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大吴风草(菊科: 千里光族)的核形态及其系统学意义*

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摘 要: 研究了大吴风草属的核形态。染色体间期为复杂型; 前期染色体为中间型。染色体长度从 3.70 μm 到 2.64 μm, 平均长度为 3.20 μm; 核型公式为 2n= 60= 14m + 26sm + 20st (4SAT), 为 3A 类型。过去认为大吴风草属与橐吾属接近, 并比之原始; 但染色体和花粉特征并不支持这种处理。

关键词: 大吴风草属; 千里光族; 核形态; 系统学
中图分类号: Q 942.4 **文献标识码**: A

Karyomorphology of *Farfugium japonicum* (Asteraceae: Senecioneae) and its systematic implication

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Abstract: Investigated in the present paper was the karyomorphology of *Farfugium japonicum*. The interphase nuclei were categorized to the complex chromocenter type, and the mitotic prophase chromosomes were classified as the interstitial type. The metaphase chromosomes of this species were relatively large, ranging from 3.70 μm to 2.64 μm and the average length was 3.20 μm. The karyotype was formulated as 2n= 60 = 14m + 26sm + 20st(4SAT) and categorized as Stebbin's 3A type. *Farfugium* had been considered to be closely related to, and more primitive than *Ligularia*. However, the karyomorphological characteristics of *Farfugium*, along with its unique pollen character do not support this treatment.

Key words: *Farfugium*; Senecioneae; karyomorphology; systmatics

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Farfugium, a small genus of the tribe Senecioneae in the Asteraceae, comprises three species: *F. grande*, *F. japonicum* and *F. hibernif lorum* [1]. *F. grande* is a cultivated species in Japan; *F. japonicum* is distributed in China and Japan and *F. hibernif lorum* is endemic to Japan[1]. However, Liu[2] suggested that three species of *Farfugium* should be treated as one species: *F. japonicum*. In our checking specimens preserved in the herbaria, we found that the leaf morphology of this genus varies greatly. We guess the leaf variation of *Farfugium* might correlate with its long cultivation as medical plants. Therefore, before completely elucidating the factors to cause the leaf variation, we agree with Liu[2] that it is better to treat three *Farfugium* species based on the leaf variation as one species.

Farfugium had been considered to be closely related to, and more primitive than *Ligularia*[14]. But my research found that the pollen wall ultrastructure of *Farfugium* belongs to "Helianthoid" type, a rare pollen type in the Senecioneae while all species of *Ligularia* have the common "Senecioid" type of this tribe[18]. Karyomorphological characters are of utmost importance for elucidating the phylogeny and evolution of the Asteraceae[4], especially for the tribe Senecioneae[5~6]. Although the karyotype of *F. japonicum* had been reported by Arano[7~8] and Su & Liu[9], their results were inconsistent. The present paper rechecked the karyotypes of *F. japonicum*. On the basis of the chromosomal data, the relationship of *Farfugium* to *Ligularia* was discussed.

1 Material and Methods

The roots of *F. japonicum* were collected in Nanchuan, Sichuan Province, China. The voucher specimen (Liu Jian-quan 421) was deposited in Northwest Plateau Institute of Biology, the Chinese Academy of Sciences (NWPB).

The root tips were pretreated in the mixture of 0.1% colchicine and 0.002 mol/L hydroxyquinoline for two hours, and then fixed overnight in Carnoy's fixative (1:3 glacial acetic acid and absolute alcohol). They were macerated in 1 mol/L HCl at 60℃ for five minutes, and stained and squashed in Carbol Fuschin solutions before observation. The karyotype formula was based on the measurements of mitotic metaphase chromosomes. The karyomorphological classifications of the resting and mitotic prophase introduced by Tanaka[10], the symbols for centromeric positions defined by Levan et al.[11], and the classification of karyotype asymmetry of Stebbins[12] were followed.

2 Result

In the resting nuclei (Plate I: 1), darkly stained chromatin blocks were formed. Some chromosomes formed many chromomeric granules and the others formed fibrous chromatin threads. Thus, morphology of the chromosomes at resting stage was

categorized as the complex chromocenter type. In the prophase chromosomes (Plate I: 2), eu- and hetero-chromatic segments were distinguishable, but boundaries of both segments were indistinct, and the transition was gradual. The heterochromatic segments were distributed in proximal, distal or interstitial regions of both arms, and usually shorter than euchromatic segments. Thus, morphology of the chromosomes at mitotic prophase was of the interstitial type.

The metaphase chromosomes were counted to be 2n= 60 (Plate I: 3), ranging from 3. 70 μm to 2. 64 μm in length (Plate I: 4). The average length was 3. 20 μm. The karyotype was formulated as 2n = 60 = 14m + 26sm + 20st (4SAT). Two pairs of chromosomes were found to have satellites. The karyotype was categorized as Stebbin's 3A type.

