Karyological Characteristics of *Impatiens* (Balsaminaceae) in Yunnan, China

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Abstract. Chromosome numbers and karyotypes of 15 species of *Impatiens* collected from south and northwestern Yunnan, China, were investigated. Nine of them were examined for the first time. As a result, seven different chromosome numbers were counted: 2n=14 in *Impatiens kamilongensis* and *I. wuchengyihi*; 2n=16 in *I. wuchengyihii*; 2n=18 in *I. corchorifolia*, *I. lachuensis*, *I. maguanensis*, *I. porphyrea*, *I. racemosa*, *I. radiata*, *I. ruiliensis*, and *I. uliginosa*; 2n=20 in *I. arguta*; 2n=34 in *I. clavigeroides*; 2n=36 in *I. linearisepala*; 2n=40 in *I. rubrostriata*. Of the eight species with 2n=18, *I. corchorifolia* only has a monomodal karyotype, while the seven others are characterized by having a bimodal karyotype in common. Based on present and previous studies we discuss karyological characteristics of *Impatiens* in Yunnan.

Key words: Balsaminaceae, chromosome number, *Impatiens*, karyotype, Yunnan.

Received September 27, 1996; accepted March 17, 1997

In our previous paper (Sugawara et al., 1994), we reported on the chromosome numbers and karyotypes of ten species of *Impatiens* collected from southwestern Yunnan, China, and suggested a close relationship of these species to the Himalayan one. Nevertheless, our knowledge of karyological aspects for Chinese *Impatiens* is still limited to the above species. According to Chen (1978) and Wu (1984), about 190 species are known in China, and approximately 80 of them are distributed in Yunnan. Recently, nine species were newly added to Chinese flora from southwest (Akiyama et al., 1995) and south Yunnan (Akiyama et al., 1996). As already stated by Akiyama et al. (1992; 1995), taxonomy of *Impatiens* in China is still uncertain and confusing. One of the reasons for the present status may be caused by the shortage of informations available for elucidating the relationships among the species. Earlier karyological studies of *Impatiens* in other area have supplied valuable data to advance our understanding of the species relationship within the genus: basic chromosome numbers show a remarkable variation among the species ranging from \(x(n)=3\) to \(x(n)=14\), 16, 17, 22, 24 and 33, and these numbers have distinctive geographic distributions (Jones and Smith, 1966;
Grey-Wilson, 1980; Govindarajan and Subramanian, 1986; Akiyama et al., 1992; see also Shimizu, 1984).

In this paper we report on the chromosome numbers and karyotypes of 15 species of *Impatiens* collected from south and northwest Yunnan, and based on this and a previous study (Sugawara et al., 1994) we discuss the karyological characteristics of *Impatiens* distributed in Yunnan.

**Materials and Methods**

The specimens examined in this study were collected from Luchun and Maguan Counties, south Yunnan, and Dali and Yangbi Counties, northwest Yunnan in 1994 and 1995. Their localities and voucher specimens are shown in Table 1. The voucher specimens were deposited in the Kunning Institute of Botany (KUN), China, and the University of Tokyo (TI), Japan.

Among the 15 species examined, *Impatiens kamtilongensis* and *I. porphyrea* are also known from Burma, *I. arguta* from North India, east Himalaya, Bhutan, and Burma (Akiyama et al., 1996), *I. radiata* from India and the Himalaya, and *I. mengtszeana* from Thailand and Vietnam (Chen, 1978). *Impatiens racemosa* widely occurs in east Asia ranging from Kashmir and South Tibet to southwestern China, and is considerably variable in floral morphology (Akiyama et al., 1991, 1995, 1996). Nine other species are known only from China, and five of them, *I. clavigeroides*, *I. luchunensis*, *I. maguanensis*, *I. wuchengyihii*, and *I. linearisepala* were recently described from Luchun and Maguan by Akiyama et al. (1996).

Methods for observation of somatic metaphase chromosomes are the same as those reported by Sugawara et al. (1994). Cell plates favorable for counting were photographed, and the chromosomes were subsequently drawn with help of the photograph. Nomenclature for centromeric position on chromosomes follows Levan et al. (1964).

**Results**

The chromosome numbers of 15 species of *Impatiens* examined in this study are shown in Table 1. Nine of them were examined for the first time. In the present study seven different chromosome numbers were found. The numbers and karyological features are described below.

