Karyotype studies on ten *Iris* species (Iridaceae) from Sichuan, China

Xiao-Fang Yu[1,2], Hai-Qing Zhang[1,2], Ming Yuan[3], Yong-Hong Zhou[1,2*]

[1]Triticeae Research Institute,
[2]Key Laboratory of Crop Genetic Resources and Improvement of Ministry of Education, Chengdu Academy of Sciences, Sichuan Agricultural University, Wenjiang 611130, Chengdu, Sichuan, P.R. China.
[3]College of Biology and Science, Sichuan Agricultural University, Ya'an 625014, Sichuan, P.R. China.

Abstract — Chromosome number and karyotype analysis of 10 taxa in the genus *Iris* (Iridaceae) from Sichuan, China were investigated in this study. The chromosome number and karyotype formula of 10 *Iris* taxa are as follows: *I. lactea*, 2n = 40 = 28m + 10sm + 2st; *I. lactea* var. *chinensis*, 2n = 40 = 18m + 16sm + 6st (6SAT); *I. chrysographes*, 2n = 40 = 18m + 22sm (2SAT); *I. japonica*, 2n = 36 = 16m + 14sm + 6st; *I. tectorum*, 2n = 28 = 16m (4SAT) + 12sm (2SAT); *I. confusa*, 2n = 32 = 8m + 18sm + 6st; *I. germanica*, 2n = 40 = 16m + 20sm + 4st; *I. sichuanensis*, 2n = 26 = 12m (4SAT) + 12sm (2SAT) + 2st; *I. leptophylla*, 2n = 26 = 14m (2SAT) + 10sm (4SAT) + 2st; *I. goniocarpa*, 2n = 26 = 12m + 12sm + 2st (2SAT). The karyotypes of *I. sichuanensis*, *I. leptophylla*, *I. goniocarpa*, *I. lactea, I. confusa* and *I. germanica* were firstly reported, and the chromosome number of *I. confusa* and *I. germanica* were newly observed. Based on the karyotype results and previous studies, we suggested that: (1) *I. wattii*, *I. confusa* and *I. japonica* are three independent species; (2) *I. sichuanensis*, *I. leptophylla* and *I. goniocarpa* are three independent species with close relationships; (3) it is reasonable to treat *I. lactea* var. *chinensis* as a variety of *I. lactea*.

Key Words: China, chromosome number, *Iris*, karyotype, taxonomy.

INTRODUCTION

Iris L. is a large genus of Iridaceae involving about 300 species in the world, which is distributed in the north temperate regions (Zhao 1985). There are 60 species, 13 varieties, and 5 forms in China, which is a distribution center of *Iris* (Waddick and Zhao 1992). Twenty three species and 2 varieties of *Iris* were reported in Sichuan province, which accounts for 1/3 of *Iris* in China (Gao 1989). The flowers of *Iris* are large and colorful, and species of *Iris* are widely used in vegetative landscape. Because a few *Iris* species have great interspecific variations in morphology and some species are difficult to be distinguished morphologically, their taxonomic treatments and interspecific relationships are still controversial.

*Corresponding author: phone: (+86) 28 82650311; e-mail: zhouyh@sicau.edu.cn

Iris sichuanensis Y. T. Zhao, *I. leptophylla* Lingelsh and *I. goniocarpa* Baker are three species in Subgen. *Iris* L. Their morphological characteristics, except the size of leaf, are similar to each other. The leaf of *I. sichuanensis* is bigger than that of *I. leptophylla* and *I. goniocarpa* (Zhao 1980). Geographically, *I. sichuanensis* and *I. leptophylla* are distributed in Gansu and the northwest of Sichuan, while *I. goniocarpa* has a wide distribution in China, Bhutan, Sikkim, India and Nepal (Zhao 1985). The taxonomic classification of these three species is always mixed up. Based on the size of leaf, Zhao (1985) suggested that *I. sichuanensis* and *I. leptophylla* should be two independent species. However, according to the similar flower and geographic distribution of *I. sichuanensis* and *I. leptophylla*, Gao (1985) suggested that *I. sichuanensis* should be a homonym of *I. leptophylla*.

Iris japonica Thunb., *I. confusa* Sealy and *I. wattii* Baker are three widely distributed species in Subgen. *Crossiris* Spach. Zhao (1980) reported that the flowers and fruits of *I. confu-*

sa are similar to those of *I. japonica*, while the vegetative parts of *I. confusa* are similar to those of *I. wattii*. WADDICK (1994) suggested that *I. japonica* and *I. confusa* may be the variants of a same species. ZHOU *et al*. (2003) reported that *I. japonica* and *I. confusa* are two independent biological species on the base of the morphology, fertility and chromosome pairing studies. The relationship between *I. confusa* and *I. wattii* are still uncertain (WADDICK and ZHAO 1992).

