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Morphology and Taxonomic Status of *Tricyrtis viridula* (Liliaceae)

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Abstract Taxonomic status of *Tricyrtis viridula*, a new species recently added to the chinese flora, was discussed based on morphology of the flower, the inflorescence and the rhizome, coloring of the flower including nectar guide, pigmentation in the roots, and the karyotype. *Tricyrtis viridula* has many features common to those of *T. affinis*, *T. setouchiensis* and *T. pilosa*, and it is assigned to sect. *Tricyrtis*. The distribution map of *T. viridula* and a key to the species of the sect. *Tricyrtis* are given.

Key words: Chinese flora, distribution, inflorescence, karyotype, nectar guide, taxonomy, *Tricyrtis viridula*.

Tricyrtis viridula Hir. Takah. is a new species recently described from south and southeast China (Takahashi, 1997). It is similar to *T. pilosa* and *T. macropoda* in habit and morphology of flower and/or inflorescence, and has been misidentified very often as either species in the chinese flora (e.g., Tsi, 1980; Takahashi, 1980; Lin, 1993). It is also similar to two Japanese species, *T. affinis* and *T. setouchiensis*, in morphology of flower and/or inflorescence (Takahashi, 1997). Therefore, it is suggested that *T. viridula* is closely related to these four species. These species are comprised in the sect. *Tricyrtis*, together with more two species (Takahashi, 1980; Table 1).

We examined morphological characters of *Tricyrtis viridula* more in detail in comparison with six species in the sect. *Tricyrtis*. As a result of the present comparative study, a key to the species of the sect. *Tricyrtis* and a distribution map of this species are also given.

Materials and Methods

Materials for the morphological observation were collected in the provinces of Zhejiang, Jiangxi and Guizhou in China.

Presence of anthraquinoid pigments was tested by the same method used by Takahashi (1974) in the roots of some herbarium specimens in SHM as well as our collections.

Seeds of *Tricyrtis viridula* were collected at Feng Yang Mountain in Zhejiang Province, and seedlings were used for karyotype analysis. Following Takahashi (1980), after the root tips were pretreated in 0.05% colchicine at about 11°C for 2.5 hours and fixed in acetic acid-ethanol mixture (1 : 3) for 5 minutes, they were washed and macerated in 1 N-HCl at 60°C for 20 seconds, and then the root meristem was squashed in 1% aceto-orcein.

The specimens deposited in KUN, SHM and TI as well as the plants collected in our expeditions to south and southeast China were used for the distribution analysis.

Results and Discussion

Flower:

The tip of the outer tepals of *Tricyrtis viridula* is stick-like, being quite different from those in sects. *Brachycyrtis* and *Flavae* (cf. Takahashi, 1980).

The filaments of *Tricyrtis viridula* are papillate on the basal part, and it is a common character in sect. *Tricyrtis*, sect. *Brachycyrtis* and some plants of *T. hirta* in sect. *Hirtae* (Takahashi, 1980).

The perianth of *Tricyrtis viridula* is very similar in shape to that of *T. affins* and *T. setouchiensis* in sect. *Tricyrtis*; it is patent at the level of about 1/3 from the base (Takahashi, 1997). However, some traits differ from each other. The ground color of the perianth is white in *T. affinis* and *T. setouchiensis*, while it is greenish white in *T. viridula* (Figs. 1–3). *Tricyrtis setouchiensis* has an orange nectar guide just below the patent point in the adaxial side of the tepal (Takahashi, 1989; Fig. 1). *Tricyrtis affinis* has a nectar guide of a large purple spot in the same area (Takahashi, 1992; Fig. 2). This spot is clearly different in size from other spots on the tepal. *Tricyrtis viridula* has some small purple spots in that area, and mostly has also a large pale-orange spot there (Fig. 3). These spots must be nectar guides, because bumblebees grope with their proboscis around them (Fig. 4). The orange spots as nectar guides are the most common in the genus *Tricyrtis* and may be a plesiomorphic character. The purple spot as the nectar guide in *T. affinis* is probably a derivative character, and *T. macropoda* probably lost nectar guides (Takahashi, 1994). The plants with orange spots in *T. viridula* may barely retain such a plesiomorphic character.

