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Cytological features of the *Aster ageratoides* complex (Asteraceae) in Taiwan

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Abstract. Chromosome cytology was examined in two species of the *Aster ageratoides* complex, *A. ageratoides* Turcz. (= *A. leiophyllus* Franch. et Sav.) and *A. lasioclada* Hayata, in Taiwan. Of the 70 individuals of *A. ageratoides* sampled, one was found to be diploid ($2n = 18$) and the rest tetraploid ($2n = 36, 37$). The occurrence of the diploid *A. ageratoides* in Taiwan appears to be ancient. Eighteen individuals of *A. lasioclada* were examined, of which 15 were diploids ($2n = 18$) and three triploids ($2n = 27, 28$). The triploid plants were not sympatric with tetraploid plants and could not be distinguished morphologically from the diploids; they may represent spontaneously occurring individuals with one unreduced gamete.

Keywords: *Aster ageratoides*; *Aster lasioclada*; *Aster leiophyllus*; Asteraceae; Chromosome number; Taiwan.

Introduction

Taiwan is a continental island that straddles the Tropic of Cancer. Its location, combined with a tall range of steep, rugged mountains, creates a wide array of environments. Many tropical and subtropical floristic elements are found in the lowlands. In the montane regions of Taiwan, warm to cold temperate elements prevail, which bear a close resemblance to those of mainland China, Japan and the Himalayas (Su, 1992), which together comprise the Sino-Japanese Region of Boreal Kingdom (Good, 1974). Takhtajan (1986) placed Taiwan in the Eastern Asiatic Region of the Boreal Kingdom; Kitamura (1993) placed lowland Taiwan in the Southeastern Asiatic Region and the uplands in the Sino-Japanese Region.

The *Aster ageratoides* complex [as "*A. leiophyllus* complex" (Soejima, 1992, 1993); see Ito and Soejima (1995) for taxonomic treatment] is one of the Sino-Japanese elements widely distributed in East Asia. It consists mainly of perennial herbs with elongate stolons; lanceolate, oblong-lanceolate or ovate leaves with three distinct nerves; basal leaves that wither at anthesis; few to many capitula 1–2 cm across arranged in corymbs or loose corymbose panicles; hemispherical involucres; and ray florets with white or pale purple corollas.

Within this complex, a polyploid series ranging from diploid to nanoploid is known (Huziwara, 1957; Peng and Hsu, 1978; Matsuda and Suyama, 1980; Matsuda and Shinohara, 1985; Irifune et al., 1985; Irifune, 1990; Soejima, 1992, 1993), and the presence of this polyploid series has been a source of confusion in the taxonomy of this complex. In order to clarify the taxonomy and to understand the biological background of this complex, cytological investigation accompanied by morphological studies throughout the range of the *A. ageratoides* complex is needed. At its southern distribution range in Taiwan, this complex is represented by two species, *A. ageratoides* Turcz. and *A. lasioclada* Hayata. *Aster morrisonensis* can be considered as a derivative of the *A. ageratoides* complex that has adapted to alpine habitats in Taiwan. Very little is known of the chromosome cytology of this complex in Taiwan, except for a tetraploid count of $2n = 36$ from a single plant of *A. ageratoides* (as "*Aster trinervius* D. Don ssp. *ageratoides* (Turcz.) Grierson") reported by Peng and Hsu (1978) without discussion. This study examines the chromosome cytology and morphological features of members of this complex in Taiwan, in an attempt to supplement and compare data, contributing to a better overall understanding of cytological-morphological relationships among all the members of *A. ageratoides* complex in East Asia.

Materials and Methods

Ninety-two plants were collected from 16 populations of *A. ageratoides* and 5 populations of *A. lasioclada* occurring in areas between 865 and 2,200 m altitude in Taiwan (Table 1, Figure 1). The aerial parts of these plants were kept as herbarium voucher specimens (at HAST) for morphological study. The stolons were cultivated at Osaka Prefecture University for cytological investigations. The cytological method follows Soejima (1992).