Morphologically, *I. lactea* has white flowers and *I. lactea* var. *chinensis* has purple flowers. Geographically, *I. lactea* is restricted to northeast and southwest of China, whereas *I. lactea* var. *chinensis* is widely distributed in China, Korea, USSR and India (ZHAO 1985). Based on their geographical and morphological differences, ZHAO (1985) treated *I. lactea* var. *chinensis* as a variety of *I. lactea*. Because the purple flower population (*I. lactea* var. *chinensis*) always grows together with the white flower population (*I. lactea*) at the same place, GAO (1985) suggested that *I. lactea* var. *chinensis* should be more likely a homonym of *I. lactea*, rather than one of its varieties.

In our present study, chromosome number observation and karyotype analysis of *I. lactea*, *I. lactea* var. *chinensis*, *I. sichuanensis*, *I. leptophylla*, *I. goniocarpa*, *I. japonica* and *I. confusa* were carried out. Meanwhile, the karyotype analyses of other three taxa of *Iris* (*Iris chrysographes* Dykes, *Iris tectorum* Maxim, *Iris germanica* L.) from Sichuan were also reported here. The objectives are: (a) to report their chromosome numbers and the karyotypical characters of these Chinese *Iris* species; and (b) to investigate their interspecific relationships of the related species.

MATERIALS AND METHODS

Ten *Iris* taxa from Sichuan, China were used in this study. Their names, geographic origins, and accession information of the taxa are listed in Table 1. All the materials were collected by the authors of this paper. Voucher specimens have been deposited at the Herbarium of Triticeae Research Institute, Sichuan Agricultural University, China (SAUTI).

For observation of somatic chromosomes, root tips were pretreated in saturated 1, 4-dichlorobenzene ($C_6H_4CL_{12}$) at room temperature for 3-4 h before being fixed in Carnoy's solution (95% ethanol : acetic acid = 3 : 1, vol/vol) at dark place for 2 h. They were then rinsed in distilled water and hydrolysed for 10 min in 0.05ml/L HCl at 42.5°C. The root tips were washed in distilled water again, stained and crushed in 1.5% carbolic acid-fuchsine solution for one night before observation. Photomicrographs of well-spread metaphase images were captured with a cooled CCD camera using a microscope (Olympus BX51). Idiograms were constructed based on the relative length and relative arm ratios of chromosome (LI and CHEN 1985). Chromosomes were arranged from the longest to the shortest, and were designated with the Arabic numerals (STEBBINS 1971).

RESULTS

Metaphase chromosomes of 10 *Iris* taxa are shown in Figs. 1-10. Karyotypes and idiograms of 10 taxa in *Iris* are shown in Figs. 11-20 and Figs. 21-30, respectively. Chromosome parameters are listed in Table 2.

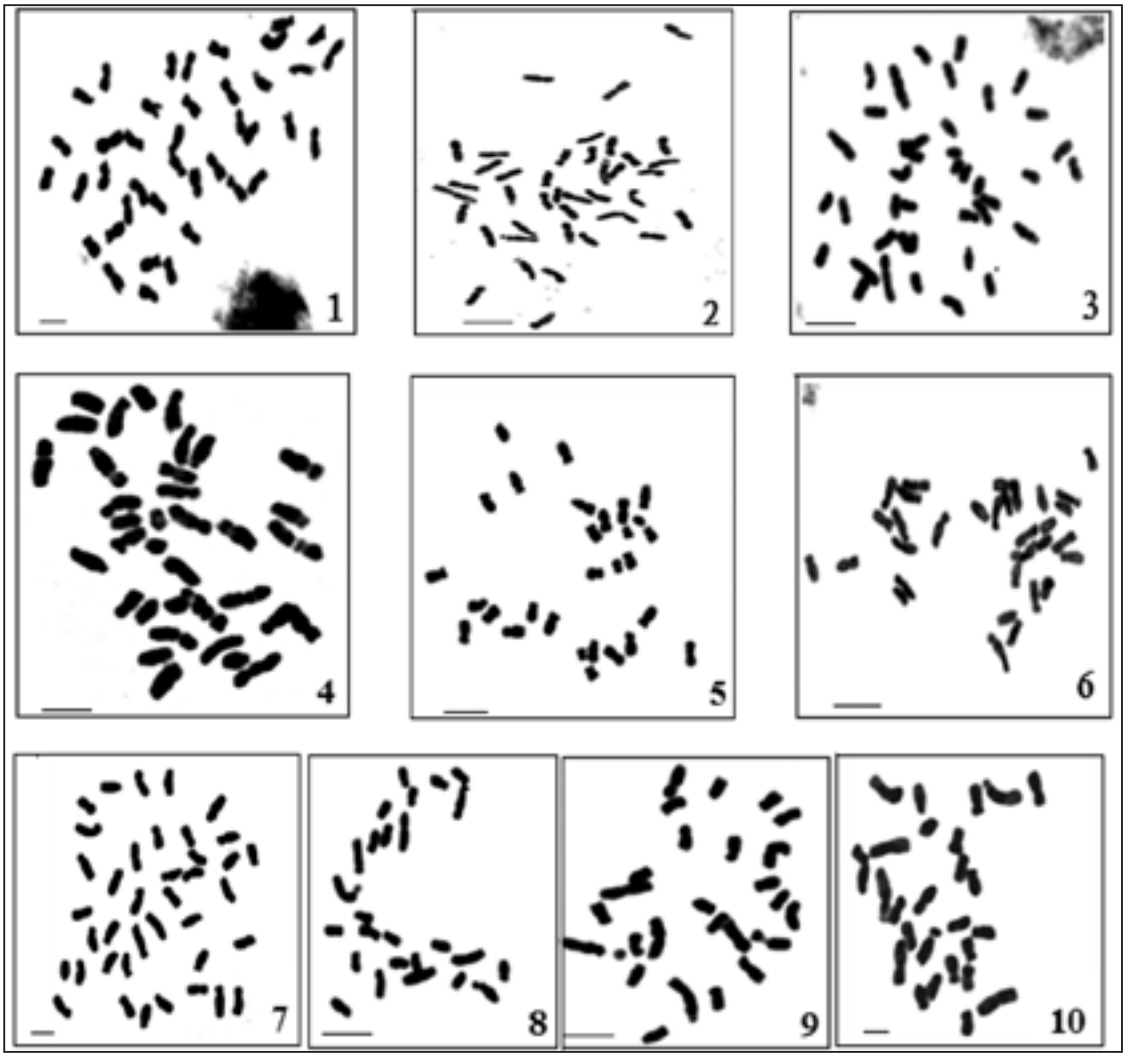
TABLE 1 — Materials used in this study.

