped in the warm water for several hours, and then observed under Stemi SV 11 (Car Zeiss Ltd, Shanghai, China) and taken photos.

Pollen samples of *Dyschoriste depressa*, *D. oblongifolia*, *D. sinica* and five species of *Championella* group of *Strobilanthes* were observed under scanning electron microscopy (SEM). The samples were collected from herbarium specimens kept in herbaria of IBSC and L (Table 1). The pollen grains were acetolysed following the modified method of Erdtman\textsuperscript{[28]}. Anthers of the samples were taken from flowers under dissecting microscope. The whole anthers were softened by glacial acetic acid for 24 hours and then stamped with tweezers to release pollen grains. Using sieve (pore diameter 50 μm) to separate the pollen grains from the mixture. Then, the samples were acetolysed under 96°C for 5–8 minutes and washed three times in 70% ethanol using ultrasonic. The pollen samples were mounted on stubs and coated with gold for 110 seconds in JFC-1600 sputter

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Locality</th>
<th>Voucher</th>
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<tbody>
<tr>
<td><em>Dyschoriste depressa</em> (L.) Nees</td>
<td>Phitsanulok, Thailand</td>
<td>T. Shimizu et al 18357 (L)</td>
</tr>
<tr>
<td><em>Dyschoriste oblongifolia</em> (Michx.) Ktze.</td>
<td>United States</td>
<td>O. L. Kela 23957 (IBSC)</td>
</tr>
<tr>
<td><em>Dyschoriste sinica</em> H. S. Lo</td>
<td>Guizhou, China</td>
<td>Exped. Guizhou 5665 (IBSC)</td>
</tr>
<tr>
<td><em>Strobilanthes japonica</em> (Thunb.) Miq.</td>
<td>Guangdong, China</td>
<td>Deng Yunfei 17950 (IBSC)</td>
</tr>
<tr>
<td><em>Strobilanthes labordei</em> H. Lév.</td>
<td>Hunan, China</td>
<td>Deng Yunfei 19843 (IBSC)</td>
</tr>
<tr>
<td><em>Strobilanthes algoetcha</em> Miq.</td>
<td>Zhejiang, China</td>
<td>Jin Xiaofeng 703363 (IBSC)</td>
</tr>
<tr>
<td><em>Strobilanthes tetrasperma</em> (Champ. ex Benth.) Druce.</td>
<td>Fujian, China</td>
<td>Zhou Wei 00037 (IBSC)</td>
</tr>
<tr>
<td><em>Strobilanthes wilsonii</em> J. R. I. Wood &amp; Y. F. Deng</td>
<td>Sichuan, China</td>
<td>Deng Yunfei 20906 (IBSC)</td>
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</table>
coaters (JEOL Ltd, Tokyo, Japan). JSM-6360LV SEM (JEOL Ltd, Tokyo, Japan) was used for observation. The palynological terminology follows that of Punt et al.\textsuperscript{[26]}.

2 Results

2.1 Morphology of flowers

The main characters of *Dyschoriste depressa*, *D. sinica* and *Stroblanthes japonica* are described as follows (Fig. 1).

**Dyschoriste depressa** Calyx 5-lobed to the above of the middle; stamens 4, didynamous; the longer and shorter pairs of filaments fused as two pairs on each side; anthers bithecous with mucronate appendages at the base (Fig 1: A–C).

**Dyschoriste sinica** Calyx 5-lobed to the base; stamens 4, didynamous; filaments united at the base by a membrane; anthers bithecous, muticous (Fig. 1: D–F).

**Stroblanthes japonica** Calyx 5-lobed to the base; stamens 4, didynamous, included; filaments united at the base by a membrane; anthers bithecous, muticous (Fig. 1: G–I).

2.2 Morphology of pollen grains

Brief descriptions of the pollen grains of *Dyschoriste depressa*, *D. oblongifolia*, *D. sinica*, and five species of group *Championella* of *Stroblanthes* are listed in Table 2.