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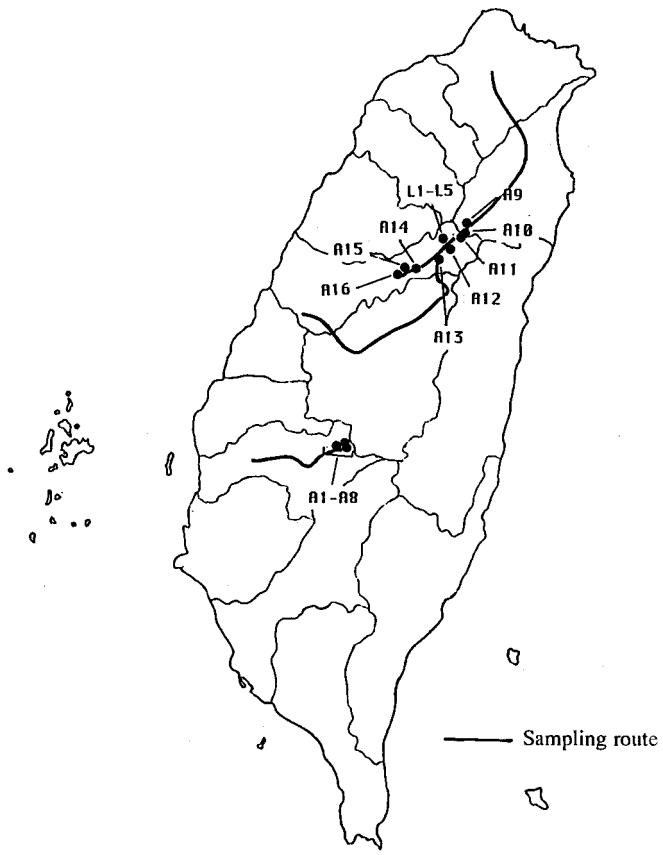

Figure 1. Map of Taiwan, showing sample localities and population acronyms (see Table 1). A, *Aster ageratoides*; L, *A. lasioclada*.

Results and Discussion

Aster ageratoides is subglabrous and its morphology is sharply distinct from *A. lasioclada*, in which stems and leaves are densely pubescent. *Aster lasioclada* has a limited distribution in Taiwan: all five populations sampled were found within a small area near Wuling Farm, 1,800–2,200 m altitude, in Shei-Pa National Park of north central Taiwan. By contrast, *Aster ageratoides* is rather common along the central cross-island highway at (865–) 1,400–2,200 m altitude. The two species do not appear to differ in habitat requirement: they both occur in semi-shaded places along roads and/or at forest margins. However, no sympatric populations were found in our survey.

In this study somatic chromosome number counts were made of 88 plants of the *A. ageratoides* complex. The results are shown in Table 1. Sixty-nine plants were tetraploid ($2n$ = 36, 37), sixteen were diploid ($2n$ = 18) and three were triploid ($2n$ = 27, 28) based on X = 9. Among the 70 plants of *A. ageratoides* sampled, 69 were tetraploid and one was diploid. Of the 18 plants of *A. lasioclada* studied, 15 were diploid and three were triploid. The triploid plants were collected in population L5 (Table 1) along with a diploid plant. One of the triploids with $2n$ = 28 had in its complement an additional chromosome, which appears to be shorter than the others (Figure 2B). In Japan, B-chromosomes are common in the *A. ageratoides* complex (Matsuda, 1970) and are always shorter than other normal chromosomes. The additional chromosome in the triploid *A. lasioclada* in Taiwan most likely represented a B-chromosome. None of the three triploid plants of *A. lasioclada* was distinguishable morphologically from the diploid plant of

Table 1. Vouchers (at HAST) and chromosome numbers of members of *Aster ageratoides* complex in Taiwan.