Taxon	Locality	Altitude (m)	Accession No.
Subgen. *Limniris* (Tausch) Spach			
Iris lactea Pall.	Maoxian, Sichuan, China	1500	Iris041
Iris lactea var. *chinensis* (Fisch) Koidz.	Maoxian, Sichuan, China	1500	Iris042
Iris chrysographes Dykes	Kangding, Sichuan, China	3800	Iris003
Subgen. *Crossiris*			
Iris japonica Thunb.	Dujiangyan, Sichuan, China	550	Iris005
Iris tectorum Maxim	Ganzi, Sichuan, China	600	Iris006
Iris confusa Sealy	Dujiangyan, Sichuan, China	550	Iris004
Subgen. *Iris* L.			
Iris germanica L.	Yaan, Sichuan, China	591	Iris007
Iris sichuanensis Y. T. Zhao	Wenchuan, Sichuan, China	1000	Iris009
Iris leptophylla Lingelsh	Wenchuan, Sichuan, China	1000	Iris010
Iris goniocarpa Baker	Maoxian, Sichuan, China	1200	Iris001

TABLE 2 — Parameters of chromosomes of 10 taxa in *Iris* from Sichuan, China.

Taxa	Karyotypic formula	A.A.R[1]	Lc[2]/Sc[3]	As.k[4](%)	Type
I. lactea	2n = 40 = 28m + 10sm + 2st	1.63	2.28	43.84	2 B
I. lactea var. *chinensis*	2n = 40 = 18m + 16sm + 6st (6SAT)	2.12	2.58	38.72	2 B
I. chrysographes	2n = 40 = 18m + 22sm (2SAT)	1.79	3.71	26.92	2 B
I. japonica	2n = 36 = 16m + 14sm + 6st	2.07	2.57	38.22	2 B
I. tectorum	2n = 28 = 16m (4SAT) + 12sm (2SAT)	1.83	2.66	37.60	2 B
I. confusa	2n = 32 = 8m + 18sm + 6st	2.19	2.16	46.38	2 B
I. germanica	2n = 40 = 16m + 20sm + 4st	2.13	3.61	27.71	3 B
I. sichuanensis	2n = 26 = 12m (4SAT) + 12sm (2SAT) + 2st	1.97	2.82	35.40	3 B
I. leptophylla	2n = 26 = 14m (2SAT) + 10sm (4SAT) + 2st	1.90	2.90	34.51	2 B
I. goniocarpa	2n = 26 = 12m + 12sm + 2st (2SAT)	1.83	3.26	30.70	2 B

Note: [1]A.A.R, average arm ratio; [2]Lc, longest chromosome; [3]Sc, shortest chromosome; [4]As.k (%), index of the karyotypic asymmetry; m, median; sm, submedian; st, subterminal; SAT, satellites. (LI, M. X., CHENG, R. Y. 1985)



Figs. 1-10 — Mitotic metaphase chromosomes of 10 *Iirs* taxa. 1. *I. lactea*; 2. *I. lactea* var. *chinensis*; 3. *I. chrysographes*; 4. *I. japonica*; 5. *I. tectorum*; 6. *I. confusa*; 7. *I. germanica*; 8. *I. sichuanensis*; 9. *I. leptophylla*; 10. *I. goniocarpa*. Scale bars: 5 μm.