*Dyschoriste depressa* and *D. oblongifolia* have similar pollen grains that are prolate, triporate and the exine between colpi divided into bands by pseudocolpi (Fig 2: A–C). The pollen grains of *D. sinica* are globose, tricolporate, exine between colpi divided into bands by pseudocolpi, different size of the verrucae arranged on distinct or indistinct rows on the surface of the bands (Fig. 2: D–E). The pollen grains of five species of *Championella* of *Stroblanthes* are globose, tricolporate, exine between colpi divided into bands by pseudocolpi, different size of echinulae or verrucae arranged on rows on the surface of the bands (Fig. 2: F–O).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Shape</th>
<th>Aperture</th>
<th>Exine</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Dyschoriste depressa</em></td>
<td>Prolate</td>
<td>Triporate</td>
<td>Exine between colpi divided into bands by pseudocolpi</td>
</tr>
<tr>
<td><em>Dyschoriste oblongifolia</em></td>
<td>Prolate</td>
<td>Triporate</td>
<td>Exine between colpi divided into bands by pseudocolpi</td>
</tr>
<tr>
<td><em>Dyschoriste sinica</em></td>
<td>Globose</td>
<td>Triporate</td>
<td>Different size of the verrucae arranged on distinct or indistinct rows on the surface of the exine</td>
</tr>
<tr>
<td><em>Stroblanthes lindlertii</em></td>
<td>Globose</td>
<td>Triporate</td>
<td>Echinulate with uniform spines developed on the punctuate insulae</td>
</tr>
<tr>
<td><em>Stroblanthes oligantha</em></td>
<td>Globose</td>
<td>Triporate</td>
<td>Exine between colpi divided into bands by pseudocolpi, different size of verrucae arranged on distinct or indistinct rows on the bands</td>
</tr>
<tr>
<td><em>Stroblanthes japonica</em></td>
<td>Globose</td>
<td>Triporate</td>
<td>Exine between colpi divided into bands by pseudocolpi, different size of verrucae arranged on distinct or indistinct rows on the bands</td>
</tr>
<tr>
<td><em>Stroblanthes tetrasperma</em></td>
<td>Globose</td>
<td>Triporate</td>
<td>Exine between colpi divided into bands by pseudocolpi, different size of verrucae arranged on distinct or indistinct rows on the bands</td>
</tr>
<tr>
<td><em>Stroblanthes wilsonii</em></td>
<td>Globose</td>
<td>Triporate</td>
<td>Exine between colpi divided into bands by pseudocolpi, different size of verrucae arranged on distinct or indistinct rows on the bands</td>
</tr>
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3 Discussion

Both *Dyschoriste* and *Stroblanthes* were placed in the tribe *Ruellieae*\textsuperscript{[15–29]}. *Stroblanthes* differs from *Dyschoriste* in having contorted corolla, the filaments united as a whole at base by a membrane and the anthers muticous at base, while in *Dyschoriste* the filaments fused into two pairs on each side and the anther–thecae with mucronate appendages at the base\textsuperscript{[1,3,4,6,7,30]}.

Present studies show that *Dyschoriste sinica* has the characters of calyx 5-lobed to the base, stamens 4,
Fig. 1 Flowers morphology of *Dyschoriste depressa* (L.) Nees, *D. sinica* H. S. Lo, and *Strobilanthus japonica* (Thunb.) Miq. under light microscope. A–C. *Dyschoriste depressa*. A. Calyx; B. Flower; C. Anthers; D–F. *D. sinica* H. S. Lo.; D. Calyx; E. Flower; F. Anthers; G–I. *Strobilanthus japonica*; G. Calyx; H. Flower; I. Anthers. b. Bracteole; ca. Calyx lobe; Me. Membrane; Mu. Micronate appendage.
Fig. 2 SEM micrographs of pollen grains for *Dyschoriste* Nees and *Strobilanthes* Blume

didynamous, filaments united at the base by a membrane, and anthers bithecous, muticous. It is similar to *Strobilanthes japonica* but different from *Dyschoriste depressa*\(^{2,18,24,31}\). These characters indicate that *D. sinica* is not *Dyschoriste*.

The potential utility of pollen morphology for systematic studies has been emphasized in Acantaceae\(^{9,11-13,15}\). Furness\(^{17}\) recognized the pollen of African *Dyschoriste* species and suggested a single basic pollen type. Furthermore, Daniel\(^{16}\) observed Mexican species and showed that the pollen grains are subprolate to perprolate, tricolporate, exine between colpi divided into bands by pseudocolpi. Present studies showed that pollen grains of *Dyschoriste depressa* and *D. oblongifolia* are subprolate, tricolporate, exine between colpi divided into bands by pseudocolpi, and are the same as the previous researches. As suggested in the previous works, pollen of *Strobilanthes* has large variation and it has potential utility for generic and infra-generic delimitation\(^{10-12,19,32}\). *Championella* is a natural group in *Strobilanthes*. Even though the pollen of species placed in group *Championella* may have little difference, they share the same characters as the previous observations, such as uniformly globose, with echinulae or verrucae on the surface\(^{23,24}\). Pollen grains of *Dyschoriste sinica* are globose, tricolporate, exine between colpi divided into bands by pseudocolpi, different size of the verrucae arranged on distinct or indistinct rows on the surface of the bands. It is indicated that *D. sinica* share the same pollen type with Group *Championella* of *Strobilanthes*.