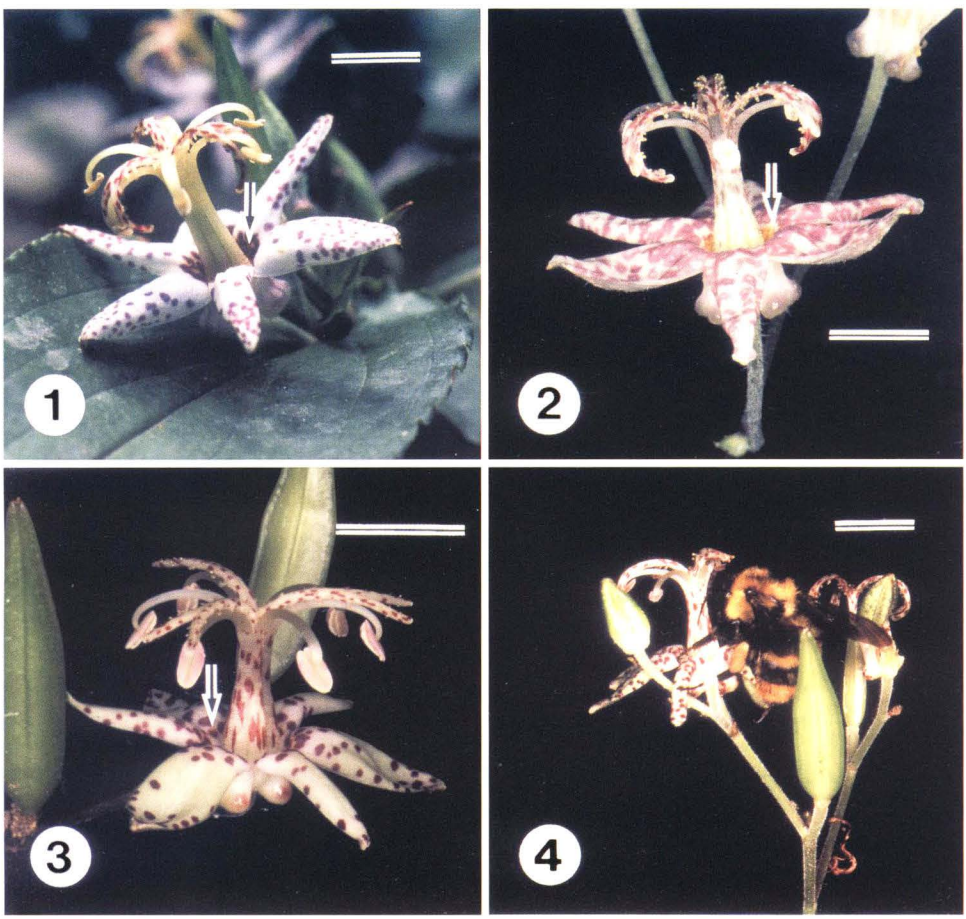
Flowers of *Tricyrtis pilosa* are very similar to that of *T. viridula* in shape and color (Bot. Mag. t. 4955). However, information about nectar guides is still insufficient.

Inflorescence:

Tricyrtis viridula has the inflorescence composed of some cymose-branchings

Table 1. The species in the sect. *Tricyrtis* and their distribution area.

Species	Distribution area
T. suzukii	Taiwan
T. setouchiensis	Japan
T. macropoda	Japan, Korea, China
T. latifolia	Japan, China
T. affinis	Japan
T. pilosa	Himalaya, China



Figs. 1–4. Flowers of *Tricyrtis affinis* (1), *T. setouchiensis* (2) and *T. viridula* (3), and bumblebee foraging on the flower of *T. viridula* (4). The arrows indicate nectar guides. Bar=1 cm.

on the stem terminal. The main shoot apex becomes the first flower of the first branching. This species usually produces many flowers, and, in that case, make three or more cymose-branchings (up to five branchings) with up to eight flowers (Figs. 7–9). The same type of inflorescence is found in most species of sect. *Tricyrtis* (Takahashi, 1980). However, they usually have two branchings but no more than three (Figs. 5 and 6). *Tricyrtis setouchiensis* with many flowers makes some lateral flowering shoots in the axils of the foliage leaves (Fig. 5). *Tricyrtis affinis* makes sometimes distinct cymose-branchings, although it mostly appear to hold flowers in the leaf axils. The cymose-branchings of *T. affinis*, however, emerge from the upper leaf axils, and the shoot apex of the main stem never becomes the first flower (Takahashi, 1980).