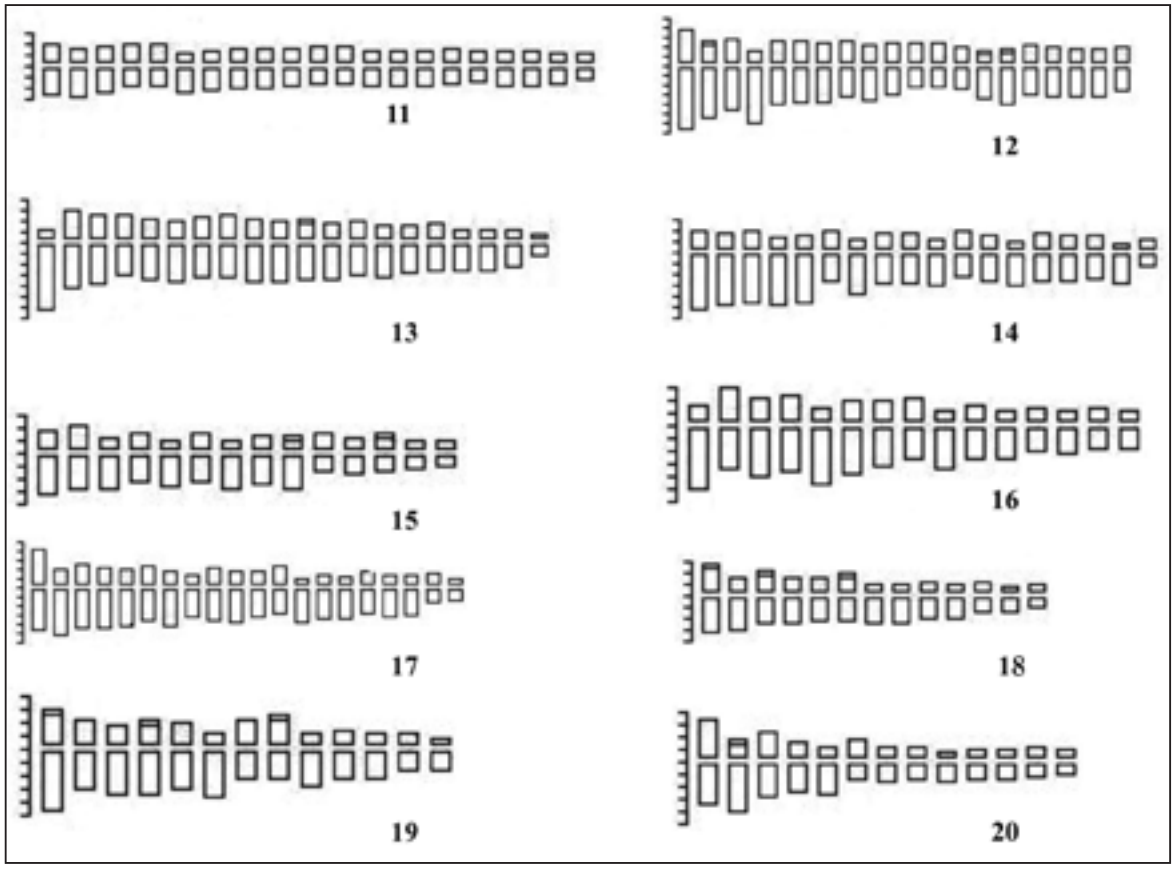
1. *I. lactea* - The chromosome number of *I. lactea* is 2n = 40, and it consists of 28 median centromeric chromosomes, 10 submedian centromeric chromosomes and 2 subterminal centromeric chromosomes. The karyotype formula is 2n = 40 = 28m + 10sm + 2st. No satellite is observed in this species. The chromosomes range from 1.78 to 4.06 in the relative length. The karyotype symmetry is type 2 B (Figs. 1, 11, 21). The karyotype is reported for the first time.

2. *I. lactea* var. *chinensis* - The chromosome number of *I. lactea* var. *chinensis* is 2n = 40. It consists of 18 median centromeric chromosomes, 16 submedian centromeric chromosomes and 6 subterminal centromeric chromosomes. The karyotype formula is 2n = 40 = 18m + 16sm + 6st (6SAT). There are three pairs of satellites on the short arms of chromosome 2, 14 and 15. The chromosomes range from 3.76 to 9.71 in the relative length. The karyotype symmetry is type 2 B (Figs. 2, 12, 22).