Subsequently, it is concluded that *Dyschoriste sinica* is a member of *Championella* group of *Strobilanthes* rather than *Dyschoriste* based on the morphological characters of flowers and pollen grains. *Strobilanthes* Blume is the third largest genus in Acanthaceae and consists of about 400 species\(^{35}\). It is mainly distributed in tropical and subtropical regions of Asia with 128 species in China\(^{31}\). The genus is characterized by its almost contorted corolla, the filaments united as a whole at base by a membrane, and anthers bithecous, muticous at base\(^{30}\). The group *Championella* is a small natural group in the genus consisting of about ten species and mainly distributed in China, with one species extending to Japan and Korea and one species endemic to South of Japan\(^{24,31,33-34}\). *Strobilanthes labordei* H. Lév., *S. longiflora* R. Ben., *S. sinica*, *S. szechuanica* (Batalin) J. R. I. Wood & Y. F. Deng, *S. tetrasperma* (Champ. ex Benth.) Druce, *S. austrosinensis* Y. F. Deng & J. R. I. Wood and S. *wilsonii* J. R. I. Wood & Y. F. Deng are endemic to China. *Strobilanthes oligantha* Miq. is found in central and eastern China, Japan and Korea. *Strobilanthes wasakana* Nakasugi & Naruhashi is endemic to S. Japan. *Strobilanthes japonica* is native in central China and introduced to Japan. The group *Championella* is characterized by its mostly weak, procumbent or decumbent isophyllous herb, flowers arranged in terminal few-flowered spikes, bracts persistent and leaf-like, calyx 5-lobed to the base, fertile stamens four, corolla funnel-shape or in *S. oligantha* and *S. longiflora* much larger, strongly bent and ventricose\(^{18,24,31}\). This group was regarded as an independent genus by Bremerkamp\(^{18}\) and followed by some authors\(^{31,35-39}\), but now it is recognized as part of *Strobilanthes* by most authors\(^{24,33,34,40-42}\). *Strobilanthes sinica* was only found from Anlong Xian, Guizhou Province, China.

Since we have transferred only Chinese species *Dyschoriste sinica* to *Strobilanthes*, we changed the Chinese name of *Dyschoriste* as “距药花属” after the generic character of the spurred anther-thecae.

4 Taxonomic treatments


Procumbent herbs, ca. 10 cm tall; stems quadrangular, glabrous, rooting at the nodes on lower portion. Leaves subsessile; blades 0.7-3 cm × 0.3-0.7 cm, oblong, apex obtuse, margin entire or serrate
upward, base attenuate, glabrous, lateral veins ca. 3 pairs on each side of midrib. Flowers solitary in upper leaf axils; bracts leaf-like, spathulate-ovate, ca. 0.7 cm; bracteoles 2, linear-spathulate, ca. 5 mm; calyx ca. 6 mm, 5-lobed to the base, lobes linear-lanceolate, ca. 0.6 mm broad; corolla purplish, ca. 1.1 cm, funnel-shaped, tube base cylindrical for ca. 4 mm long, then gradually widened to 1 cm at mouth, limb 5-lobed, lobes oblong, ca. 2–3 mm × 2 mm, apex obtuse. Stamens 4, didynamous, included; filaments glabrous, the longer pair ca. 3.5 mm, the shorter pair ca. 1 mm, united at the base by a membrane; anthers oblong, bithecous, muticous at the base; ovary glabrous, 2 ovules per locule borne on the hook-like retinacula; styles ca. 8 mm, sparsely pubescent. Capsule clavate, ca. 6 mm, 4-seeded. Seeds ovate in
outline, ca. 2 mm × 2 mm, pilose with mucilaginous
hairs, areola minute.

**Distributions:** It is endemic to Guizhou, China.
Only the type collection was seen.

*Strobilanthes sinica* belongs to *Championella*
group. It is related to *S. japonica*, but differs in its
procumbent habits, oblong-elliptic, subsessile leaves,
and solitary flowers in leaf axils.

To compare *S. sinica* with its related species, a
key to the species of *Championella* group of
*Strobilanthes* is provided below.

**Key to Championella group of Strobilanthes**

1a. Stamens exerted ...................................................... *S. labordei*
1b. Stamens included.

2a. Corolla ventricose, often curved, longer than 2 cm
2b. Corolla funnel-shaped, usually shorter than 1.5 cm.

3a. Leaf blade glabrous ...................................................... *S. longiflora*
3b. Leaf blade pubescent.

4a. Bracts oblong-elliptic, obovate, broadest near apex ...................................................... *S. austrosinosensis*
4b. Bracts lanceolate or oblong-elliptic, widest below middle ...................................................... *S. oligantha*

5a. Procumbent herbs, ca. 10 cm tall; leaves sessile; flowers solitary in leaf axils ...................................................... *S. sinica*
5b. Erect herbs, up to 30 cm tall; leaves petiolate; flowers arranged in terminal spikes.

6a. Leaf blade pubescent ...................................................... *S. wasakana*
6b. Leaf blade glabrous.

7a. Leaf margin entire or undulate; inflorescence glabrous.
7b. Leaf margin crenate or serrate; inflorescence pubescent.

8a. Leaf blades oblong to lanceolate, 2–6 cm long, tapered at the base; petiole glabrous; calyx with multicelled hairs ...................................................... *S. japonica*
8b. Leaf blades ovate, less than 2.2 cm long, cuneate at the base; petiole pubescent; calyx without multicelled hairs ...................................................... *S. szechuanica*

9a. Petiole equal to leaf blade, coarsely hirsute with multicelled hairs ...................................................... *S. wilsonii*
9b. Petiole much shorter than leaf blade, pubescent ...................................................... *S. tetrasperma*

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