Table 1 Parameters of mitotic metaphase chromosomes of F. japonicum

NO	RL	AR	T	IRL	NO	RL	AR	T	IRL
1	1. 45+ 4. 84= 6. 29	3. 34	st	1. 89	16	1. 50+ 1. 69= 3. 19	1. 13	m	0. 97
2	1. 21+ 4. 11= 5. 32	3. 40	st	1. 60	17	1. 45+ 1. 60= 3. 05	1. 10	m	0. 91
3	1. 31+ 2. 90= 4. 21	2. 21	sm	1. 26	18	1. 35+ 1. 60= 2. 95	1. 19	m	0. 89
4	1. 69+ 2. 42= 4. 11	1. 43	m	1. 23	19	1. 26+ 1. 64= 2. 90	1. 30	m	0. 87
5	1. 26+ 2. 56= 3. 82	2. 03	sm	1. 19	20	1. 21+ 1. 69= 2. 90	1. 40	m	0. 87
6	1. 60+ 2. 13= 3. 73	1. 33	m	1. 12	21	1. 16+ 1. 74= 2. 90	1. 50	m	0. 87
7	0. 82+ 2. 71= 3. 53	3. 30	st	1. 06	22	1. 06+ 1. 79= 2. 85	1. 69	m	0. 86
8	1. 26+ 2. 18= 3. 44	1. 73	sm	1. 03	23	1. 21+ 1. 64= 2. 85	1. 36	m	0. 86
9	1. 11+ 2. 27= 3. 38	2. 05	sm	1. 02	24	1. 11+ 1. 74= 2. 85	1. 57	m	0. 86
10	1. 50+ 1. 84= 3. 34	1. 23	m	1. 00	25	1. 06+ 1. 74= 2. 80	1. 64	m	0. 84
11	1. 45+ 1. 84= 3. 24	1. 27	m	0. 99	26	1. 00+ 1. 79= 2. 79	1. 79	sm	0. 84
12	1. 40+ 1. 84= 3. 24	1. 31	m	0. 97	27	1. 26+ 1. 50= 2. 76	1. 19	m	0. 83
13	0. 20+ 3. 04= 3. 24	15. 0	t	0. 97	28	1. 21+ 1. 50= 2. 71	1. 24	m	0. 81
14	1. 55+ 1. 69= 3. 24	1. 09	m	0. 97	29	1. 21+ 1. 45= 2. 66	1. 19	m	0. 80
15	1. 50+ 1. 69= 3. 19	1. 06	m	0. 97	30	1. 21+ 1. 26= 2. 47	1. 04	m	0. 74

RL: relative length; AR: arm ratio; T: type; IRL: index of relative length.

3 Discussion

The chromosome number of 2n= 60 of *Farfugium japonicum* is here reconfirmed. But the karyotype is a little different from those reported before. Arano[6] found the population from Japan has the karyotype of 2n= 60= 38st+ 20sm + 2m (2SAT) while the population from Hubei province was reported to have the karyotype of 2n= 46sm + 12st + 2m. The population from Sichuan province in the present study has the karyotype of 2n= 60= 14m + 26sm + 20st (4SAT). The difference of the karyotypes from different populations might be due to different pretreating or karyotype differentiation along the geographical distribution. However, of all three populations, the chromosomes with the arm ratio (the long arm／the short arm) above 2. 00 exceed 50% of the whole complement; therefore, the karyotypes should be categorized as 3A or 3B type[8~9]

according to the karyotype classification of Stebbins[12].

Although some author thought that *Farfugium* consists of three species[1], as stated in the introduction, we tend to reduce the other two species as variations of *F. japonicum*. At any rate, *F. japonicum* is type species of the genus and can represent the genus to discuss its systematic position. Koyama[3] suggested that *Farfugium* should be closely related to *Ligularia*. Gross-morphologically the former differs with the latter genus in the involute young leaves and hairy achenes. This suggestion was followed by Jeffrey and Chen[13] and Bremer[6]. Furthermore, Liu[14] thought that the involute young leaves occur mainly in the fern plants, and *Farfugium* with this character should be more primitive than *Ligularia*. The pollen wall ultrastructure of *Farfugium* belongs to "Helianthoid" type, a rare pollen type, only found in *Packera*, *Pericallis* and *Doronicum* of the Senecioneae[15~17] while all species of *Ligularia* have the common "Senecioid" type of this tribe[18]. The chromosome number of most species of *Ligularia* is 2n = 58, the chromosomes with the arm ratio above 2.00 do not exceed 50% of the whole complement and the karyotype belongs to 2A type[18]. Both pollen and chromosome characteristics do not support that *Farfugium* and *Ligularia* are closely related to each other. According to Karis[19], "Helianthoid" pollen type represents a apomorphic character in the Senecioneae. In most angiosperms, the karyotype evolution is from symmetry to asymmetry[12]. The 3A or 3B karyotype of *Farfugium* should be at more evolutionary stage than the 2A karyotype of *Ligularia*. So, both pollen and karyomorphological data can not also agree with the opinion that *Farfugium* is more primitive than *Ligularia*. The systematic position of *Farfugium* in the Senecioneae needs a further study.