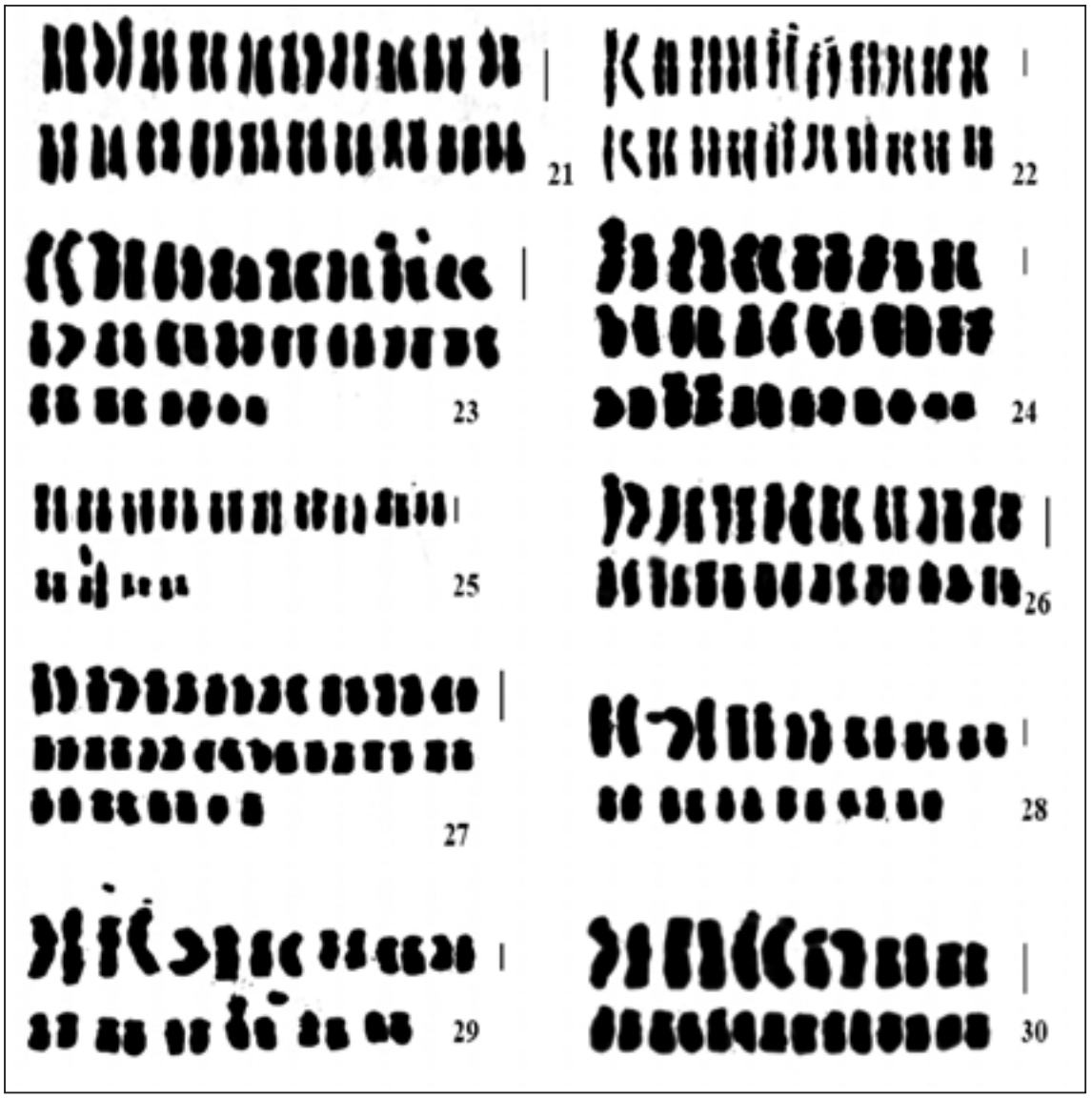
3. *I. chrysographes* - The chromosome number of *I. chrysographes* is 2n = 40. It consists of 18 median centromeric chromosomes and 22 submedian centromeric chromosomes. The karyotype formula is 2n = 40 = 18m + 22sm (2SAT). There is one pair of satellites on the short arm of chromosome 11. The chromosomes range from 1.89 to 7.02 in the relative length. The karyotype asymmetry is type 2 B (Figs. 3, 13, 23).

4. *I. japonica* - The chromosome number of *I. japonica* is 2n = 36. It consists of 16 median centromeric chromosomes, 14 submedian centromeric chromosomes and 6 subterminal centromeric chromosomes. The karyotype formula is 2n = 36 = 16m + 14sm + 6st. No satellite is observed in this species. The chromosomes range from 2.24 to 5.77 in the relative length. The karyotype symmetry is type 2 B (Figs. 4, 14, 24).

5. *I. tectorum* - The chromosome number of *I. tectorum* is 2n = 28. It consists of 16 median centromeric chromosomes and 12 submedian cen-



Figs. 11-20 — Ideograms in 10 taxa of *Iris*. 11 *I. lactea*; 12. *I.lactea* var. *chinensis*; 13. *I. chrysographes*; 14. *I. japonica*; 15. *I. tectorum*; 16. *I. confusa*; 17. *I. germanica*; 18. *I. sichuanensis*; 19. *I. leptophylla*; 20. *I. goniocarpa.*



Figs. 21-30 — Karyograms of 10 *Iirs* taxa. 21. *I. lactea*; 22. *I. lactea* var. *chinensis*; 23. *I. chrysographes*; 24. *I. japonica*; 25. *I. tectorum*; 26. *I. confusa*; 27. *I. germanica*; 28. *I. sichuanensis*; 29. *I. leptophylla*; 30. *I. goniocarpa*. Bars: 5 μm.

tromeric chromosomes. The karyotype formula is 2n = 28 = 16m (4SAT) + 12sm (2SAT). There are two pairs of satellites on the short arms of chromosome 9 and 12. The chromosomes range from 1.76 to 4.68 in the relative length. The karyotype symmetry is type 2 B (Figs. 5, 15, 25).