The chromosome numbers of *Impatiens wuchengyihii* and *I. kamtilongensis* were 2n=14 (Fig. 1A, B). In metaphase chromosome the chromosomal length ranged from 3.0 μm to 1.2 μm in *I. wuchengyihii* and from 2.2 μm to 1.0 μm in *I. kamtilongensis*, respectively. Their karyotypes were similar to each other, and no significant difference was found: four or six chromosomes have a centromere at submedian region, and remaining chromosomes at the median region.

The chromosome number of *Impatiens mengtszeana* was 2n=16, in agreement with previous reports for the plant from Thailand (Larsen,
### TABLE 1. Species examined of *Impatiens*, and their collections and chromosome numbers.

<table>
<thead>
<tr>
<th>Species</th>
<th>Collection</th>
<th>Chromosome number (2n)</th>
<th>Karyotype</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Impatiens kamii longensis</em> Toppin</td>
<td>Maguan. Gulingquing, alt. 1700–1900m (Wu et al. 2659; KUN, TI)</td>
<td>14*</td>
<td>mono 1)</td>
</tr>
<tr>
<td></td>
<td>Maguan. Gulingquing. Xiaocunzi, alt. 1050m (Wu et al. 2678; KUN, TI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>I. wuchongyihi</em></td>
<td>Luchun. Huanglianshan, alt. 1700m (Wu et al. 2457; KUN, TI)</td>
<td>14*</td>
<td>mono</td>
</tr>
<tr>
<td>S. Akiyama, H. Ohba &amp; S. K. Wu</td>
<td>Luchun. Huanglianshan, alt. 2200m (Wu et al. 2474; KUN, TI)</td>
<td>16</td>
<td>mono</td>
</tr>
<tr>
<td><em>I. mengtsezaana</em> Hook. f.</td>
<td>Yangbi. Xueshanhe, alt. 2200–2300m (Cheng et al. 2749; KUN, TI)</td>
<td>18*</td>
<td>mono</td>
</tr>
<tr>
<td><em>I. coronata</em> Franch.</td>
<td>Luchun. Huanglianshan, alt. 2200m (Wu et al. 2475; KUN, TI)</td>
<td>18*</td>
<td>bi 2)</td>
</tr>
<tr>
<td><em>I. maguanensis</em> S. Akiyama, H. Ohba &amp; S. K. Wu</td>
<td>Maguan. Gulingquing, alt. 1700–1900m (Wu et al. 2658; KUN, TI)</td>
<td>18*</td>
<td>bi</td>
</tr>
<tr>
<td><em>I. porphyrea</em> Toppin</td>
<td>Luchun. Huanglianshan, alt. 1700m (Wu et al. 2452; KUN, TI)</td>
<td>18*</td>
<td>bi</td>
</tr>
<tr>
<td><em>I. racemosa DC.</em></td>
<td>Dali. Cangshan, alt. 2950m (Cheng et al. 2703; KUN, TI)</td>
<td>18</td>
<td>bi</td>
</tr>
<tr>
<td></td>
<td>Yangbi. Xueshanhe, alt. 2200–2300m (Cheng et al. 2748; KUN, TI)</td>
<td>18</td>
<td>bi</td>
</tr>
<tr>
<td><em>I. radiata</em> Hook. f. &amp; Thomson</td>
<td>Yangbi. Xueshanhe, alt. 2200–2300m (Cheng et al. 2746; KUN, TI)</td>
<td>18</td>
<td>bi</td>
</tr>
<tr>
<td><em>I. ruiliensis</em> S. Akiyama &amp; H. Ohba</td>
<td>Luchun. Huanglianshan, alt. 1700m (Wu et al. 2451; KUN, TI)</td>
<td>18</td>
<td>bi</td>
</tr>
<tr>
<td><em>I. uliginosa</em> Franch.</td>
<td>Yangbi. Zhongshan, Baishahc, alt. 2200–2700m (Cheng et al. 2795; KUN, TI)</td>
<td>18</td>
<td>bi</td>
</tr>
<tr>
<td></td>
<td>Dali. Gantongsi, alt. 2000m (Cheng et al. 3280; KUN, TI)</td>
<td>18</td>
<td>bi</td>
</tr>
<tr>
<td><em>I. arguta</em> Hook. f. &amp; Thomson</td>
<td>Dali. Changshan, alt. 2950m (Cheng et al. 2702; KUN, TI)</td>
<td>20*</td>
<td>mono</td>
</tr>
<tr>
<td></td>
<td>Yangbi. Xueshanghe, alt. 2200–2700m (Cheng et al. 2747; KUN, TI)</td>
<td>20*</td>
<td>mono</td>
</tr>
<tr>
<td><em>I. clavigeroides</em> S. Akiyama, H. Ohba &amp; S. K. Wu</td>
<td>Luchun. Huanglianshan, alt. 1700m (Wu et al. 2403; KUN, TI)</td>
<td>34*</td>
<td>mono</td>
</tr>
<tr>
<td><em>I. linearisepala</em> S. Akiyama, H. Ohba &amp; S. K. Wu</td>
<td>Maguan. Gulingquing, alt. 1700–1900m (Wu et al. 2652; KUN, TI)</td>
<td>36*</td>
<td>mono</td>
</tr>
<tr>
<td><em>I. rubrostiata</em> Hook. f.</td>
<td>Luchun. Huanglianshan, alt. 1700m (Wu et al. 2453; KUN, TI)</td>
<td>40*</td>
<td>mono</td>
</tr>
</tbody>
</table>