Population acronym and locality		Voucher specimen	Somatic chromosome no.
Aster ageratoides Turcz.			
A1	Chiayi Hsien: Mt. Alishan	*Soejima 931101*	36 (4)[a], 37 (1)
A2	Chiayi Hsien: Mt. Alishan	*Soejima 931102*	36 (4)
A3	Chiayi Hsien: Mt. Alishan	*Soejima 931103*	36 (5)
A4	Chiayi Hsien: Mt. Alishan	*Soejima 931104*	36 (3)
A5	Chiayi Hsien: Mt. Alishan	*Soejima 931105*	36 (5)
A6	Chiayi Hsien: Mt. Alishan	*Soejima 931106*	36 (3)
A7	Chiayi Hsien: Mt. Alishan	*Soejima 931107*	36 (4)
A8	Chiayi Hsien: Mt. Alishan	*Soejima 931109*	36 (8)
A9	Ilan Hsien: Nanshan, 1415 m alt.	*Soejima 931111*	36 (6)
A10	Ilan Hsien: Nanshan, 1585 m alt.	*Soejima 931112*	36 (5)
A11	Taichung Hsien: at the entrance to Mt. Nanhutashan, 2055 m alt.	*Soejima 931113*	36 (5)
A12	Taichung Hsien: at the branch to Wuling from central cross-island hwy, 1880 m alt.	*Soejima 931119*	36 (2)
A13	Taichung Hsien: Lishan, 1890 m alt.	*Soejima 931120*	36 (5)
A14	Taichung Hsien: between Lishan and Kukuan, 1550 m alt.	*Soejima 931121*	36 (4), 18 (1)
A15	Taichung Hsien: between Lishan and Kukuan, 1470 m alt.	*Soejima 931122*	36 (2)
A16	Taichung Hsien: Kukuan, 865 m alt.	*Soejima 931123*	36 (3)
Aster lasioclada Hayata			
L1	Taichung Hsien: in front of Wuling hut, 1810 m alt.	*Soejima 931114*	18 (3)
L2	Taichung Hsien: Wuling, in *Pinus* forest, 1820 m alt.	*Soejima 931115*	18 (6)
L3	Taichung Hsien: Wuling, Taoyuen waterfall, 2200 m alt.	*Soejima 931116*	18 (1)
L4	Taichung Hsien: Wuling, Taoyuen waterfall, 2200 m alt.	*Soejima 931117*	18 (4)
L5	Taichung Hsien: Wuling, in *Pinus* forest, 1820 m alt.	*Soejima 931118*	18 (1), 27 (2), 28 (1)

[a]Number within parentheses indicates the number of individuals for which chromosome counts were made.