6. *I. confusa* - The chromosome number of *I. confusa* is 2n = 32. It consists of 8 median centromeric chromosomes, 18 submedian centromeric chromosomes and 6 subterminal centromeric. The karyotype formula is 2n = 32 = 8m + 18sm + 6st. No satellite is observed in this species. The chromosomes range from 2.82 to 6.08 in the relative length. The karyotype asymmetry is type 2 B (Figs. 6, 16, 26). The chromosome number of *I. confusa* is newly observed and the karyotype of this species is firstly reported.

7. *I. germanica* - The chromosome number of *I. germanica* is 2n = 40. It consists of 16 median centromeric chromosomes, 20 submedian centromeric chromosomes and 4 subterminal centromeric. The karyotype formula is 2n = 40 = 16m + 20sm + 4st. No satellite is observed in this species. The chromosomes range from 2.30 to 8.30 in the relative length. The karyotype asymmetry is type 3 B (Figs. 7, 17, 27). The chromosome number of

I. germanica is newly observed and the karyotype of this species is firstly reported.

8. *I. sichuanensis* - The chromosome number of *I. sichuanensis* is 2n = 26. It consists of 12 median centromeric chromosomes, 12 submedian centromeric chromosomes and 2 subterminal centromeric. There are three pairs of satellites on the short arms of chromosome 1, 3 and 6. The karyotype formula is 2n = 26 = 12m (4SAT) + 12sm (2SAT) + 2st. The chromosomes range from 1.82 to 5.14 in the relative length. The karyotype asymmetry is type 3 B (Figs. 8, 18, 28). The karyotype and chromosome number of *I. sichuanensis* are reported for the first time.

9. *I. leptophylla* - The chromosome number of *I. leptophylla* is 2n = 26. It consists of 14 median centromeric chromosomes, 10 submedian centromeric chromosomes and 2 subterminal centromeric. There are three pairs of satellites on the short arms of chromosome 1, 4 and 8. The karyotype formula is 2n = 26 = 14m (2SAT) + 10sm (4SAT) + 2st. The chromosomes range from 2.34 to 6.78 in the relative length. The karyotype asymmetry is type 2 B (Figs. 9, 19, 29). The karyotype and chromosome number of *I. leptophylla* are reported for the first time.

10. *I. goniocarpa* - The chromosome number of *I. goniocarpa* is 2n = 26. It consists of 12 median centromeric chromosomes, 12 submedian centromeric chromosomes and 2 subterminal centromeric. The karyotype formula is 2n = 26 = 12m + 12sm + 2st (2SAT). There is one pair of satellites on the short arms of chromosome 2. The chromosomes range from 1.87 to 6.09 in the relative length. The karyotype asymmetry is type 2 B (Figs. 10, 20, 30). The karyotype and chromosome number of *I. goniocarpa* are reported for the first time.

DISCUSSION

Relationships among I. sichuanensis, I. leptophylla and I. goniocarpa - Morphologically, *I. sichuanensis*, *I. leptophylla* and *I. goniocarpa* are very similar. ZHAO (1985) suggested that *I. sichuanensis* and *I. leptophylla* should be two independent species based on the size of leaf, while GAO (1985) suggested that *I. sichuanensis* should be a homonym of *I. leptophylla*.

Similar karyotypes of the three species are observed in this study. All of them have chromosome number of 2n = 26. There are differences in the number of satellite chromosome among the three species. *I. goniocarpa* has two satellites, while *I. leptophylla* and *I. sichuanensis* have six satellites. The number, size, and distribution of the satellite are remarkable characters to distinguish the related species or genera (STEBBINS 1971). Thus, data of karyotype analysis indicated that *I. sichuanensis*, *I. leptophylla* and *I. goniocarpa* may more likely constitute three independent species, and the relationship between *I. leptophylla* and *I. sichuanensis* should be closer than that with *I. goniocarpa*.

Karyotype symmetry of *I. leptophylla* and *I. goniocarpa* belongs to Stebbins's 2 B type, while that of *I. sichuanensis* is type 3 B. According to STEBBINS'S theory (1971), the tendency of chromosomal evolution is from symmetry to asymmetry. So, karyotypes of *I. leptophylla* and *I. goniocarpa* show the ancestral character states, and they may have originated before than *I. sichuanensis*.

Relationships among I. japonica, I. confusa and I. wattii - Previous studies showed that *I. confusa* has chromosome number of 2n = 28, 30, 34, 36, 42, *I. japonica* is of 2n = 28, 30, 31-33, 32, 34, 35, 36, 38, 42, 46, 52, 54, 55, 56, 60, and *I. wattii* is of 2n =30 (DARLINGTON and WYLIE 1955; CHIMPHAMBA 1973; MAO *et al*. 1986; SHU *et al*. 1992; COLASANTE and SAUER 1993; LU *et al*. 1993; DONG *et al*. 1994; YEN *et al*. 1994; ELLIS 2000; SHEN *et al*. 2007). It is reported that cytomixis occurring in meiotic prophase of pollen mother cells (PMCs) might be the important reason for the origin of aneuploidy and multiploidy shown by different populations of *I. japonica* and *I. confusa* (YEN *et al*. 1994).