The same type of inflorescence as *Tricyrtis viridula* is made in most species of the sect. *Hirtae* (Takahashi, 1980). These inflorescences in which the main shoot apex forms the first cymose-branching do not have more than three branchings on the terminal as well, though each branching holds many flowers.

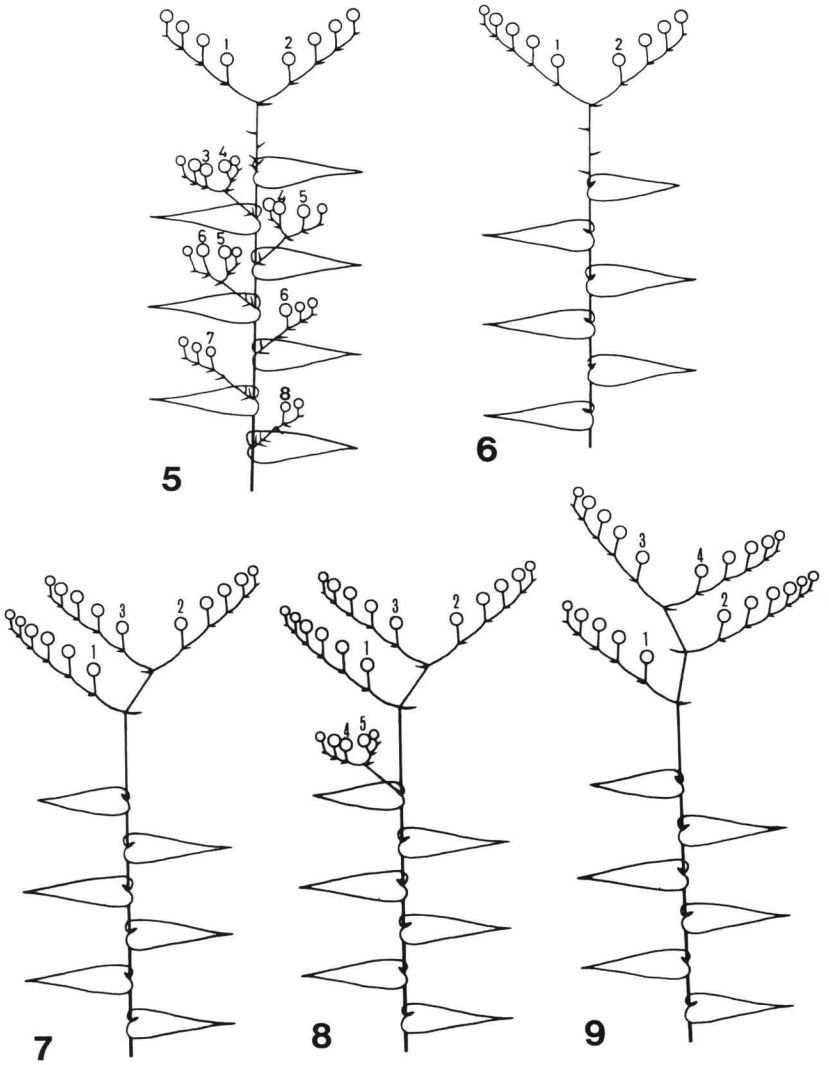
Rhizome and root:

All species of sects. *Brachycyrtis* and *Hirtae* and most species of sect. *Tricyrtis* produce distinct horizontal stoloniform rhizomes, terminal buds of which develop into new plants in the following year. Since the internodes are decayed by the next season, the new plants become independent. *Tricyrtis macropoda* in sect. *Tricyrtis*, however, produces one or rarely two rhizomes which live for several years (Takahashi, 1974). The species of sect. *Flavae*, on the other hand, produce no horizontal rhizomes, and the buds of the next generation are produced on the underground part of the stem, i.e., vertical rhizome (Takahashi, 1980). Distinct horizontal rhizomes are formed in *T. viridula*. They are, however, fewer (usually only one) and shorter (0.5–1.5 cm long) than those in *T. affinis* and *T. setouchiensis* (up to four and 1–10 cm long).

No anthraquinoid pigments were detected in any plants of *Tricyrtis viridula*. Although the pigments in roots are charcteristic of the sect. *Tricyrtis*, some species contain no pigments (Takahashi, 1974).