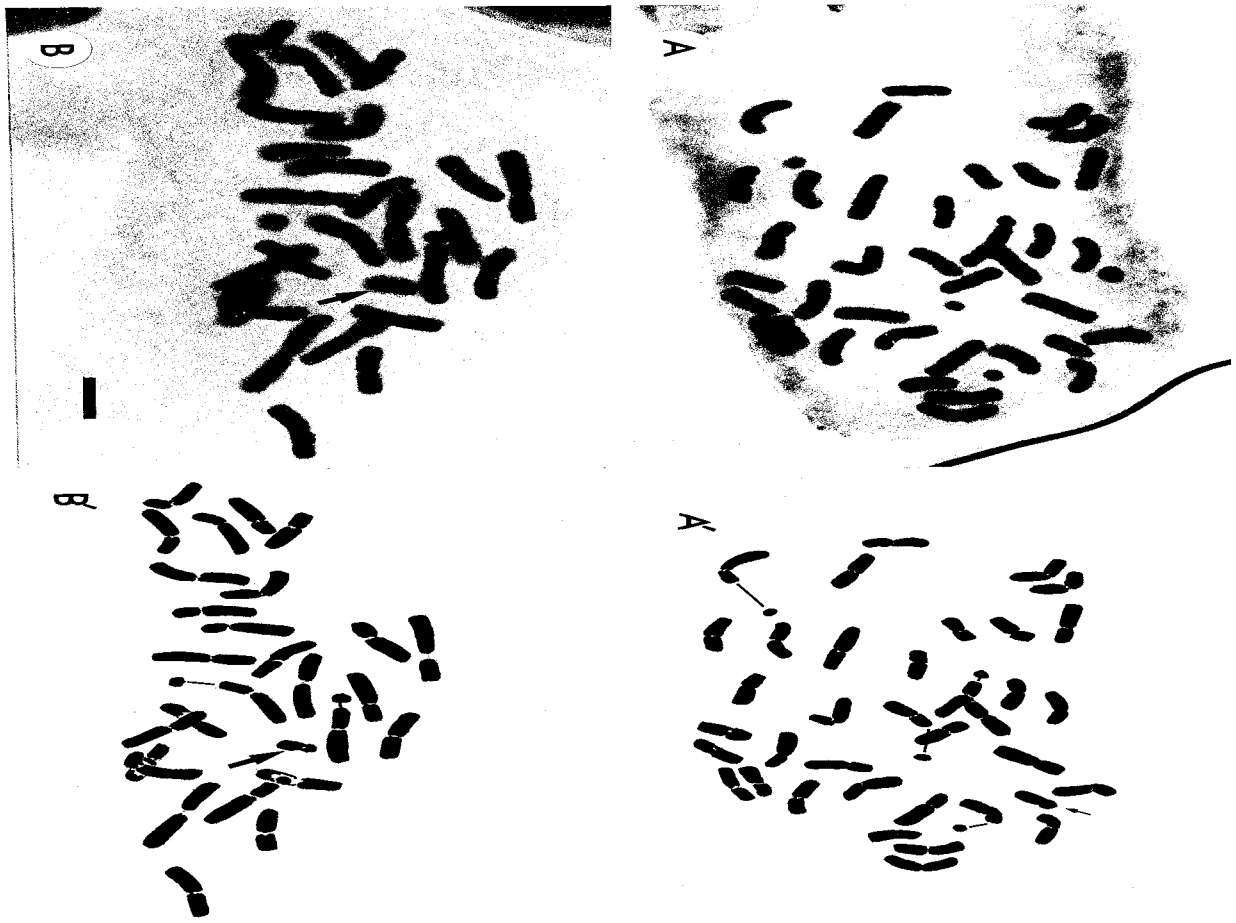

Figure 2. Somatic chromosomes at metaphase of root tip cells. A, A': *Aster ageratoides* (*Soejima 931101-1*, 2*n* = 37). B, B': *A. lasioclada* (*Soejima 931118-4*, 2*n* = 28) with a B-chromosome (arrow). Bar = 5 μm.

the same population. This, in addition to the fact that tetraploid *A. lasioclada* was not found in Taiwan, suggests that triploids may represent spontaneously occurring individuals with one unreduced gamete.

A plant of *A. ageratoides* from population A1 (Table 1) had 37 chromosomes (Figure 2A). Its root tip cells contain mostly median or submedian centromeric chromosomes, four of which satellited. A single subterminal centromeric chromosome was also recognized. Because some other chromosomes were shorter than the subterminal one, it was difficult to judge whether it represents a B-chromosome. All other tetraploids we examined had 36 normal chromosomes and no B-chromosomes were found.

Aster ageratoides is distributed in mainland China, Korea, Taiwan and Japan. Preliminary studies (Soejima, 1992, 1993) revealed that diploid individuals of *A. ageratoides* occurs in China, Korea and Japan. Tetraploids are also known from China and Japan. In Taiwan, we found 69 tetraploid plants and one diploid plant of *A. ageratoides*; the latter, collected in population A14, was sympatric with tetraploids. The diploid is a glabrous plant that resembled the tetraploids, but has smaller leaves and a shorter stem. Polyploidization is usually an irreversible phenomenon in wild plants (Stebbins, 1980). It therefore seems likely that diploid *A. ageratoides* migrated to Taiwan first, and that tetraploids were derived thereafter. In nature, tetraploid plants, being stouter and more competitive, may out-complete diploids with which they co-occur. Some studies, however, suggest that polyploidization can be reversible (Raven and Thompson, 1964; deWet, 1971, 1980). We cannot therefore rule out the possibility that the single diploid count obtained came from a plant that originated from haploidization of a tetraploid. It is also possible, however, that there were multiple dispersal and colonization events, with the diploid and teteraploid strains reaching Taiwan independently. A more thorough inventory with additional cytological study will be required to understand better the cytogeography of the *A. ageratoides* plant complex.

Aster lasioclada is distributed both in Taiwan and in southern mainland China. For lack of chromosome number reports on this species from other parts of its range, however, we are unable to comment on the possible relationship between plants of *Aster lasioclada* across the Taiwan Strait.

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