*New chromosome count for the taxon.
1) mono: monomodal karyotype
2) bi: bimodal karyotype

1981; Shimizu, 1984) and from southwestern Yunnan (Sugawara et al., 1994).

The chromosome numbers of *Impatiens corchorifolia* (Fig. 1C), *I. luchunensis* (Fig. 1F), *I. maguanensis* (Fig. 1D), *I. porphyrea* (Fig. 1E), *I. racemosa*, *I. radiata*, *I. ruiliensis*, and *I. uliginosa* were 2n=18. Previous reports (Akiyama et al., 1992; Sugawara et al., 1994) for *I. racemosa*, *I. radiata*, *I. ruiliensis*, and *I. uliginosa* were reconfirmed in the present study. Two different karyotypes, monomodal and bimodal, were recognized in the eight species. *Impatiens corchorifolia* has a monomodal
karyotype. In the karyotype of this species all the metaphase chromosomes were very small (approximately 1 \( \mu m \) to 0.7 \( \mu m \) in length), and similar in size. Bimodal karyotype was found in the seven other species. In the karyotype two chromosomes were obviously longer (about 3.5 \( \mu m \) in length) than the others, and had centromeres at the submedian region, while the 16 remaining chromosomes were very small (1.3 \( \mu m \) to 0.7 \( \mu m \) in length) and had centromeres at the median region.

The chromosome number of *Impatiens arguta* was \( 2n=20 \) (Fig. 1G). Its metaphase chromosomes were highly symmetrical, and very small (less than 1.5 \( \mu m \) in length). Previous counts for the species had been made on the plants from east Himalaya and North India, and two different chromosome numbers, \( n=6 \) (\( 2n=12 \)) and \( n=9 \), had been reported (Chatterjee and Sharma, 1970; see also Shimizu, 1984). In the present study the number \( 2n=20 \) was observed in the plants collected from two different localities.

The chromosome number of *Impatiens clavigeroides* was \( 2n=34 \) (Fig. 1H). Its metaphase chromosomes were very small (less than 1.5 \( \mu m \) in length), monomodal in size and had centromeres commonly at the median region.

The chromosome number of *Impatiens linearisepala* was \( 2n=36 \) (Fig. 1I). Its metaphase chromosomes were very small (less than 1 \( \mu m \) in length) and monomodal in size. Almost all the chromosomes possessed centromeres at the median region.

The chromosome number of *Impatiens rubrostriata* was counted as \( 2n=40 \) (Fig.1J). Its metaphase chromosomes were also small (less than 1 \( \mu m \) in length) and monomodal in size. The karyotype was largely composed of metacentric chromosomes. In our previous study (Sugawara et al., 1994), the number \( 2n=20 \) was counted for the plants collected from Jingdong, southwestern Yunnan. The number \( 2n=40 \) counted here may be a tetraploid based on \( x=10 \).

**Discussion**

It was confirmed that the species of *Impatiens* from south and northwest Yunnan were considerably diversified in chromosome number. Seven different number, i.e., \( 2n=14, 16, 18, 20, 34, 36 \) and 40 were counted for the 15 species examined. The numbers \( 2n=14, 34, 36 \) and 40 are reported for the first time for Chinese species. As already suggested by Chatterjee and Sharma (1970), who studied meiosis for several species of *Impatiens* indigenous to east Himalaya, the numbers \( 2n=14, 16, 18, 20, \) and 34 are considered to be diploid, while the numbers \( 2n=36 \) and 40 may be tetraploids on \( x=9 \) and \( x=10 \), respectively.