Karyotype:

The karyotype of *Tricyrtis viridula* is very similar to that of *T. affinis* and *T. macropoda* (Takahashi, 1980). The somatic chromosome number is 26 (Fig. 10). Two pairs of large chromosomes are acrocentric, one pair of middle-sized ones is subtelocentric, eight pairs of middle to small sized ones are submetacentric or metacentric and two pairs of small ones are telocentrics. One pair of the large acrocentrics has satellites on their short arms, and one of the middle-sized submetacentrics also has a satellite on the short arm. This karyotype is also similar to that of *T. setouchiensis*, but satellites on the middle-sized subtelocentrics, which were recognized in the latter species, were not observed in *T. viridula*.



Figs. 5–9. Inflorescences of *Tricyrtis setouchiensis* (5), *T. macropooda* (6), and *T. viridula* (7–9). Figs. 6 and 7: from Takahashi (1980).

Fig. 10. Somatic chromosomes of *Tricyrtis viridula*. Bar=5 μ.

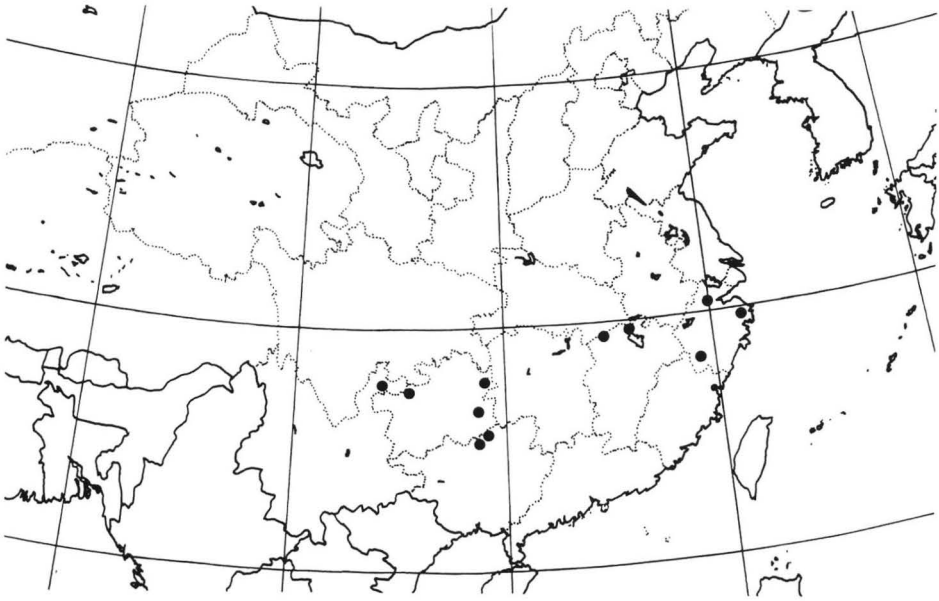


Fig. 11. Distribution map of *Tricyrtis viridula*.

Although the karyotype of *Tricyrtis viridula* is similar to that of *T. formosana* and *T. hirta* as well, the satellites are on the different type of chromosome from each other and/or on the different arms of chromosomes of the same type (Takahashi, 1980, 1991). The species of sects. *Brachycyrtis* and *Flavae* are different from these three species in having no telocentric chromosomes.

Distribution:

Tricyrtis viridula is distributed in south and southeast China; Zhejiang, Jiangxi, Guizhou, Guangxi, and northeast Yunnan (Fig. 11). It grows at forest margins or on forest floors in the upper warm-temperate to the cool-temperate zone. *Tricyrtis pilosa* is not found in East China, but in north-eastern Yunnan.

Conclusion and Key to the Species of the Section *Tricyrtis*

Our investigations of the above morphological characters show that it is reasonable to assigne *Tricyrtis viridula* to sect. *Tricyrtis*.

Key to the species of the sect. *Tricyrtis* is as follows:

1. Roots with pigments of anthraquinoid
   2. Perianth spreading obliquely upward ..... *T. suzukii*
   2. Perianth patent or recurved
      3. Perianth patent ..... *T. setouchiensis*

3. Perianth recurved..... *T. macropoda*

1. Roots without pigments of anthraquinoid
   2. Perianth spreading obliquely upward yellow with red-purple spot .... *T. latifolia*
   2. Perianth patent
      3. Perianth white with purple spots ..... *T. affinis*
      3. Perianth greenish white with purple spots
         4. Stem and leaves pubescent. Inflorescence with a few flowers .... *T. pilosa*
         4. Stem and leaves nearly glabrous. Inflorescence with many flowers; perianth often with pale orange spots just below the patent point .... *T. viridula*

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