In this study, the chromosome number of *I. confusa* is 2n = 32, while *I. japonica* is 2n = 36. The karyotype of *I. japonica* is 2n = 36 = 16m + 14sm + 6st and *I. confusa* is 2n = 32 = 8m + 18sm + 6st. SHEN *et al*. (2007) reported the karyotype of *I. japonica* is 2*n* = 34 = 16m + 18sm (2SAT). The variability in its chromosome number and karyotype occurred may be due to geographical difference.

SHEN *et al*. (2007) reported the karyotype of *Iris wattii* was 2n = 30 = 18m + 12sm (2SAT). The results showed that the kayotype of *I. wattii* is different from that of *I. japonica* and *I. confusa*. *Iris wattii* has two satellites, while no satellite was observed in *I. japonica* and *I. confusa*. Thus, karyotypes of the three *Iris* species are different from each other in chromosome size, chromosome number and satellite chromosomes. The present karyotype results suggest that it is reasonable to treat *I. japonica*, *I. confusa* and *I. wat-*

tii as three species.

Relationship between I. lactea and I. lactea var. chinensis - DORONKIN and KRASNIKOV (1984) reported that the chromosome number of *I. lactea* was 2n = 40. However, various chromosome number of 2n = 40, 42, 44 had been observed in *I. lactea* var. *chinensis* (MAO and XUE 1986; ZHANG 1994; YAN *et al.* 1995; HUANG *et al.* 1996; SHEN *et al.* 2007). In this study, the chromosome number of *I. lactea* and *I. lactea* var. *chinensis* are identical with 2n = 40. Our results are consistent with DORONKIN and KRASNIKOV (1984), ZHANG (1994) and SHEN *et al.* (2007).

Most of the chromosomes of these two taxa are median centromeric or submedian centromeric chromosomes. Karyotype symmetries of both taxa belong to Stebbins's 2 B type. However, they are difference in the number of satellites. *Iris lactea* var. *chinensis* has three pairs of satellites, while no satellite is found in *I. lactea*. Furthermore, *I. lactea* var. *chinensis* has 6 subterminal centromeric chromosomes, but *I. lactea* just has two. The differences observed between the karyotypes of *I. lactea* and *I. lactea* var. *chinensis* give to our consideration of *I. lactea* var. *chinensis* as a variety of *I. lactea*.

Karyotypes of I. tectorum, I. germanica and I. chrysographes - Chromosome number of 2n = 28, 32 and 36 had been observed in *I. tectorum* (MAO *et al.* 1986; DONG *et al.* 1994; LU 2000; QIN *et al.* 2002). In this study, *Iris tectorum* has chromosome number of 2n = 28, which is consistent with LU (2000) and QIN *et al.* (2002). The karyotype of *I. tectorum* is 2n = 28 = 16m (4SAT) + 12sm (2SAT), while is different from the previous results from 2n = 4x = 28 = 16M + 4sm + 8st (LU 2000) and 2n = 28 = 10M + 18sm (QIN *et al.* 2002).

MAO and XUE (1986) reported that the chromosome number of *Iris germanica* was 2n = 28. In the present study, the chromosome number of *I. germanica* is 2n = 40, with the karyotype formula of 2n = 40 = 16m + 20sm + 4st. *I. germanica* used in MAO and XUE (1986) was from Zhejiang, while the material of *I. germanica* in this study was collected from Sichuan. The materials from different places might result in the different chromosome number of *I. germanica*.

Previous studies showed that the chromosome number of *Iris chrysographes* is 2n = 40 (DARLINGTON and WYLIE 1955; FEDOROV 1969; SHEN *et al.* 2007). In this study, the same chromosome number of 2n = 40 in *I. chrysographes* was observed. The karyotype formula of *I. chrysographes* in this study is 2n = 40 = 18m + 22sm (2SAT) and the type is 2 B, which is different from the karyotype of 2n = 40 = 26m + 12sm + 2st and type of 2 A (SHEN *et al.* 2007). The reason might be attributed to the different geography distribution of *I. chrysographes*.

Acknowledgements — This study was supported by grants from the Program for Changjiang Scholars and Innovative Research Team in University (PCSIRT), China (No. IRT 0453), the National Natural Science Foundation of China (Nos. 30670150, 30870154), and the Science and Technology Bureau and Education Bureau of Sichuan Province, China.

REFERENCES

CHIMPHAMBA B. B., 1973 — *Cytogenetic studies in the genus Iris*: *Subsection Evansia Benth*. Cytologia, 38: 501-514.

COLASANTE M. and SAUER W., 1993 — *The genus Iris L. in Latium: general remarks on the morphological and karyological differentiation as well as on the ecological adaptation and flowering periods*. Linzer Biologische Beiträge, 25: 1189-1204.

DARLINGTON C. D. and WYLIE A. P., 1955 — *Chromosome atlas of flowering Plants*. George Allen & Unwin Ltd. London.