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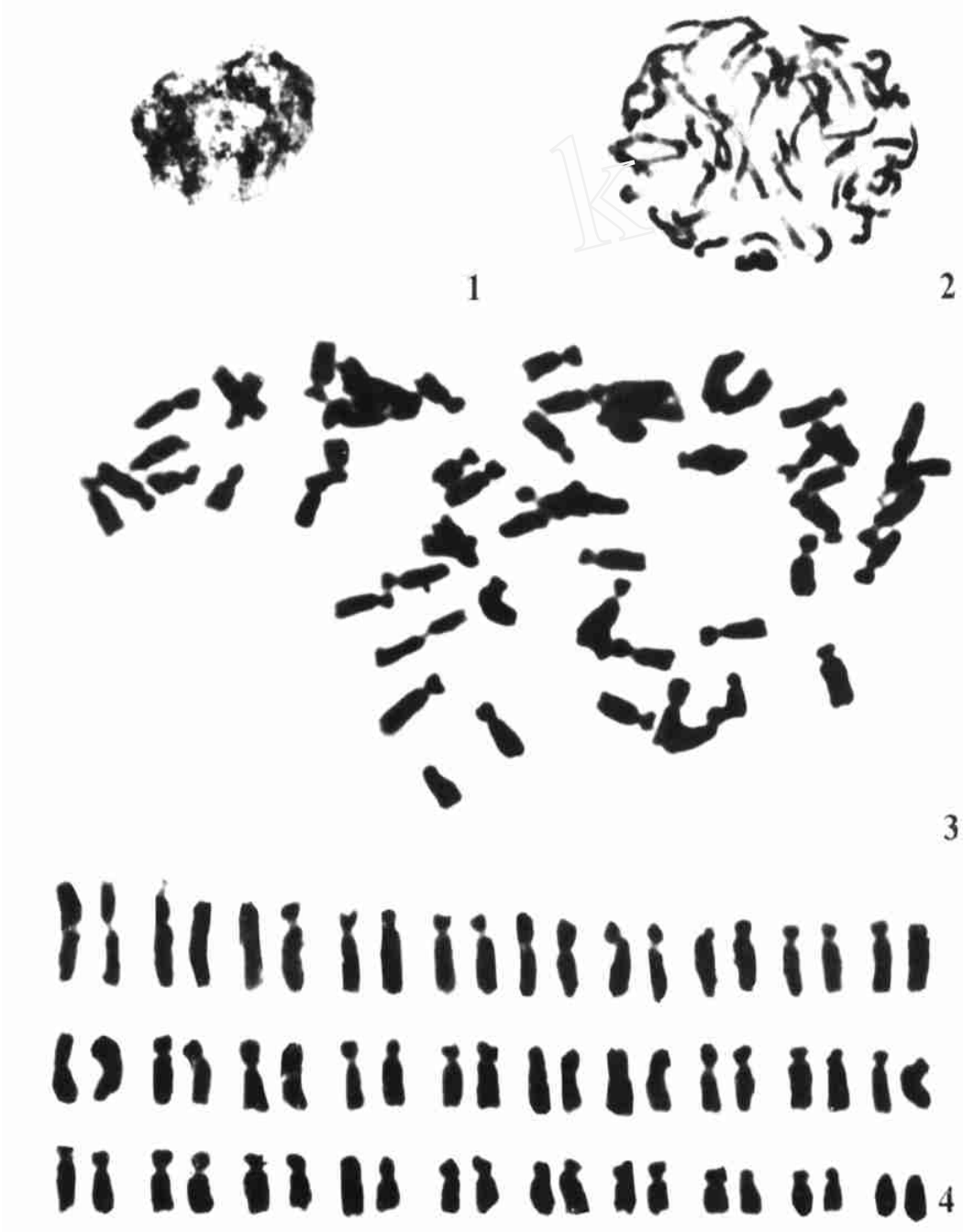
Explanation of plate:

Plate Ⅰ　1. The resting nuclei ×1 800; 2. The prophase chromosome ×3 000; 3. The metaphase chromosomes ×3 000; 4. Karyotype



See explanation at the end of text