Among the eight species with \( 2n=18 \), monomodal and bimodal karyotypes were recognized. The former was found only in *I. corchorifolia* collected from northwestern Yunnan. Previously, monomodal karyotype was also reported for *I. scullyi*, a species distributed in east Himalaya (Akiyama et al., 1992). As to the evolution of the two different karyotypes, Akiyama et al. (1992) presumed that the monomodal
The karyotype has been derived from the bimodal one, although there is no evidence to indicate which of these two karyotypes is more specialized. Aside from the evolution of the two karyotypes, it is notable that the number $x=9$ with a bimodal karyotype is predominant in south and southwest Yunnan.

Fig. 2 shows the collection site and chromosome numbers of 20 species examined in this and a previous study (Sugawara et al., 1994). This figure reveals the fact that the species with $2n=18$ is spread widely in Yunnan, while the species with $2n=14$, $34$, $36$, and $40$ are restricted to south Yunnan.

Although Zinov'eva-Stahevitch and Grant (1984), Rao et al. (1986), and Akiyama et al. (1992) mentioned that the number $x(n)=9$ was largely confined to central and east Himalaya, it is also the most common in Yunnan.

It is known that the number $x=10$ is widely found in species of the temperate zones on the Northern Hemisphere (Shimizu, 1984; Zinov'eva-Stahevitch and Grant, 1984). This number was also found in two species of Yunnan, *I. arguta* and *I. rubrostriata*.

![Map showing the chromosome numbers and collection sites of the 20 species examined of *Impatiens* in Yunnan.](image-url)
The number \(x(n)=17\) has hitherto been reported only from four species in South India, Malaya, and Thailand (Larsen, 1981; Shimizu, 1984; Zinov'eva-Stahevitch and Grant, 1984). Existence of *Impatiens clavigeroides*, a species with \(2n=34\) in south Yunnan, reveals that the number \(x=17\) extends as far as southwestern China.

Although it has been known that the numbers \(x(n)=7\) and \(x(n)=8\) are more common in species of south to northwest Himalaya, south India, southeastern Asia, and Africa (Jones and Smith, 1966; Okada, 1984; Govindarajan and Subramanian, 1986; Shimizu, 1984; Rao et al., 1986; Akiyama et al., 1992), the present results show that these two numbers are also characteristic of the species distributed in south to southwestern Yunnan.

In conclusion, karyologically it may be said that Yunnan species of *Impatiens* are diversified in chromosome number, but many of them share karyological characteristics with the species of central and east Himalaya, and some are related to the species distributed in south to southeastern Asia.

We are grateful to Prof. S. K. Wu and the members of Kunming Institute of Botany, Academia Sinica, for providing research facilities and for their help in the field. Thanks are also due to Mr. T. Saito, Tokyo Metropolitan University, for obtaining literatures. This study was partly supported by Grant-in-Aid for Overseas Science Survey No.05041081 to J. Murata from the Ministry of Education, Science, Culture and Sports, Japan.

References


摘 要
菅原 敬¹・秋山 忍²・楊 永平³・邑田 仁⁴：雲南省に産するツリフネソウ属植物の核形態学的特徴
これまで中国雲南省から80種以上のツリフネソウ属植物が記載されているが、1993年の
南西部、そして1995年の南部地域調査で新たに9種が見いだされた。雲南省におけるツリ
フネソウ属草植物の核形態学的多様性は、先の調査で多少わからてきたが、同地域における
著しい種分化を考えると情報は依然不十分といわざるをえない。そこで、南部地域からの5
新種を含む雲南省産15種の染色体数と核型解析した。その結果、染色体数は2n=14
(Impatiens kamtilongensis, I. wuchengyihi), 2n=18 (I. corcorifolia, I. luchunensis, I.
maguanensis, I. porphyrea, I. racemosa, I. radiata, I. ruiliensis, I. uliginosa), 2n=20 (I.
arguta), 2n=34 (I. clavigeroides), 2n=36 (I. linearisepala), 2n=40 (I. rubrostriata)であ
った。2n=14, 2n=34, 2n=36, 2n=40は、雲南省に産する種では初めての報告である。先
の雲南省南部地域産に関する結果を総合して考えると、雲南省西部のx(n)=9が最も普
通で広く分布し、その核型は中部・東ヒマラヤ地域に産する種に強く類似することが示され
た。また、雲南省南部から南西部地域にはx(n)=7, x(n)=8, x(n)=17の染色体数をもつ種
が数多く分布するが、これらはインドや東南アジア南部地域からの拡がりを示していると考え
られる。

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