DONG X. D., XIE H., MA Y. X., ZHAO H. and ZHAO Y. T., 1994 — *On the karyotype of 4 species of Iris from Yunnan of China*. Bulletin of Botanical Research, 14(4): 26-32.

DORONKIN V. M. and KRASNIKOV A. A., 1984 — *Cytotaxonomic studies in some Siberian species of the genus Iris (Iridaceae)*. Botaniceskjij Žurnal SSSR, 65(5): 683-685.

ELLIS J. R., 2000 — *The crested Irises of Asia*. New Plantsman, **7**(2): 123-125.

FEDOROV A. A., 1969 — *Chromosome numbers of flowering Plants*. Komarov Botanical Institute, Academy of Science of the USSR, Leningrad.

GAO B. C., 1985 — *Notes on the genus Iris of Sichuan*. Journal of the Southwest Teachers College, 3: 11-15.

GAO B. C., 1989 — *Flora of Sichuan*. Sichuan Nationality Press, Chengdu.

HONG D. Y., 1990 — *Plant Cytotaxonomy*. Science Press, Beijing.

HUANG R. F., SHEN S. D. and LU X. F., 1996 — *Studies on the chromosome number and polyploidy for a number of plants in the Northeast Qinghai-Xizang Plateau*. Acta Botanica Boreali-Occidentalia Sinica, 16(3): 310-318.

WADDICK J. W. and ZHAO Y. T., 1992 — *Iris of China*. Timber Press, Portland.

WADDICK J. W., 1994 — *Collecting Irises in Western China*. Bulletin of the American *Iris* society, 3: 74-92.

LI M. X. and CHEN R. Y., 1985 — *A suggestion on the standardization of karyotype analysis in plants*. Jour-

nal of Wuhan Botanical Research, 3: 297-302.
LU J. C., 2000 — *Karyotype study on Iris tectorum*. Journal of Shangdong Normal University (Natural Science), 15(2): 214-216.
LU J. M., HAN L. J., ZHANG L. and SHANG Y. L., 1993 — *Karyotype analysis on Iris tigridia*. Journal of Wuhan Botanical Research (Nutural Science Edition), 1: 36-38.
MAO J. Q. and XUE X. J., 1986 — *Chromosome numbers of thirteen Iridaceous species from Zhejiang Province*. Acta Agriculture Universitatis Zhejiangensis, 12(1): 97-101.
QIN M. J., HU J., YU G. D., YUAN J. S. and TOSHIHIRO T., 2002 — *Analysis of chromosome karyotypes of Belamcanda chinensis and Iris tectorum*. Primary Journal of Chinese Material Medica, 16(4): 18-19.
SHEN Y. G., WANG Z. L. and GUAN K. Y., 2007 — *Karyotypical studies on thirteen Iris plants from China*. Acta Phytotaxonomica Sinica, 45(5): 601-618.
STACE C. A., 2000 — *Cytology and cytogenetics as a fundamental taxonomic resource for the 20th and 21th centuries*. Taxon, 49: 451-477.
STEBBINS G. L., 1971 — *Chromosomal evolution in higher plants*. Edward Arnold Press, London.
SHU H. L., YAN C. and YANG J. L., 1992 — *Cytological study on Iris confusa Sealy*. Journal of Sichuan Agricutural University, 10(4): 586-591.
YAN G. X., ZHANG S. Z., XIE F. H., YUN J. F., WANG L. Y. and FU X. Q., 1995 — *The chromosome numbers of 35 forage species and their geographical distribution*. Chinese Journal of Grassland, 1: 16-20.
YEN C., SUN G. L. and YANG J. Y., 1994 — *The Mechanism of the origination of auto-allopolyploidy and aneuploidy in higher plants based on the cases of Iris and Triticeae*. Proceeding of the 2nd International *Tirticeae* Symposium, 45-50.
ZHANG L. H. and XIA Y. P., 2003 — *The application and studies of ground cover plants in landscape architecture*. Journal of Chinese Landscape, 9: 54-57.
ZHANG Y. X., 1994 — *Studies on chromosomes of some plants from Guandi Mountain, Shangxi*. Journal of Wuhan Botanical Research, 12(2): 201-206.
ZHAO Y. T., 1980 — *Some notes on the genus Iris of China*. Acta Phytotaxonomica Sinica, 18(1): 53-62.
ZHAO Y. T., 1985 — *Flora of China*. Science Press, Beijing.
ZHOU Y. H., WU B. H., YAN J., YANG R. W. DING C. B. and ZHANG L., 2003 — *Cytogenetic study on the interspecific hybrid between Iris japonica and Iris confusa (Irisaceae)*. Acta Botanica Yunnanica, 25(4): 497-502.

Received June 19th 2009; accepted September 22th 2009

Published September 30th 2009

Editore: Università degli Studi di Firenze
Registrazione Tribunale di Firenze n. 478 del 13/7/1951
Redazione: Dipartimento di Biologia Vegetale
Via La Pira, 4 - 50121 FIRENZE
Direttore Responsabile: Dr. ALESSIO PAPINI
Stampato a Firenze da Mozzon S.r.l. - September 2009